

# Nanotechnology for Disaster Relief and Development Cooperation



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# **Nanotechnology for Disaster Relief and Development Cooperation**

Volume 17 of the publication series Hessen-Nanotech

# Imprint

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## Nanotechnology for Disaster Relief and Development Cooperation

Volume 17 of the publication series of the Aktionslinie Hessen-Nanotech  
of the Hessian Ministry of Economy, Transport, Urban and Regional Development

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# Preface



left: Dieter Posch

Hessian Minister of Economics, Transport,  
Urban and Regional Development

right: Boris Rhein

Hessian Minister of the Interior and Sports

Nanotechnology is one of the most promising future technologies known to date and is increasingly gaining importance in almost all areas of life. In the next few years, nanotechnology applications will be driving innovation and shaping economic development.

Like in many cases, numerous fundamental developments come from Germany, and often from the state of Hessen. They enable local businesses to overcome technological boundaries and maintain their leading position in international competition.

## **Nanotechnology for Disaster Relief**

Safety technology is an important market with annual growth rates of 7 percent, according to OECD estimates. This market faces a high demand of high-tech products, which the state of Hessen - as a high technology location - can meet.

In the state of Hessen alone, the municipal, voluntary and plant fire brigades account for more than 74,000 fire fighters and more than 8,200 emergency vehicles. Nanotechnology provides opportunities for the fire brigades to equip themselves appropriately for the dangerous work. The protective clothing, for example, must be fire and heat resistant, yet also tear-resistant, dirt repellent and impervious to hazardous substances. However, it should also be breathable and allow mobility. Faced with this multitude of requirements, traditional materials quickly reach their limits. Nanotechnology, however, can provide solutions for these challenges.

## **Innovation potentials in the Development Cooperation sector**

The Nobel Peace Prize winner Professor Muhammad Yunus once said that access to technology can alleviate poverty. From this perspective, nanotechnology provides enormous potential which is subsequently presented in this brochure.

New products and processes can revolutionise international Development Cooperation. The growing market of water is just one example: In order to be able to achieve the Millennium Development Goals, many emerging and almost all developing countries need to take action today.

This is important because as of today we need to secure an adequate supply of drinking water for 1.1 billion people and build sanitation facilities for 2.6 billion people. Numerous nanotechnology-optimised solutions are already available on the market and many more are currently being developed. In addition, the development of sustainable agriculture has huge potential to protect resources while simultaneously providing food security for the world's population. Some examples in this field are new modes of soil enhancements as well as pesticides and fertilisers which are tailored to suit the conditions they will be used in.

Nanotechnology can help us decouple economic growth from resource consumption and pollution. This could facilitate a new form of Development Cooperation that would narrow the gap between emerging and developing countries and developed countries, without putting undue pressures on the environment and the climate.

### Specific benefits for people are crucial

If, in addition to the tough conditions of everyday life, a developing country is also struck by a natural disaster such as the earthquake in Haiti or the floods in Pakistan, its infrastructure – and therefore also its water supply – collapses.

Scientists at the University of Kassel have developed the PAUL water backpack that can filter bacteria and viruses from water using a nano-porous membrane. This example illustrates how well Hessian universities and businesses are cooperating and how their collaboration drives innovation.

A backpack can supply about 200 people permanently with potable water without requiring any electricity, fuel or other supplies. The user manual consists of only four icons – pour water into the opening at the top and draw drinking water from the tap. The state of Hessen has made these water backpacks available for relief efforts in Pakistan and Vietnam. As of today the backpacks are being used in nine countries in Asia, Africa and South America.

The water backpack illustrates how high technology from Hessen – applied in an intelligent and practical manner – can solve today's challenges and help people. And it offers an excellent demonstration of the practical potential of nanotechnology rather than having to refer to abstract data and measurements.

With this brochure we want to give an overview of the potential of nanotechnology for both Disaster Relief and Development Cooperation. By doing so, we want to encourage both users and developers to discuss the potential provided by current applications and future developments. After all, if we do not have access to a platform for exchange, we will not be able to develop new marketable products.



Dieter Posch  
Hessian Minister of Economics,  
Transport, Urban and Regional  
Development



Boris Rhein  
Hessian Minister of the Interior  
and Sports

# Preface



Dr. h. c. Ralf Ackermann  
President,  
State Fire Brigade  
Association Hessen



At first glance, the term “nanotechnology” suggests there is something mystical about it. Often there are misconceptions, and some application areas do not appear very accessible at first sight. Many technological developments require a leap of faith before their relevance is recognised by the public. Achieving this broad acceptance by the public is a point that should be emphasized more when it comes to the prevention of hazards, such as fire protection and Disaster Relief. After all, there is high demand for research and development in this field to ensure the protection of the public in general and of the Emergency Response forces in particular. Emergency Response forces can only deliver high-quality aid if they have the “correct” equipment. This is where innovation is needed! The question of how one could have prevented certain types of hazardous situations is often only brought up once it is too late. It is therefore very important that this issue is taken up in discussions – hopefully resulting in some new approaches. We do not always use the latest technology or design in hazard prevention,

thus an external viewpoint may indeed be very useful to further improve established methods. For example, we are now using fabrics made from aramid fibres in the protective clothing of our emergency forces. These fibres were originally developed for a different purpose. Following severe burns suffered by firemen despite wearing protective clothing, the conventional cotton fabrics were eventually replaced with more robust fabrics made from aramid fibres. Nanotechnology offers the opportunity to further optimise progress of this kind in improving the properties of protective equipment. After all, in the state of Hessen alone, more than 74,000 fire fighters across municipal, voluntary and plant fire brigades provide vital Emergency Response efforts, using more than 8,200 emergency vehicles. This publication uses practical examples to provide starting points for nanotechnology innovations and to enable the application of innovative technologies in the future. I hope that this brochure will present you with many interesting insights into the “world of tomorrow”.



Dr. h. c. Ralf Ackermann

President, State Fire Brigade Association Hessen



Ulf Langemeier  
Head of Missions Division,  
Association for the States of  
Hessen/Rhineland Palatinate /  
Saarland,  
Federal Agency for Technical  
Relief (THW)



The German Federal Agency for Technical Relief (THW) and its Technical Support Divisions and various specialist groups are always faced with a wide range of different hazards on the one hand, and on the other hand to tackle these hazards adequately they require a wide range of specialist vehicles and equipment. In order to maintain the best level of operability for these vehicles and the equipment, continuous development is required. As a result, this means for the THW, that the equipment is renewed on a regular basis, and that alongside these replacements, the organisation has to offer education and training courses to introduce staff to this new equipment. In this context, the use of nanotechnology results first of all in the saving of resources: less space is required and additional equipment may - in part - be dispensed with, "invisible" protection mechanisms which takeover vital functions. The need for maintenance and repair is thus reduced and the durability of equipment

is extended. As a result, resources are freed up and applied in other areas, which was previously impossible. Secondly, nanotechnology leads to an increased level of protection for the THW volunteers, either through passive protection mechanisms built into the equipment or through the development of personal protective equipment. Ultimately, we will be particularly interested in innovations that - unlike those mentioned above - do not require additional training resources. It is obvious that any new product or process that does not lead to a major change in procedures or training, will be easier to implement and will lead to an increased acceptance within the organisation. Nanotechnology offers great opportunities to augment the relative performance levels of our services in unchanged conditions, and to therefore optimise the Emergency Response system as a whole. This publication provides an excellent insight into the world of nanotechnology and to the many opportunities this technology presents. Let us work together on shaping these improvements!

Ulf Langemeier  
Head of Missions Division, Association  
for the States of Hessen/Rhineland  
Palatinate / Saarland,  
Federal Agency for Technical Relief  
(THW)

# Preface

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Stefan Opitz  
Head of Water, Energy,  
Transport  
Deutsche Gesellschaft  
für internationale  
Zusammenarbeit (GIZ)  
GmbH



Development Cooperation pursues the goal of creating a world without poverty, violent conflicts and environmental destruction. Germany contributes substantially to reaching these goals, and it is to this end that we apply our ideas, concepts and technologies.

Nanotechnology, one of the most promising enabling technologies with applications in almost all areas of life, emerges in this field as increasingly important. In the near future nanotechnology based applications will shape not only economic development and act as a main driver for growth and employment. By enabling new products and process innovations, nanotechnologies will also make an enormous contribution to opening up new possibilities in International Development Cooperation and Disaster Relief. To single out but two areas: in the growth market of *water management*, nanotechnologies offer great potential for even more customised and efficient water treatment; exciting opportunities also lie ahead for more efficient and more environmentally friendly means of producing, storing and distributing *energy*.

A very user-focused way of thinking has been at the root of nanotechnology's successes so far. In dealing with the rather special "market" of Development Cooperation, it will be even more important to consider the specific needs of and advantages for users when developing new products.

Costs and possible savings, however, are of no less importance. In addition to new opportunities, nanotechnologies also pose certain risks which we will need to be able to manage. This in turn presents German Development Coordination with a range of new responsibilities.

As Head of the department with the most technical assignment for "Water, Energy, Transport", I oversee the GIZ department with the most technology-focused responsibilities. I very much welcome this project of developing an overview of both the promising applications of nanotechnology and the urgent needs in the areas of International Development Cooperation and Disaster Relief. I am in no doubt that this project will contribute to bringing about positive and effective future developments, which will be of particular benefit to Development Cooperation. Even though a publication of this kind can only ever touch upon this subject due to its sheer scope, I wish to express my joy and satisfaction with this final report. Furthermore, I would like to invite everybody to take part in this exciting dialogue and innovation process, and to impart their knowledge and experience for the development of those much needed products of tomorrow.

I would like to wish every success to the initiative of the Hessian Ministry of Economy, Transport, Urban and Regional Development.

Stefan Opitz  
Head of Water, Energy, Transport  
Deutsche Gesellschaft für internationale  
Zusammenarbeit (GIZ) GmbH

# Reader's Guide

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This publication aims to inform managers and staff working in Emergency Response services and Development Cooperation as well as related institutions about the innovation potential of nanotechnology for their respective fields of work, and to highlight areas of overlap. However, this brochure also addresses companies and industry representatives that are already operating in this area or are interested in tapping in to this market. With their cutting-edge products, they contribute considerably to enabling the implementation of innovations in Disaster Relief and Development Cooperation.

The nanotech solutions and manufacturing companies which are featured in this brochure are representative of a multitude of highly innovative companies and research institutions in the state of Hessen that develop and produce high-quality products based on nano materials or nanotechnology applications yet are equally concerned about their products' safety requirements.

It is impossible to rule out that certain nano materials – similar to certain chemicals – might pose risks to human health and the environment if they are present, for example, in the form of free, unbound particles. In recognition of this challenge, a number of research projects are currently in progress.

The results so far are reassuring, especially since end-users hardly come into contact with nano materials themselves; these often exist in bound form within products and – even during use – do not easily detach from materials. Nevertheless, all manufacturers and processing companies of nano materials are urged to pay special attention to occupational health and safety, as well as environmental and consumer protection, and to act in accordance with the precautionary principle, i.e. to always “play it safe”.

In order to promote transparency and to present research on nanomaterials and their effects on humans and the environment in a way that can be understood by consumers, for example, a knowledge platform has been developed: “DaNa – acquisition, evaluation and public-oriented presentation of society-relevant data and findings relating to nanomaterials” ([www.nanopartikel.info](http://www.nanopartikel.info)).

To facilitate reading and further use of this publication as a workbook and a resource for ideas, we have developed a design-oriented structure. To start with, each chapter is structured as follows:

- The *introduction* outlines a number of basic facts on a certain application area from a user's perspective.
- The so-called *application panorama* (e.g. pandemic prevention) uses one selected example to explain the work of Development Cooperation or Disaster Relief and highlights possible solutions nanotechnology might offer.
- The *challenges* illustrate recurring problems within this application area.
- The *nanolutions* highlight existing nanotechnology-based solutions in response to these challenges.
- In the *NanoFUTURE* section we refer to innovations in science and the private sector which could provide solutions in the future.

The different nano solutions (Nanolutions and NanoFUTURE) are identified by five elements of a symbolic nano world which are introduced on the in the next few pages. This symbolic nano-world has been introduced as a new way of displaying content and is designed to highlight the characteristics or requirements of nanotechnology to users, developers and manufacturers alike. As a result, a developer or manufacturer of surface technologies, for example, can see very quickly whether he might be able to help in a particular application area. A user can access information on those areas where nanotechnology has the potential to deliver improvements. And even the interested layman is able to quickly gain an overview of the various application areas.

We hope that this publication will prove a useful starting point if you are researching particular options for action by offering directions for further research and strategic decisions.

# Introduction

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## Why this brochure?

Nanotechnology is considered one of the key technologies of the 21st Century. In many areas it already plays an important role as an enabling and cross-sectoral technology.

The word "nano" derives from Greek, meaning "dwarf". In a scientific context "nano" describes a unit of measure. One nanometre (abbrev. 1 nm) is one billionth of a meter ( $1/1,000,000,000 \text{ m} = 10^{-9}\text{m}$ ). In comparison, the thickness of one human hair is approximately 40,000 - 100,000 nanometres.

The various applications of nanotechnology are based primarily on the specific technical use of objects and structures in a size range between 1 and 100 nanometres. They are seen less as basic technologies in the classical sense with a clear and distinct definition, but rather describe interdisciplinary and cross-sectoral research approaches. The number of areas in which nanotechnology is applied is steadily increasing due to their unique role as cross-sectional technology. In the last few years, the versatile opportunities of nanotechnology predominantly received recognition in the areas of improved efficiency, resource conservation and more sustainable production mechanisms. However, a number of improved and innovative solutions in the areas of Disaster Relief and Development Cooperation are now also on the market.

Nanotechnology has played a critical role in ensuring that the technological advances of the last few years have not only resulted in more robust materials, but that they have also enabled and sped up the miniaturisation of wireless information systems and sensors.

This development in particular is of great relevance to both the security forces and rescue units in Disaster Relief, as well as for fire brigades and the THW. In the case of the former, nanotechnology enables specific technological improvements and innovations in the key areas of protective equipment, communications and navigation systems. While for the latter, clear benefits exist with regard to the improvement of technical equipment and rescue vehicles.

In the area of Development Cooperation which - like Disaster Relief - is often confronted with demands and scenarios that are hard to predict, nanotechnology based solutions can offer interesting perspectives for medical care, water treatment, agriculture and food, as well as rural infrastructure development in developing countries.

"Access to technology  
can alleviate poverty."

Prof. Muhammad Yunus, Nobel Peace Prize winner

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## Five Nanotechnology Disciplines for Disaster Relief and Development Cooperation

Nanotechnology is an umbrella term for a variety of material-based technologies, disciplines and procedures that have one thing in common: They all focus on structures in a size range of less than 100 nanometres (nm) and whose size changes the functionality of a material or process. Even a well-known material such as gold can change its properties so fundamentally that its new functionality allows it to be used for technical purposes.

As early as in 1959, Richard Feynman introduced the new possibilities arising from the exploration of these tiny dimensions, when he aptly said: "There is plenty of room at the bottom". Nevertheless, nanotechnology is still a relatively new family of technology. Humankind may have first experimented with nano-scaled materials tens of thousands of years ago; and the Romans used "nanotechnology" for the colouring of glass - albeit without knowing it. In some application areas (e.g. car tyres, sun screen lotion), we already possess a few decades of experience.

What is new, however, is the targeted, methodical exploration and development of these technologies on an industrial scale. According to experts, the big future of nanotechnology is yet to come - in positive (low carbon production, cancer therapies) as well as in negative scenarios (possible toxic side effects of free nano particles on humans or the environment). Therefore, it is vital that during the processes of production, application and recycling or disposal, safety mechanisms are in place to prevent any possible release of nano particles.

The question then is why should we engage with a technology that is still in the early stages of widespread industrial use? Because the use of nanotechnology not only promises enormous market potentials, but it is already creating value and facilitating innovation in many industry sectors.

Nanotechnology will play a key role in tackling great challenges posed by an industrial transformation from a carbon-dependent to a low carbon economy. In short: a "green" industrial evolution cannot be realised without nanotechnology. Even the critics acknowledge this fact, despite generally putting more emphasis on the risks of this new technology (e.g. the risk free nano particles might pose to humans).

All in all, scientists, entrepreneurs, politicians as well as governmental and non-governmental organisations are in the very fortunate situation of being able to publish information on the possible risks and opportunities at a technological stage of development. No such debate took place during the introduction of electronic data processing or during the internet revolution. On the other hand, a multitude of nano based products, applications or processes are already available commercially. As the term "nano" is not protected, there are numerous applications on the market - especially in the technical area - that advertise their "nano" characteristics but which do not rely on nanotechnology in any way - neither for functionality nor in production.

The potential of nanotechnology is not yet appropriately known and understood by the general public. In this brochure, we are therefore introduce a system which distinguishes between five basic nano strategies during product development and research known as the "five nano disciplines". It may well be that several disciplines are relevant for the same application; one discipline however, should always be applied: sustainability.

## Intelligent surfaces

Many end users know of nanotechnology because of the so-called lotus-effect. For example, this application makes surfaces less susceptible to pollution, which in turn leads to a reduction in the use of water, energy and detergents. What is less well known is the diverse potential for improving the characteristics of surfaces, in terms of disinfection, conductivity, changing their colour or making them resistant to radiation. In the case of marine paints nano coatings can now prevent the adhesion of barnacles. As a result, the use of highly toxic biocides can be avoided, and up to 30 % may be saved in fuel usage. For aircraft, paints are currently being tested that are able to indicate hairline cracks in the fuselage, wings or tail unit by changing colour, thereby contributing to increased safety.

## Sustainability

The sustainable and responsible use of nanotechnology is the most important discipline of all. The great promises and opportunities that nanotechnology has to offer will only come to fruition if we handle nanotechnology with great care and foresight. The European Commission is proposing a code of conduct, which is due to reach as far as covering research of individual mechanisms - even though at the current stage many researchers still do not know the possible consequences and application areas of their research results. Throughout the life cycle of nanotechnology - i.e. during their production, processing,

## Improved processes

Intelligent surfaces and new materials enable better processes. Nanotechnology offers great potential for finding technological answers to key questions of the 21st Century. More specifically, nanotechnology opens up opportunities in the area of process optimisation and already delivers solutions for a more efficient and effective use of resources and raw materials. In the field of energy and telecommunications, the potential is considered to be high as well.

## New materials

Nanoscale materials or materials that have been treated with nanotechnology can deliver great potential for efficiency. If used in technical systems, they allow an extension of life due to the reduction of the material-specific wear and tear of traditional materials such as metal, plastics and ceramics. In addition, intelligent materials – so-called smart materials – such as hybrid or composite materials enable entirely new products. The breadth of applications in this area is enormous and the potential for development is far from exhausted. Applications range from electrospun wound dressings with in-built drug depots, to skyscrapers built with nano scale building materials, where the benefits of nanotechnology can be

seen in a number of ways, ranging from shell and core of structural work made of ultra high strength concrete to fire resistant thermal glazing.

use and disposal – potential risks and consequences ought to be identified and adequately researched or addressed, in line with the precautionary principle. Aside from safety, a second principle ought to be applied: nanotechnology should be used in those areas where they not only create added value, but where they also make a contribution to sustainable development.

Our Common Future (1987): “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

innovations can already give a taste of the potential of developments yet to come. Great promise is currently found in the areas of analytics and sensor technology as well as in their combination with information and telecommunication technologies, which are also highly relevant for Disaster Relief and Development Cooperation.

## A taste of the future

From mobile phones with built-in food or environmental sensors to multi-functional textiles with flexible displays or new chips for medical diagnosis: the full potential of nano analytics and nano sensor systems may have only been researched in part so far, but many product developments and

# 1. Medicine and Health Protection

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Recently operated patients of the Grameen Eye Care Hospital in Bogra (Bangladesh). Source: :response

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“Risk of infection from viruses and germs is a constant threat – not only for our work in hospitals worldwide, but here in Germany too. If we manage to eliminate or reduce this problem, hundreds of thousands of lives around the world can be saved.”

Dr. Harald Kischlat

General Secretary, Ärzte für die Dritte Welt  
– German Doctors e. V.

“In the case of a health crisis – such as the outbreak of a pandemic – our most urgent task is to curb the spread of the disease. The earlier and more accurately we can start implementing preventative measures, the more successful we will be in combating the threat of highly contagious epidemics.”

Regierungsdirektor Jochen Decher

Head for Fire, Emergency and Rescue Services,  
Giessen Regional Council

## Introduction

In the area of medicine and health protection, innovation potentials have been unlocked by nanotechnology which will lead to significant advances for medicine and health protection not only in everyday life but also in the case of a disaster.

Medical treatment of the general public in the case of an emergency is regulated by state and federal level laws and regulations. The term Disaster Medicine includes all medical interventions which are necessary when dealing with a mass casualty incident involving injured or ill people. Disaster medicine is the link between emergency services and disaster management and is regulated by the respective German federal states' relevant emergency services or disaster management laws. One key challenge in disaster medicine is that medical treatment of

individual with regard to hygiene, precision and diagnostics can only be delivered and maintained to a limited extent. In Development Cooperation, the general lack of medical care is one of the key factors. Developing countries and some emerging countries are characterised by a generally low life expectancy and high rates of infant and child mortality. These are mainly due to a high infection risk, lack of medical staff, lack of drugs and patients' weak immune systems caused by malnutrition.

# 1. Medicine and Health Protection

## “Application Panorama” Pandemic Prevention

	Sequence of events
Background	A passenger plane is forced to land at Frankfurt Airport because of a passenger’s poor health condition. The ill person’s symptoms include a high fever and shortness of breath.
Relief Mission	The passenger has been moved from the airplane to the isolation ward at Frankfurt University Hospital and is in a critical condition. The other passengers have been put into provisional quarantine at Frankfurt Airport. Investigations are taking place, as to which passengers or members of the in-flight crew may have contracted the disease.
Mission Follow-up	Those fellow passengers who are not showing any symptoms of the disease are released into home quarantine. Large-scale disinfection and prevention measures are initiated. All rooms and vehicles that contained or transported patients are being disinfected. Any objects that may have come in to contact with ill persons are also being disinfected.



## Problems

The threat posed by a contagious and infectious disease is often not immediately apparent. For a long time it is unclear what kind of disease it is, who may already be carrying the agent and where it may have spread to. For example, it could be a virus that can spread rapidly from human to human.

Rescue workers might transfer the disease on to healthy individuals or contract the disease themselves.

The conventional scouring and wiping disinfection process has no long-term effect and is insufficient. The contaminated materials and vehicles are difficult to clean. During the contamination process the vehicles and equipment are not available for use.

## Solutions

- Visual access control, possibly supplemented by infrared camera-led body temperature measurement
- In suspicious cases use of mobile analytics or rapid tests
- Reducing the risk of transmission via contaminated objects by using antibacterial / virucidal coating with long-term effect (e.g. on door knobs, toilets, light switches and faucets in busy locations or transport hubs)
- Air conditioning systems that filter or kill viruses and germs reliably

- Mobile analytics: Where is a risk of infection and what kind of infection is it?
- Professional protective equipment that filters or kills viruses reliably
- Basic protective equipment for the general public (masks, gloves)

- Pre-treatment of quarantine areas
- Long-lasting protection achieved by using self-disinfecting surfaces, e.g. for floors and vehicle interiors



# 1. Medicine and Health Protection

## Challenges

### Multidrug-resistant bacteria

Poor hygiene and multi-resistant germs cause many diseases in Germany as well as in developing countries. In many areas, climatic conditions speed up the propagation and spread of germs. Germ-resistant surfaces and antibacterial coatings could help reduce this risk.

### Mobile analytics

In the case of a nuclear, biological or chemical alarm, rescue units must receive information quickly in order to be able to react appropriately. Mobile sensors for the analysis of soils, air and water could help estimate the type and scale of the danger faster and more accurately.

### Disinfection of ambulance vehicles and rescue helicopters

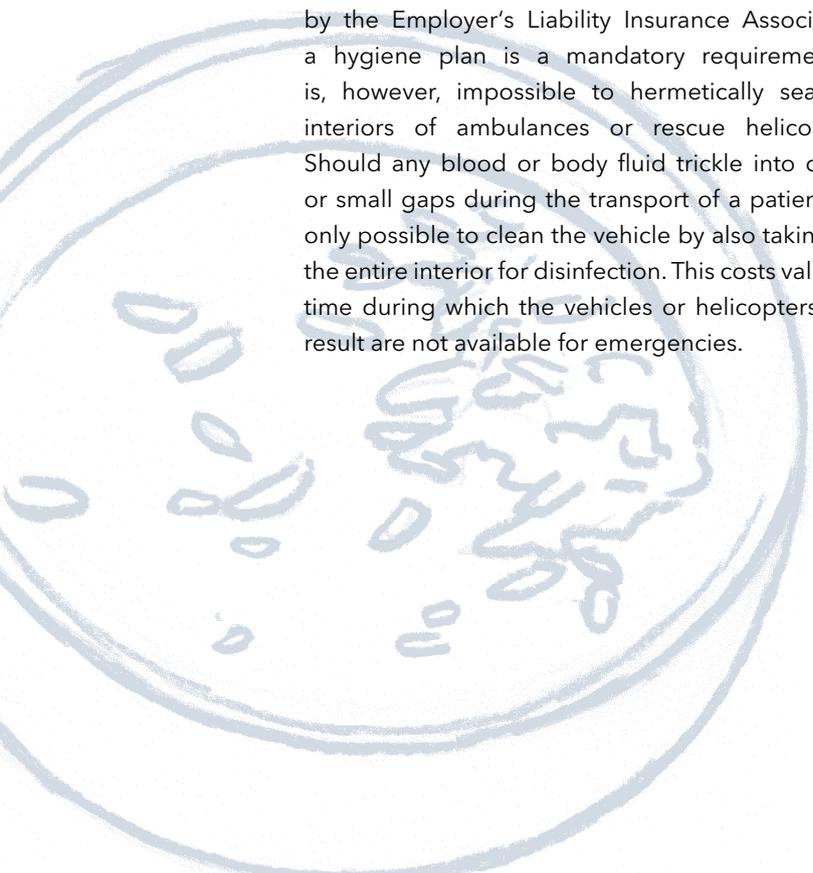
In Germany, according to the Infection Protection Act and the accident prevention regulations as issued by the Employer's Liability Insurance Association, a hygiene plan is a mandatory requirement. It is, however, impossible to hermetically seal the interiors of ambulances or rescue helicopters. Should any blood or body fluid trickle into cracks or small gaps during the transport of a patient it is only possible to clean the vehicle by also taking out the entire interior for disinfection. This costs valuable time during which the vehicles or helicopters as a result are not available for emergencies.

### Long-term efficacy of disinfectants

The mandatory hygiene and disinfection plan prescribes exactly how medical instruments, equipment and vehicles are to be disinfected and cleaned after each use. It also details what types of disinfectants must be used in this process. All vehicles are disinfected on a daily basis. Once a week, they are washed out completely. For this purpose, all equipment is removed from the vehicle to also undergo disinfection. Conventional disinfectants, however, are not sufficiently long-term efficient so that - should some time have lapsed since they were last used - the vehicles and the equipment would need to undergo the entire process again, prior to being used in the next mission.

### Cooling chain and provisions

When transporting and storing heat-sensitive drugs and foodstuffs, a closed cooling chain is vital. Even in the event of a disaster, strict hygiene regulations apply for the preparation and serving of meals. These tasks could be simplified and valuable time could be gained, if surfaces e.g. work surfaces, kitchen equipment or (cooking) dishes were coated specifically.



# Nanolutions: Medicine and Health Protection

## Innovative disinfectants with long-term efficacy



With the help of chemical nanotechnology it is also possible to produce disinfectants without using nano particles. In addition to the traditional disinfection (within 5 minutes), these disinfectants offer a long lasting antiviral effect against viruses such as BVDV, Vaccinia, Hepatitis B and C, HIV, Herpes, Adenoviruses and Noroviruses or Influenza. They also protect against bacteria and fungi.

Possible applications of this new generation of surface disinfectants listed by Association for Applied Hygiene (VAH) include the disinfection of medical equipment as well as of laboratory and treatment surfaces.

Once the disinfectant has evaporated, Bacoban forms a "nano-sponge". Incorporated in this sponge are biocides which - following contamination - diffuse to the surface where they kill bacteria and fungi with a long-term effect of up to 10 days. Studies have shown that compared with conventional disinfectants the cleaning effort is reduced by more than 50 percent whilst simultaneously closing the hygiene gap.

[More information: Adexano Spezialprodukte für Gesundheit, Pflege und Prävention GmbH](#)

The antibacterial effect of nano silver opens up new perspectives of further increasing the sterility of medical instruments in the future. The Nuremberg-based company Bio-Gate is researching opportunities of coating medical instruments (including catheters) with antimicrobial silver, in collaboration with scientists from the Fraunhofer Institute IFAM in Bremen.

[More information: Fraunhofer Institute IFAM](#)

## "Lab-on-a-Chip": Miniature laboratories for use in clinical diagnostics



The chemical laboratory of the future fits on a finger nail. In such a "lab-on-a-chip" the tiniest amounts of biological material can be investigated at low cost. These

tools for the accurate diagnosis of diseases are miniaturised systems that can be operated without any complex manual actions. These micro-labs are equipped with nano-components and are able to overcome problems such as unreliable cooling chains, long storage times and low resources, or poorly qualified staff on site. Correct diagnosis facilitates appropriate treatment and reduces both the use of resources and drug resistance.

Developed by Siemens Corporate Technology, the Quicklab diagnostic device is a diagnostic system for point-of-care applications, and is based on an electrical biochip with nano structured electrodes. Biomolecules such as DNA and proteins can be detected electronically. Compared to optical methods, electrochemical detection has the advantage of being mechanically more robust yet being also suitable for cheap mass production.

[More information: Siemens AG, Corporate Technology](#)

## Antimicrobial wound dressings



Researchers at Philipps-University Marburg (Hessen) have succeeded in developing electrospinning setups that are able to produce ultra-thin synthetic polymer nanofibres with a diameter of just a few nanometres. In this process a number of polymers such as polyamides, polylactide or cellulose derivatives can be spun together. Trials have shown that these fibres made from functional tissue can be applied directly to the wounds. Other studies resulted in a very good coverage of the fibres with cells, so that the use of this application in the treatment of wounds seems a possibility.

[More information: Philipps-University Marburg, Group Prof. Wendorff](#)

# 1. Medicine and Health Protection

## Insecticides in textiles can save lives



The use of nanotechnology components in the production of textiles opens up new possibilities for a more effective protection from mosquitoes especially in malaria areas. ZeroFly is a plastic sheeting with an insecticide-incorporated nano coated surface. This sheeting provides important and reliable protection against insects during the construction of tents and temporary shelters and thus plays an active part in the prevention of diseases that are transmitted by mosquitoes or other insects.

More information: [Vestergaard Frandsen S.A.](#) (Switzerland)

In the fight against malaria, BASF has developed a mosquito net which is coated with the insecticide Fendona and which remains effective in combating mosquitoes for a number of years. With this development, the Interceptor® net meets the request of the World Health Organisation (WHO) for a “long lasting insecticidal net” (LLIN). According to the WHO, these nets represent one of the most efficient means of preventing malaria infections. Basic, untreated mosquito nets that are suspended above sleeping quarters keep the insects at bay, but are not able to prevent further transmission of the disease among unprotected humans. Only by treating the net with an insecticide that is not harmful to humans can the insects be incapacitated with certainty. According to a recent WHO Report\*, global malaria control efforts have resulted in a reduction in the estimated number of deaths from nearly 1 million in 2000 to 781,000 in 2009.

More information: [BASF SE](#)

\* WHO Global Malaria Program, WORLD MALARIA REPORT 2010  
The size of the active ingredient particles on the Interceptor nets exceeds the size of nanoparticles by several decimal orders of magnitude

## Improved cooling chain and intelligent packaging



Nanotechnology enables new processes for improved means of cooling foodstuffs and heat-sensitive drugs. Nanoporous packaging materials reduce the transfer of heat and are setting new standards in ensuring closed cooling chains. A different possibility consists of intelligent food and drug packaging with sensors indicating the product's end of shelf life. Silver coatings can reduce the spreading of germs and other agents.

## Mobile diagnostics



While mobile phone reception works well in developing countries, diagnostic facilities are scarce. U.S. researchers have developed a cell phone microscope that is able to create detailed images and then analyse them for the diagnosis of diseases. On this basis, the non-profit organisation Grameen Phone, a social business founded by Nobel Peace Prize winner Muhammad Yunus, is setting up a medical care system in rural areas of Bangladesh. Mobile diagnostics can thus facilitate the provision of a minimum of medical care even in remote areas. At present nanotechnology is already enabling improved battery and storage technology.

More information: [Grameen Phone Ltd.](#)



## Refrigerator box running on fuel cells



Students at the University of Applied Sciences Wiesbaden in Russelsheim (Hessen) have built a fuel cell-powered refrigerator box for drugs and heat-sensitive goods.

Thus, cooling capacity can be ensured without access to electricity. Nanotechnology is responsible for the high efficiency of the storage technology that supplies the fuel cell, the fuel cell itself, as well as for the insulation materials.

More information: Hochschule RheinMain (University of Applied Sciences)

## Improved bioavailability of drugs



In the field of pharmacology, nanotechnology enables the production of optimised and more effective medicines. The use of nanotechnology components

during the production process increases the bioavailability of poorly soluble drugs and thus also their efficacy and tolerability.

## Innovative sensor technology



Nanotechnology opens up new and more effective Disaster Relief options in contamination measurement, such as the monitoring of large areas after a chemical accident. Sensors equipped with nanotechnological components transmit analytical measurements in real time with improved geographical resolution and at lower cost.

# NanoFUTURE: Medicine and Health Protection

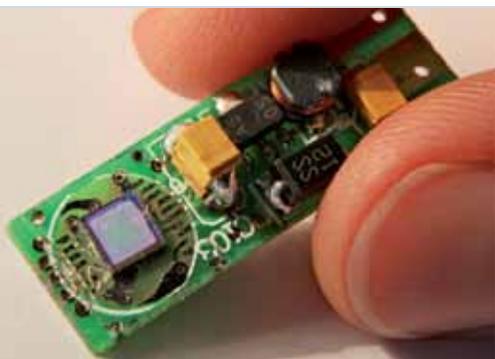
## NanoSpectrometer



The NanoSpectrometer is designed to enable non-invasive measurements of health-related data. Diabetics, for example, would in the future no longer have to prick themselves three times daily to determine their blood sugar levels. The NanoSpectrometer is by far superior to the conventional optical systems. More specifically, in spite of a hundred-fold miniaturisation it generates 100 times more information on the substance to be detected than present-day state of the art technology. This encourages developers to continue working on the implementation of devices for the non-invasive measurement of blood sugar.

This development is the result of a collaboration between the Kassel based Institute run by Prof. Dr. Hillmer (see below) and the start-up company Opsolution NanoPhotonics GmbH (OPN) which was founded for this joint project. In future, this miniaturised NanoSpectrometer can be inserted into mobile phones, wrist watches or other devices that people carry with them at all times. New production processes allow for cost effective mass production. In addition, the combination of nano imprint processes with networked sensors opens up further application areas, for example in the automotive industry. In this area, this system has already been used to detect toxic exhaust gases in a vehicle which were previously not measurable. Based on this information harmful emissions may be reduced and the overall fuel consumption of a vehicle be improved.

More information: Opsolution NanoPhotonics GmbH, Centre for Interdisciplinary Nanostructure Science and Technology (University of Kassel)



## 2. Emergency Response Resources and Pro



Source: André Reichardt - Fotolia.com

# Protective Equipment

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“Nanotechnology offers great potential and opportunities for the development of protective clothing. We must be careful, however, not to compromise

the beneficial features of protective clothing in use today, which is why in-depth research processes are vital.”

Dr. Jan Beringer

Scientific Director, Department of Function and Care Scientific, Hohenstein Institute

## Introduction

In many professions the use of personal protective equipment (e.g. safety shoes, helmets and gloves, or bulletproof vests) is mandatory. This is detailed in the accident prevention regulations and rules of the accident insurance institutions and by state-level legislations of the federal states. The wearing of appropriate personal protective equipment to protect against hazards in fire fighting activities is required in accordance with the applicable regulations (EU directives, occupational safety regulations, accident prevention regulations and fire service regulations).

Protective equipment is designed to protect Emergency Service personnel from adverse or dangerous external impacts which cannot be averted by other means. The protective equipment of some 1.1 million fire fighters in Germany is particularly comprehensive: a fire fighter’s personal minimum protective equipment consists of protective clothing, a fire helmet, fire resistant gloves and protective fire fighting footwear. For particularly hazardous situations, fire fighters also have recourse to special equipment, such as chemical protective suits for incidents involving hazardous materials, heat resistant clothing, and anti-contamination or anti-infection suits.

Protective equipment is procured locally as fire brigades in Germany are managed at municipal level; similar rules apply for Emergency Services. The German Federal Agency for Technical Relief (THW) is an exception because the procurement of professional and protective equipment for its volunteers is managed centrally, at federal level.

The implications for the federal state of Hessen are as follows:

In general, the fire services in each of the 426 Hessian municipalities order their own protective equipment and can choose from different manufacturers. The range of protective equipment on offer varies in scope and design, but the protective qualities of each individual item must comply with the relevant European standards. The purpose of these standards is to establish minimum requirements for protective fire fighting clothing.

At present, the state of Hessen coordinates the test procedures and is in charge of the “Manufacturing and Test Standard for universal fire protection clothing” (HuPF standard). This design guide is based on a risk analysis of fire department operations and sets out how universal protective clothing should be designed and equipped. Compliance with the HuPF standard relieves the buyer of protective clothing of the duty of commissioning a separate risk assessment from their municipality.

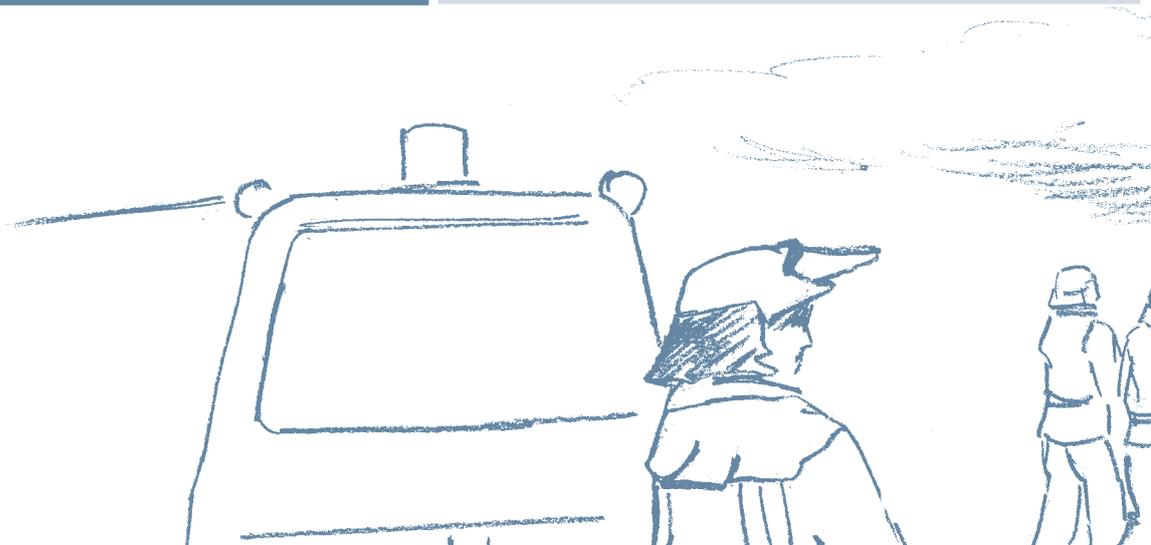
It is important to choose the correct types of personal protective clothing for the most common types of emergencies the fire brigade is confronted with. It has to comply with the normative requirements and must offer certified protection against hazards and be comfortable to wear.

For example, fire protection clothing has to resist the following impacts and influences: mechanical and thermal effects, contamination by combustion by-products, toxic and corrosive substances, hazardous substances, liquid hydrocarbons, dust and sediment.

## 2. Emergency Response Resources and Procurement

### "Application Panorama": House Fire

	Sequence of events
Background	Fire alarm: a house is on fire. The fire is threatening to leap to adjoining buildings. The fire brigade staff are preparing their protective gear, which is stored partly inside the fire station and partly inside fire engine (protective breathing masks). The fire engines make their way to the incident.
Relief Mission	At the incident an initial assessment of the situation takes place and fire commands are issued. In order to rescue individuals, fire fighters need to enter the inner building equipped with safety equipment and breathing masks. Simultaneously, measures are being taken to extinguish the fire. Inside the building, the protective and technical equipment is exposed to high temperatures. The fire results in large volumes of smoke, leaving the interior of the rooms and all equipment blackened. Paramedics need to attend to any injured individuals.
Mission Follow-up	Any equipment (e.g. fire engines, technical equipment, fire hoses, controls, accident assistance equipment, ropes) and protective equipment used during the Emergency Response operation need to be cleaned.



# Protective Equipment

## Problems

Within 10 minutes of the alarm the fire fighters must have reached the incident and initiated effective emergency assistance. Occasionally, considerable time may pass between one Emergency Response operation and the next, resulting in substantial ageing of the equipment. However, during an Emergency Response operation a great amount of stress will generally be placed on the equipment.

At night the location of the incident needs to be illuminated. Extreme heat and large volumes of smoke challenge the working conditions tremendously. In addition, there is increased danger of a flashover, caused by the ignition of combustible gases by oxygen floating in through broken windows.

The protective clothing - consisting of a fire fighting overcoat and trousers - is bulky and often restricts the fire officer's mobility. The clothing is so thickly padded with heat resistant materials that it impairs the fire fighter's natural senses to assess the hazardous situation exactly. In the case of an inside attack, fire fighters are at risk of scalding from evaporating fire water.

The fire brigade is not able to clean all elements of the protective equipment and has to employ specialist companies instead. Any fire hoses that were used have to be cleaned in the fire brigade's special hose wash facilities. Fire engines and any other fire equipment also have to undergo a time-consuming cleaning and maintenance process. Once it has been cleaned, any protective clothing needs to be regularly waterproofed. The susceptibility to wear and ageing of e.g. the fire fighting foam tanks because of corrosion is also problematic.

## Solutions

- Increasing the weather resistance and anti-ageing capabilities of emergency vehicles and protective equipment
- Improving the lubrication of moving parts in engines and power transmission elements even after they have dried out

- Functional, light-weight, personal protective equipment with dirt and water repellent surfaces
- Remote sensors to assess the hazardous situation

- Textiles with high quality water and cleaning-resistant surface protection (water repellent treatment for textiles (against water, chemicals, petrol, and oil))
- Self cleaning and anti-corrosion coatings for fire engines and technical equipment



## 2. Emergency Response Resources and Pro

### Challenges

#### High demands on the quality of protective clothing

During an Emergency Response operation fire fighters are often pushed to their physical limits. In order to keep any additional pressures to a minimum, their protective clothing should therefore be flexible and weigh as less as possible, whilst delivering maximum mechanical protection. At the same time it should provide protection from heat, moisture, cold, oils, chemicals and smoke as well as shield against small objects that might be falling down onto the fire fighter. If the clothing is made from too thick or too rigid materials, they restrict the person's motor and sensory abilities - as a result, hazardous situations may be incorrectly assessed or movement restricted.

#### Changing requirements

Fire brigades in Germany attend to approximately 3.5 million incidents per year, with wide-ranging requirements: a forest fire cannot be compared to a fire in an apartment block, which in turn is completely different from an accident involving hazardous substances. A rescue mission in response to a road accident presents fire fighters with very different challenges than the rescue of flood victims. Fire brigades therefore respond to a large variety of emergency scenarios, and it is impossible to always have in stock or be wearing the relevant type of special protective clothing. For each Emergency Response operation, fire fighters wear, as a minimum, their basic personal protective equipment. Depending on the incident, additional protective equipment will be used for incidents involving fires or accidents.

#### Cleaning and waterproofing of protective clothing

After each Emergency Response operation, dirty or contaminated protective clothing needs to be cleaned. This is time consuming and thus poses certain challenges because the protective clothing cannot be used by fire fighters while it is being cleaned, unless spare sets are in stock at the fire station. In addition, some important qualities are lost with each wash or dry-cleaning process: most items of protective clothing, for example, need to be impregnated with waterproofing substances after every cycle of cleaning in order to maintain their required protective qualities (i.e. preventing the penetration of liquids such as water, petrol, oil). For economical and cost-effectiveness reasons protective clothing needs to be durable and retain its protective qualities for as long as possible.

#### Impairment by restricted vision

Helmet visors, breathing masks and protective glasses and diving goggles are designed to protect the eyes or the face from external impacts and ensure a clear vision for the fire fighters. However, these devices can impair the officer's vision and it is very difficult to restore a clear vision during the course of an emergency operation. Up until now, it has been difficult to combine several properties - such as scratch resistance, anti fog and anti soiling properties, as well as protection from heat and UV rays in one single material.

## Nanolutions: Protective Equipment

The coating or sealing of surfaces is the area in which nanotechnology excels. As such, nanotechnology can be used to refine not only a wide range of textiles but also other relevant materials such as leather, glass, plastics or rubber - all of which are used in the manufacturing of protective clothing.

### Coatings with long-term efficacy



Nano-coated fabric surfaces repel water and dirt. In contrast, conventional materials used for uniforms and protective clothing do not have the extraordinary longevity nano-coated fabrics are characterised by. Due to their hydro and oleophobic properties, pollutants such as greases and oils, lime scale and waste resulting from environmental pollution are less able to adhere to the coated textiles, and can easily be removed from those surfaces without the use of abrasive detergents. As a result, it is no longer necessary to treat protective clothing with waterproofing substances after each cycle of cleaning.

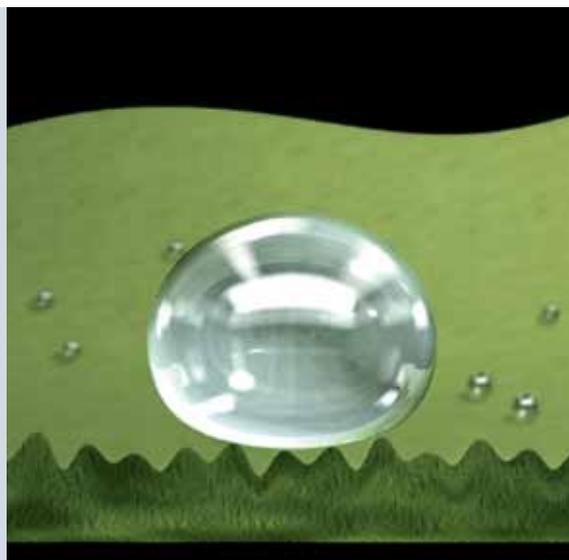
More information: [Schoeller Technologies AG](#)

### Increased stab resistance



Nanosol coatings enable the production of efficient and robust protective systems for Emergency Response personnel. For example, this technology can be used to make police vests not only bulletproof, but also stab resistant. The Deutsche Textil- und Forschungszentrum Nord-West e. V. has developed nanosol based protective equipment for police officers which could add stab resistance properties to conventional bulletproof vests. Special processes ensure that - based on para-aramid fibres - these nanosol enhanced vests provide reliable protection.

More information: [Deutsches Textilforschungszentrum Nord-West e. V.](#), Institute based at University Duisburg-Essen



Coatings with long-term effects,  
Source: Schoeller Technologies

## 2. Emergency Response Resources and Products

### Anti reflective coating for visors, protective goggles and displays



Nanoporous polymer films can be applied onto helmet visors, protective goggles and displays as anti reflective coating, thus making the Emergency Response officer's work easier and safer. Thin polymer films are applied to optical displays, monitors, lenses, ophthalmic lenses and flat glass in order to reduce any potentially disruptive reflections. This result is linked to exploiting the interference of light on the surface of thin layers. Effective antireflection coating of glass should show a refractive index  $n=1.22$ . Contemporary materials with refractive indices  $n<1.3$ , however, are not known to exist. This new nano process now enables the production of thin layers of the required index.

### Anti fog coating for visors, protective goggles and displays



Nanotechnologies enable the production of anti fog coatings for helmet visors, protective goggles and displays. As a result, the coatings not only improve the vision of fire fighters, but also facilitate the cleaning of these elements of protective equipment after each use. The Frankfurt based company De Cie GmbH has developed a "nano anti fog set", which is a perfectly matched combination

of care and sealing systems. Once surfaces have been treated, they are protected long-term against renewed soiling and have much better cleaning properties. Presently, alcohol-based antifogging agents are used, which harm some types of glass surfaces. In addition, they are skin irritants and not completely compliant with environmental standards. To address these challenges, De Cie GmbH has come up with a water-based antifog nanocoating that is environmental friendly. The company has developed a water soluble solution that is solvent-free comprising of organofunctional copolymer nanoparticles. It works on the principle of nanoscale wetting, which helps it to bind to the surface to be coated. As the coating combines with the surface, there is no optical distortion. Due to its adhesive properties, the nanocoating can be applied on to any glass and transparent plastic surface.

More information: [De Cie GmbH](#)

### Innovative filters for breathing masks



In the field of air filtration, a filter's filtration efficiency for gases, particles and substances is the critical factor and key safety element for respiratory equipment of Emergency Response personnel. In this connection, microfibrils made from nanofabric are able to offer a high degree of protection. Prerequisite for the industrial use of nano-fibers in filters is that the nanofibers are stable under the often sensitive conditions in which the filter will be used and that the production of these nanofibers is possible at large scale.



## NanoFUTURE: Protective Equipment

### Conductive textiles for medical monitoring



As part of the programme "Research for Civil Security - protection systems for security and emergency services", the Institute of Textile Chemistry and Chemical Fibers (ITCF) of the German Institutes for Textile and Fiber Research Denkendorf (DITF) - in cooperation with the Fraunhofer Institute for Integrated Circuits (IIS) in Erlangen and industry partners - is developing an integrated sensory protective clothing system (SensProCloth) for fire brigades and disaster management. The systems to be integrated will comprise a recording and communications system with a localisation facility, designed to support emergency operations and initiate aid and rescue measures. In addition, these clothing systems will be equipped with specially adapted sensory technology, electronics and energy supply systems. This will enable them to automatically record and report environmental conditions, such as temperature, position or pollutant exposure. The physiological condition of the wearer will also be monitored in this way, including information on pulse (ECG), respiration rate and the generation of heat.

More information: [Project "SensProCloth", Institut für Textilchemie- und Chemiefasern \(ITCF\) of Deutsche Institute für Textil- und Faserforschung Denkendorf \(DITF\)](#)

### Multifunctional silicone additives



The treatment of fabrics with novel multifunctional products enables the production of innovative protective clothing for fire fighters and Disaster Relief services. This new type of clothing is designed to not only ensure safety, comfort and durability for the wearer, but also features a number of other functionalities, making it resistant to a multitude of emergency scenarios. The chemical company Dow Corning has developed a silicone additive that minimizes the loss of flame retardant performance and also achieves excellent water repellent characteristics.

More information: [Dow Corning GmbH](#)

### Textiles with intelligent luminescent properties



Conventional safety and high-visibility clothing relies on fluorescence and only works in the presence of light. Electroluminescent layers that emit light when subjected to electrical voltage make it possible to produce innovative and intelligent high-visibility clothing that also functions reliably in complete darkness. As part of the programme "Research for Civil Security - protection systems for security and emergency services" - funded by the Federal Ministry of Education and Research - the Institute of Textile Chemistry and Chemical Fibers (ITCF) of the German Institutes for Textile and Fiber Research Denkendorf (DITF), together with the Fraunhofer Institute for Integrated Circuits (IIS) in Erlangen and industry partners - is researching possibilities for the manufacture of intelligently switchable light effects on textiles.

More information: [Project "LUMITEX", Institut für Textilchemie- und Chemiefasern \(ITCF\) of Deutsche Institute für Textil- und Faserforschung Denkendorf \(DITF\)](#)

### Snail provides design principles for new helmets and lacquers



A deep sea snail only a few centimetres in size may help us develop better protective equipment and armours. Its shell is extremely resistant to pressure, shock and tears, due to a very unusual structure. U.S. researchers at the Massachusetts Institute of Technology (MIT) made this discovery when they investigated the reinforced structure of a deep-sea snail (*Crysmallon Squamiferum*). The snail lives on the seabed of the Indian Ocean near hydrothermal vents, where living conditions are extremely harsh. If someone could find a way to copy the design principles of its layered shell, doors would open to developing more stable materials e.g. for protective helmets or protective vests.

More information: [Massachusetts Institute of Technology \(MIT\)](#)

### 3. Emergency Vehicles and Emergency Eq

Pressure from melt water threatens to break a barrage.  
Source: German Federal Agency for Technical Relief (THW)



“Nanotechnology can make a valuable contribution in the field of fire protection and disaster Relief. Particularly when it comes to emergency vehicles and emergency equipment, new materials and surface coatings can make a huge contribution to achieving greater strength and durability. In addition to improved safety for emergency

response personnel, I believe that new surface coatings in particular can potentially offer assistance in often very time-consuming cleaning processes of emergency equipment following each emergency response mission.”

Prof. Dr. Reinhard Ries

Director, Fire Department Frankfurt/Main

## Introduction

The demands placed on emergency vehicles and equipment used in fire protection and disaster relief are high: peaks of extreme pressure alternate with long periods of rest, and a fire engine is generally in use for approximately 25 years. In this time span, the vehicles do not accumulate a very high mileage because in some cases, several days or weeks can pass between emergency response operations or training exercises. However, it is these long periods of rest which are particularly challenging for these vehicles. In an emergency, the emergency equipment has to withstand short but high-intensity periods of pressure e.g. from heat or water, just to then remain unused until the next emergency.

The above scenario not only applies to emergency vehicles but also concerns emergency equipment: it must be ready for use within seconds and has to function with absolute reliability. In the field of International Development Cooperation, the resilience of equipment to ageing and weather is also of particular importance. In many developing countries, vehicles, machinery and technical equipment are subjected to extreme climatic conditions. Spare parts are hard to come by and there is usually not enough money to fund new purchases. An increase in the “life span” of existing equipment is therefore of vital interest.

# 3. Emergency Vehicles and Emergency Eq

## “Application Panorama” Flooding

	Sequence of events
Background	After a period of prolonged heavy rain, the water levels of the rivers are rising far above their usual levels. The dikes are soaking. Mobile flood protection systems are in use. A few days later a second wave of flooding hits the area. First cracks begin to appear in the crests of dikes. Sand bags prevent them from breaking. The dikes are reinforced with sheeting and sand bags. First evacuations are taking place.
Relief Mission	A few days later the first dikes are breaking. As a result, wide-scale evacuation measures are being taken. In addition to the fire services and the Federal Agency for Technical Relief (THW), the Armed Forces, police and a number of civil relief organisations provide assistance. Appropriate quantities of drinking water and food have to be provided. Bloating or damaged oil tanks and sewage from damaged sewers contaminate the surface water. There are widespread power failures. To ensure power supply, emergency power units and generators are being set up.
Mission Follow-up	The continuous rain has stopped and the water levels in the rivers are falling. The cleanup work begins with the pumping of water from flooded buildings and their drainage. Roads and paths, as well as any equipment used, are being cleaned. Damage assessments are carried out. Any dike sections that were destroyed are being repaired.



## Problems

The efforts of relief and rescue forces need to be coordinated. Communication errors compromise the Emergency Response operation. Communication media repeatedly cut out due to a lack in electricity supply or weak batteries.

The tents of emergency shelters are soaking through. Appropriate levels of hygiene must be adhered to (according to hygiene regulations) during the process of supplying flood victims with food. Sanitation and waste disposal present further challenges to the relief forces.

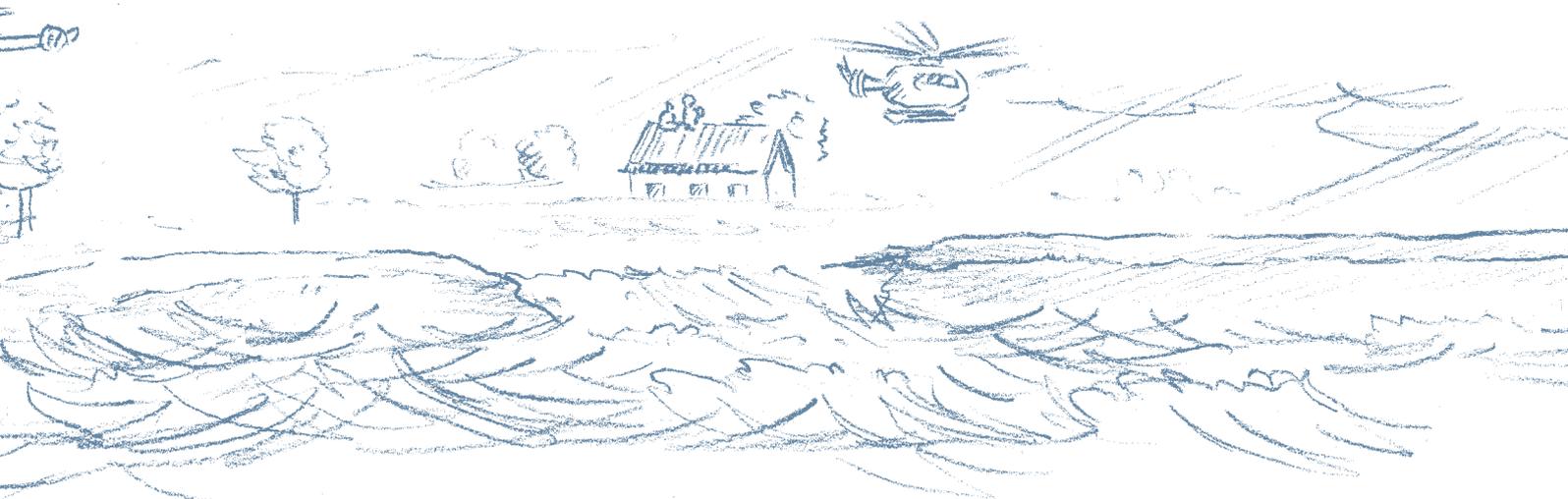
The pollutants in the slurry the floods left behind pose a risk to the health of the flood victims and the environment. In addition, the cleaning of the mobile flood protection systems is complex and time-consuming.

## Solutions

- Fuel cells as energy suppliers
- Increasing the performance of batteries

- Insulate emergency shelters to protect from rain and cold
- Anti-mould protection
- Pre-treatment of emergency shelters against germs
- Antibacterial surface coatings for kitchen equipment and tables
- Apply surface coatings to fire engines, making their tanks suitable for the transport of drinking water
- Mobile water purification systems
- Separation of oil from contaminated water

- Self cleaning surfaces
- Water repellent surface coatings for facades and basement walls



# 3. Emergency Vehicles and Emergency Eq

## Challenges

### Corrosion of fire fighting foam tanks

The types of foam used for fire fighting are aggressive and corrode the walls of foam tanks. In many cases, the tanks will be so corroded after a few years that they can no longer be used, while the actual vehicle is still in good condition.

### Weight and cleaning of fire hoses

The standard fire hoses used by fire departments are made of durable polyester fabric with a rubber coating. This material makes the hoses robust but at the same time increases their own weight considerably, thus making their handling more difficult. In addition, the cleaning of these hoses after each use from the inside and the outside is both complex and time-consuming.

### Environmentally friendly cleaning

After each Emergency Response mission, any equipment used must also be cleaned. This can be very time-consuming, depending on the kind of incident and the type of dirt. Dirt repellent surface coatings could help save time and reduce the use of detergents which would also have environmental benefits.



### Lack of protection against contamination

The decontamination of emergency vehicles and equipment with radioactive, biological or chemical materials is time-consuming and bears risks for cleaning personnel. Surface coatings available to date are not yet able to provide appropriate protection if applied directly onto the equipment or vehicles.

### Damage from ageing and weather effects

Emergency vehicles often remain unused for long periods of time between two emergency operations. UV rays, heat or cold can have an adverse effect on tires, lacquers, engines and on-board electronics, even if the vehicles are inside the fire station. An increased resilience to ageing or weather effects could reduce the amount of time spent on maintenance and replacement. Technological solutions to these problems would be equally beneficial for alleviating the high stresses placed on relief equipment in developing countries.



Rescue: Together for efficient civil protection. Source: THW

### Displays not appropriately adapted for use in emergencies

Protective clothing restricts the fine motor skills of Emergency Response personnel; however, in an emergency electronic devices need to be operated regardless. There is great demand for displays with improved usability which, for example, can also be operated with safety gloves.

## Nanolutions: Emergency Vehicles and Emergency Equipment

### Safety, durability and reduced fuel consumption



Wear and abrasion of engines, gears, bearings and various mobile mechanical systems are caused by internal contacts of the metal surfaces. In general, lubricants are used to generate an oil film, which prevents the direct contact of metal surfaces. If this does not work the grinding parts are affected. REWITEC has succeeded in developing a nano coating technology which is able to protect grinding metal surfaces permanently from wear and abrasion, in the case that a disjunctive lubricating film cannot be built or is only of a temporary nature. REWITEC nano coating offers protection for combustion engines, gear boxes, compressors and all kinds of bearings, even under extreme conditions.

More information: [Rewitec GmbH](#)

### Self-cleaning and anti-corrosive coatings



Torglas, a company based in Hessen, develops special glass and synthetic solutions for gates in manufacturing plants and fire stations. The company is currently developing processes for applying a synthetic UV protection layer to the gates of fire stations, in order to protect fire engines from UV rays and prevent the vehicle colours from fading for as long as possible. Nano coated scratch resistant synthetic windshields are available on the market already.

More information: [Torglas GmbH](#)

In the field of surface coatings, a number of nanotechnology based solutions are already commercially available. There is great potential for a wide range of features across a large variety of application areas. New processes based on nanostructures have also been developed in the areas of anti-corrosive coatings and vehicle lacquers, featuring properties that reduce staining from pollutants and facilitate cleaning processes. These new properties are often advertised as "non-stick", "easy-to-clean", "lotus effect" or "self cleaning". Ceramic nanoparticles in coatings can considerably increase the service life of technical equipment and emergency vehicles. Whilst they may not be able to completely prevent the adhesion of dirt, they do make surfaces much easier to clean, thus improving their anti static properties considerably.

Nanoparticles such as silicon dioxide can be used to make automotive lacquer coatings more scratch resistant and dirt repellent. These coatings protect underlying layers and slow down abrasion, and as a result slow down progressive wear and tear in general. With the use of special nano lacquers extremely thin layers of lacquer can now also be processed, with the same or better properties. For example, zirconium oxide nanoparticles are used in nano coatings to protect surfaces from corrosion. Toxic compounds or heavy metals which were traditionally used in corrosion protection are thus becoming obsolete.



Nano coating technology protects grinding metal surfaces permanently from wear and abrasion. Source: REWITEC GmbH

Nanomaterials have been used in the production of car tires for a long time. The use of new types of nanoscale Carbon Black leads to a reduction of the rolling resistance and as a result to a longer life span of the tires as well as reduced fuel consumption. The addition of nanoscale and surface-modified hydrophilic silica (silica) in combination with silanes in the tread resulted in an improvement in wet skid behaviour, particularly in winter tires. In addition, the Silica Network minimizes heat build-up in tires, thus reducing the ageing process in the polymer structure and ensuring a longer life-span of the tires.

# 3. Emergency Vehicles

## Applications for Nanofiber-Coated Media



Nanofibers can improve the performance of filter media's ability to remove particulates from air streams. This improvement can be seen in air intake streams of vehicles, computer disk drive ventilation and high-efficiency filtration. In the case of cabin air filters, removing the particulate matter improves the comfort and health of the passengers. Nanofibers offer enhanced filtration performance in both mobile and stationary engines and industrial filtration applications.

With respect to engines, gas turbines and combustion furnaces, it is important to remove particulate material from the air stream supply that can cause substantial damage to the internal components. In other instances, production gases or off gases from combustion engines and industrial processes may contain damaging particulate material. The removal of this particulate is desirable to protect downstream equipment and minimize pollution discharge to the environment.

More information: [Hollingsworth & Vose GmbH](#)

## NanoFUTURE: Emergency Vehicles and Emergency Equipment

### Appropriately adapted displays and equipment for use in emergencies



Another area in which nanotechnologies prove their potential for enabling innovative developments is Organic Light Emitting Diodes (OLEDs). OLED describes components covered with thin layers of organic semi-conductor materials which are able to emit light in response to the passage of an electric current (electroluminescence). In future, these layers are intended to be increasingly be used in flat panel displays and flexible displays. Compared to LCD technology the benefits of this new technology are manifold. OLEDs emit light themselves, do not require any backlight and are able to achieve very high contrast ratios. Further advantages include their low power consumption and fast response

time when playing movies. While LCDs have to be permanently back-lit and relies on liquid crystals to switch individual pixels on and off, OLEDs emit coloured light with extremely high switching speed only where it is needed.

The manufacturing process of OLED flat panel displays is fundamentally different from that of liquid crystal displays (LCD). The use of flexible substrates or films and the unnecessary backlight open up future possibilities of roll-up displays being fabricated, or of embedding displays in clothing. Because of their high energy efficiency, OLEDs are well suited for use in small portable systems such as smart phones and MP3 music or video players.

Merck KGaA is one of the leading companies in the development and production of OLED materials.

More information: [Merck KGaA](#)



Organic Light Emitting Polymers by Merck  
Source: Merck

A new generation of touch pads will be able to significantly facilitate the work of emergency response personnel because they offer more user friendly surfaces and improved operability. The special feature of Microsoft's Nano-Touch-Display is that it can be operated from the back. This new technology is designed to improve the operability of smaller touch screens. One benefit, for example, is that the user no longer needs to place his or her fingers on the display in order to operate it, but that their fingers can stay at the back of the device. As a result, the display on the front is fully visible.

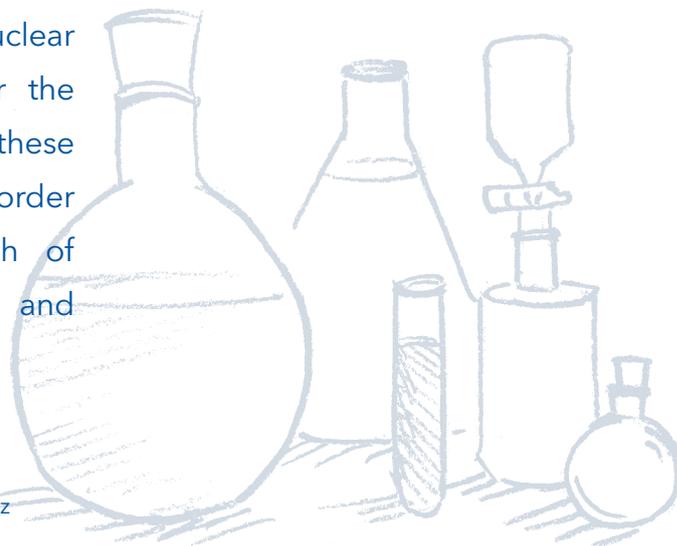
## 4. Decontamination

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“In the case of a dangerous release of chemical, biological or nuclear substances, efficient facilities for the analysis and decontamination of these hazardous substances are vital in order to effectively ensure the health of Emergency Response personnel and civilians.”

Regierungsdirektor Jochen Decher

Dezernatsleiter Brandschutz, Katastrophenschutz und Rettungsdienst, Giessen Regional Council



### Introduction

In general, decontamination describes the treatment of pollution caused by hazardous radioactive, biological or chemical substances. General decontamination measures carried out by fire fighters include the primary cleaning of Emergency Response staff and their protective clothing, as well as the cleaning of civilians, equipment and vehicles. In addition, the term decontamination includes the cleaning of polluted objects and areas with the aim of reducing existing contamination to an acceptable level.

Emergency Response operations involving dangers posed by radioactive, biological or chemical substances therefore place very particular demands on fire and disaster management personnel - not only during the acute phase of deployment but also in the aftermath: the first step is to contain the contamination as well as possible and to clean contaminated individuals without further spreading the contamination. At a later stage, a huge yet often neglected challenge is the disposal of polluted, contaminated (fire fighting) water which must not enter the sewage system or ground water unfiltered.

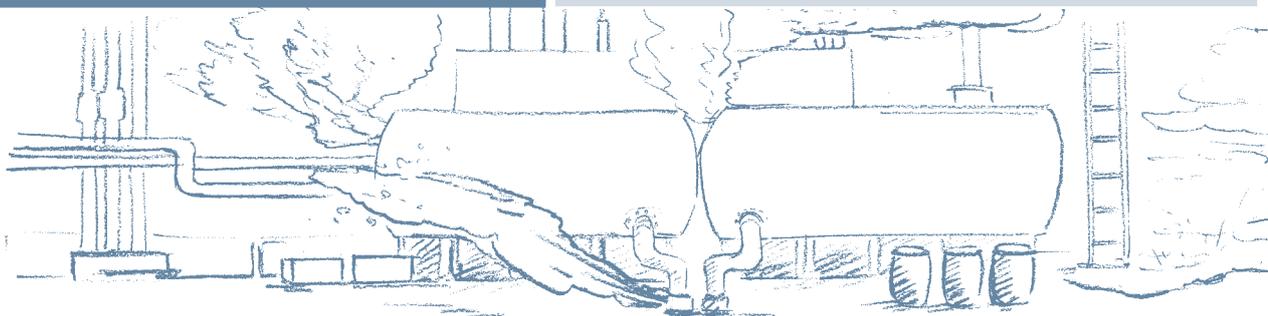


Source: Berliner Feuerwehr (Berlin Fire Brigade)

## 4. Decontamination

### “Application Panorama” Accident at a Chemical Plant

	Sequence of events
Background	During the decanting process in a chemical plant two chemicals accidentally mix. The two chemicals react violently and form a huge cloud of corrosive chlorine gas. The substance irritates the skin and respiratory tract and at the worst can lead to a pulmonary oedema. As no wind is blowing, the cloud only disperses very slowly.
Relief Mission	The plant fire brigade responds to the alarm, the municipal fire brigade is called in for support, and the police and ambulance service are called for assistance. Any skin contact with the toxic substance or its inhalation must be avoided at all cost. The emergency forces directly deployed to the incident site are wearing chemical protection suits and heavy duty respiratory equipment. The area surrounding the scene of the incident is cordoned off. The fire fighters try to bind the toxic cloud in the air with a water spray jet. A mobile decontamination system is being set up and the injured are cleaned of the chemical. Ambulances then take the injured to nearby hospitals. In order to classify the risk constant air measurements are being taken. Are local residents at risk? Warning messages through loudspeakers and on the radio issue advice to keep doors and windows closed.
Mission Follow-up	The operation area and its surroundings need to be cleaned in an environmentally responsible way. Potential long-term consequences and repercussions need to be recognised and be prevented by initiating appropriate measures.



## Problems

For a long time, it is uncertain which type of gas or gas mixture has escaped.

This large scale operation requires a high degree of coordination among the Emergency Response units. Because of the high physical and mental stress of their work no one wearing a protective suit is allowed to work for more than 20 - 25 minutes at a time. An additional restrictive factor is the limited resistance of their protective suits to the various chemicals. The chemical protection suits leave very little freedom of movement, and the visors of both the respiratory equipment and the chemical protection suits get steamed up. Thereby, working in heavy equipment is hindered considerably. In order to avoid endangering their own health, doctors are only able to treat the injured once these have undergone decontamination procedures.

Any emergency vehicles and equipment that have been contaminated externally by the chemicals need to be cleaned, and any contaminated water be disposed of appropriately. The decontamination of protective clothing presents the Emergency Response units with an additional problem.

Conventional methods for cleaning vehicle interiors are not sufficient. During the decontamination process, both the emergency equipment and protective clothing are not available for emergencies.

In order to be able to appropriately dispose of the water which was used to bind the gas cloud it would need to be collected. Mobile facilities for this purpose are available.

## Solutions

- Quicker mobile B and C analysis to provide information on the type of hazard

- Mobile equipment for air and water analytics
- Protective clothing that provides reliable protection (against radiation, germs, viruses) yet does not restrict motor and sensory abilities
- Establish black areas and white areas, pre-treatment of treatment rooms

- Surface coatings offering improved protection from contamination
- Removing chemical pollutants during the waste water disposal process



# 4. Decontamination

## Challenges

### Harmful substances in the air

In many (developing) countries, large amounts of pollutants are released into the air through unfiltered emissions from industry, road traffic or waste incineration. Low-cost filtration systems and well managed waste-to-energy facilities may help reduce pollution related health risks for the general public.

### Disposal of contaminated fire water and soil

Especially in the case of accidents involving hazardous substances, contaminated fire water and soil may accumulate in large quantities. When dealing with a major fire the fire brigade often uses several thousands of cubic metres of water. The contaminated water flows partially unfiltered into the sewage systems or seeps into the ground. An environmentally sound way of disposing or cleaning the water is currently only possible with great effort and only where appropriate fire water retention systems are installed, for example in chemical plants.

### Nuclear, biological or chemical (NBC) contamination

During Emergency Response operations involving hazardous substances any injured or contaminated persons are decontaminated prior to receiving medical treatment. Any protective clothes, emergency vehicles and emergency equipment used during the operation have to be cleaned. In many cases, emergency personnel only have facilities on site that allow for preliminary cleaning in order to reduce the levels of contamination to an acceptable level.

### Analysis of nuclear, biological or chemical (NBC) contamination

Threats from radioactive, biological or chemical agents are often imperceptible with human senses. Analytical methods exist which are able to accurately determine and indicate the nature and extent of an NBC contamination, or whether a decontamination programme was successful and comprehensive.

### Decontamination (black and white areas)

During a contamination programme, the fire brigade is responsible for the preliminary cleaning of Emergency Response personnel and their protective clothing, as well as of other people and any equipment used. Any further decontamination measures fall under the responsibility of the relevant technical authorities. In the case of an emergency the fire brigade will generally set up a decontamination area and divide it into a "black area" (dirty side) and a "white area" (clean side), with the aim of preventing further contamination from spreading. Wherever possible and medically necessary, contaminated persons are to be decontaminated and disinfected on site. During emergency response operations involving radioactive substances contamination controls must be carried out. Wherever possible, contaminated emergency equipment should undergo preliminary cleaning on site. In addition, early decontamination should help prevent a possible reaction of the equipment material with the hazardous substance in question.



Emergency response operations involving dangers posed by chemical substances place very particular demands on fire and disaster management personnel. Source: Berliner Feuerwehr (Berlin Fire Brigade)

# Nanolutions: Decontamination

## Decontamination of fire water and soil



Golder Associates have developed a process by which contaminated ground water can be remediated faster and cheaper with the help of iron nanoparticles. Zero-valent, i.e. non-oxidized metallic iron is introduced into the soil in the form of tiny particles in an aqueous suspension. Because of its nanoscale, the iron has an enormous total surface area - a typical nano effect - making it much more reactive than coarser-grained varieties. In order to remediate soil, the environmentally friendly iron oxide nanoparticles can be introduced into the ground as a suspension in water. Nano-structured iron in the form of agglomerated nanoparticles can be used for pollutant removal efficiently. Chlorinated hydrocarbons are chemically "reduced" by the nano iron. The iron itself is oxidized in the process - it simply dissolves as rust, and as a result does not further pollute the water. Chromium and nickel, however, are fixed by the nano iron, so that their solubility in groundwater is reduced dramatically.

More information: [Golder Associates GmbH](#)

For fire fighting, foam offers one big advantage over water: it has an immediate effect and the flames are smothered instantly. One of the drawbacks, however, is that the disposal of fire fighting foam or its components can be problematic. In order for the foam to be broken down quickly in the sewage treatment plant, a precipitating agent was developed based on nanotechnology. The "Nanofloc" agent consists of metal oxide nanoparticles which are coupled to specific organic charge carriers. At the treatment plant these particles set the desired

chemical reactions in motion, thus enabling the discharge values to quickly return to normal.

More information: [VTA Deutschland GmbH](#)



Nanofloc - a new dimension of sewage treatment technology. Source: VTA Deutschland GmbH

## Improved sensor technology



Nanotechnology enables the development of a variety of new sensors, which can offer efficient solutions for the continuous and timely monitoring of many environmental indicators. Chemical and biosensors can be used to detect pollutants in water, soil and air. Nano-based sensors are characterised by high sensitivity, selectivity and real-time capability. The Technical University Darmstadt (Hessen) is a leader in the research field of environmental diagnostics with micro-systems, and particularly in the areas of fibre-optical, electrochemical and voltammetric gas sensor technology.

More information: [Technical University Darmstadt](#)

# NanoFUTURE: Decontamination

## Biosensors



Lab-on-a-chip technology enables quick and inexpensive sample preparation on site. Currently in development are artificial noses, i.e. an array of different sensors which signals are analysed using pattern recognition

processes. Biological and chemical sensors equipped with nano-based ICT (and the appropriate nano-based electricity supply) can be combined to form wireless sensor networks, thus enabling large-scale environmental monitoring.

## 5. Water

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Polluted waters (Bangladesh). The consumption of this water can be fatal in the long term. Source: :response

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“One of the great challenges of the coming decades will be to supply the world’s population with drinking water and industrial water, and coupled to this the challenge of reprocessing and reusing water in cycles. Waters are not only polluted by toxic compounds and pathogenic microorganisms, but increasingly also by residues of endocrine disrupting substances. At the same time the proliferation of diversifying nanoparticles into the

environment creates new challenges for the monitoring and cleaning of water. In this field, nanotechnology provides potential for resolving these problems with a variety of applications ranging from new materials for the purification of water and using sensors for the selective monitoring of water quality, to the substitution of water-polluting processes with innovative methods.”

Stefan Opitz

Head of Water, Energy, Transport  
Deutsche Gesellschaft für internationale  
Zusammenarbeit (GIZ) GmbH

## Introduction

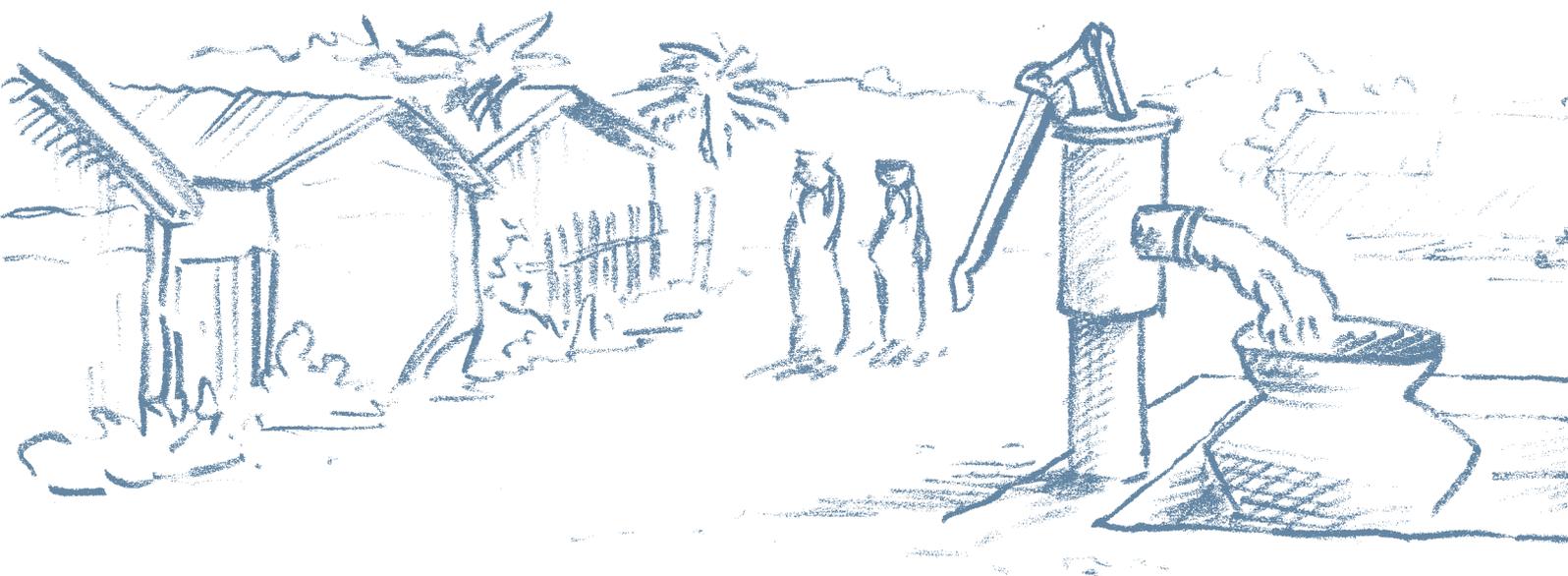
In the field of water purification, nanotechnology can provide valuable services which will be of particular benefit to Development Cooperation and Disaster Relief. Nanotechnology applications are already available on the market in the form of cleaning mechanisms, such as water treatment, wastewater treatment or groundwater remediation. The issues of safe water supply and drinking water are central to the cooperation work with developing countries. The image of smiling children by a gushing water tap is literally synonymous to a successful project. In fact, in many areas of the world, the provision of safe drinking water often provides the foundations for a decent life. The issue of wastewater disposal, however, is often neglected in this context, despite its huge relevance - in the rural areas of Africa as much as in the sprawling megacities of Asia or Latin America.

The main problem is that the cost for the disposal and cleaning of polluted water is about three times higher than the cost of water supply. The consequences of a lack of waste disposal systems are obvious: in addition to serious environmental pollution there is an increased risk of infections and diseases. However, the issue of water is not only relevant in Development Cooperation. Even in countries with functioning water supply and sanitation systems such as Germany, the systems remain susceptible to failure. The risk of terrorist attacks on the drinking water supply - with possibly fatal consequences - is at least conceivable. In many disaster management plans, the treatment of drinking water has so far been neglected. Experience shows, however, that in the case of emergency, the transport and mobile treatment of drinking water become issues of vital importance requiring fast resolution.

## 5. Water

### “Application Panorama” Technical Cooperation in Bangladesh

	Sequence of events
Background	The soil in Bangladesh contains arsenic. The chemical enters the drinking water supply via wells. Surface water does exist but is often heavily polluted.
Relief Mission	During the months of April and May as well as in September and October, Bangladesh is regularly hit by cyclones causing devastating floods. Due to the pressure of the flood, the water in the numerous rivers accumulates and floods large parts of the low-lying country.
Mission Follow-up	After the floods, any water supplies that are intact and not contaminated with arsenic need to be cleaned of salt, dirt and mud. The development of more efficient rain water collection systems - which in many areas could meet the drinking water needs of the population due to the high levels of precipitation - must be extended further.



## Problems

People suffer from gradual arsenic poisoning, which only becomes visible years later. Water taken from the "safe" well is stored in canisters and often exposed to direct heat for several days. Water containers quickly become contaminated by mould spores. There is no effective wastewater treatment system. Therefore, wastewater remains untreated and adds further pollution to the already heavily polluted rivers and groundwater.

The floods result in additional pressures on the surface waters. Emergency supplies of drinking water and mobile water treatment facilities are often greatly needed in areas hit worst by flooding but they usually lack appropriate equipment and public infrastructure. This in turn makes the transport of clean drinking water more difficult.

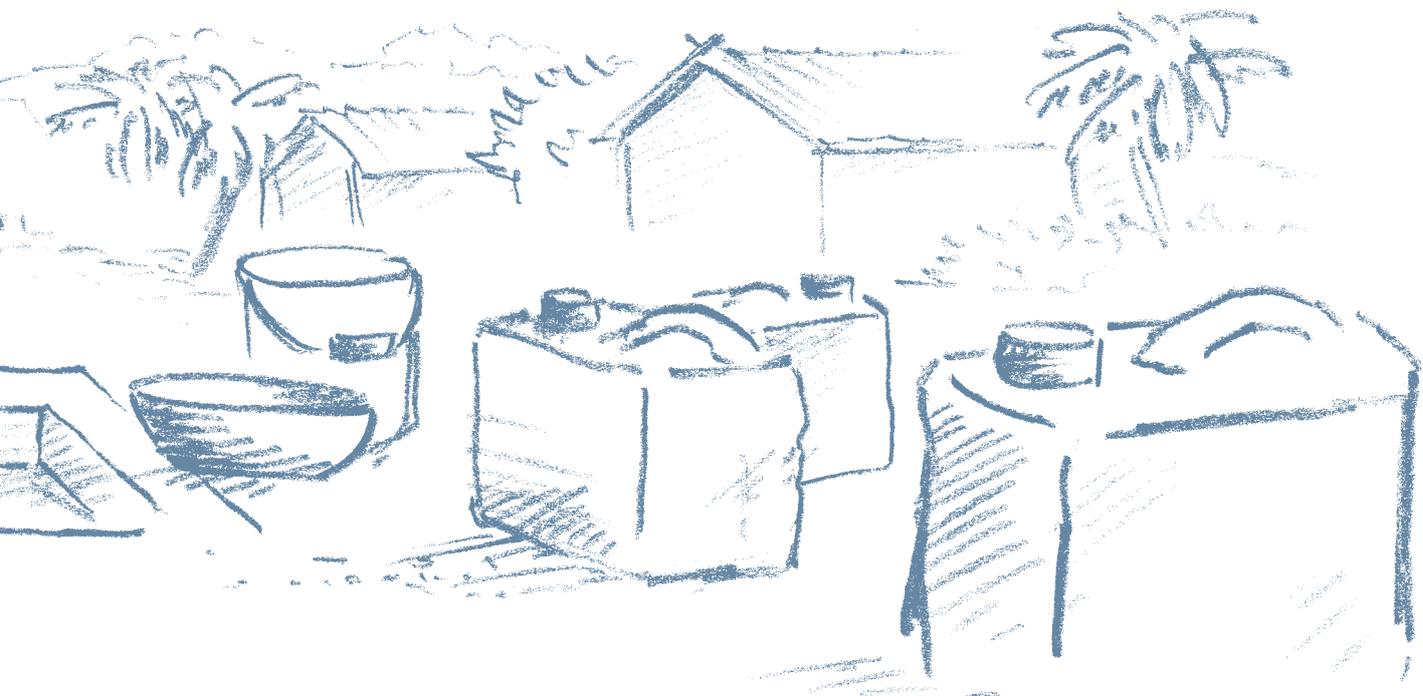
Bangladesh does not possess the necessary financial resources for large scale infrastructure projects, particularly in rural areas. Efforts to raise awareness among the public on the danger of arsenic in drinking water must be stepped up, and more work needs to be done in establishing mobile filtration systems in rural areas.

## Solutions

- Detection of arsenic
- Surface coatings to prevent bacterial contamination in water containers

- Mobile water treatment facilities for polluted surface water
- Arsenic filters in the form of small affordable systems
- Light, off-road tank vehicles

- Use of porous iron hydroxide in wells contaminated by arsenic
- Portable filters and affordable systems for the filtration of surface water



# 5. Water

## Challenges

### Bacterial contamination of water containers and jerry cans

In Monze, a small city in Zambia, Violet Moomba runs a water kiosk. Her shop is connected to the central municipal water supply; customers draw the drinking water directly from the tap and pay per litre. In order to prevent infections even more effectively, it is important to also permanently protect containers and bottles from bacterial contamination. These containers are used to transport the water and are often stored in warm conditions. With regards to the practicalities of water transport and storage, lighter and UV-resistant canisters would be desirable.

### Wastewater disposal and treatment

In many developing and emerging countries, too little importance is attached to the issue of wastewater disposal. Affordable and efficient methods are needed to solve this wastewater problem. Small mobile units which can filter chemical and biological impurities are needed just as much as large facilities.

### Arsenic in drinking water

Arsenic in drinking water is endangering the health of millions of people in both developed and developing countries. Existing methods use nanotechnology to remove the dangerous chemical element from drinking water. In poorer countries, many established processes quickly reach their limits because they are too expensive and require too much maintenance.

### Transport of drinking water

Should the water supply break down, the institutional responsibility for the transport of drinking water, for example to elevated tanks or homes falls to organisations such as the fire brigade and the German Federal Agency for Technical Relief. As specified by the German drinking water ordinance, the tanks of the relevant fire engines must be disinfected prior to transporting water, so as to eliminate any health risks from microorganisms.

## Nanolutions: Water

### Filtration of drinking water



Membranes form the core component for the filtration of contaminated water which can be used again once it has been treated.

This component is highly relevant in relation to disaster prevention and development coordination. The Wiesbaden based company Microdyn-Nadir GmbH has extensive expertise in the field of micro- ultra- and nanofiltration and offers solutions for a wide range of industries and problems.

More information: [Microdyn-Nadir GmbH](#)



Microdyn Nadir\_BIO-CEL® Modul BC400.  
Source: Microdyn-Nadir GmbH



Even very muddy water can be consumed through the "LifeStraw". Source: Vestergaard Frandsen S.A. (Switzerland)

The portable filtration stick "LifeStraw" filters viruses and bacteria out of polluted surface water with the help of nanoscale filter materials and because of its handy size helps people in developing countries help themselves. The key feature is a 30 cm long plastic casing which contains filter membranes made from Ultrason E. These membranes can purify around 700 litres (1 year at 2l per day) before needing to be replaced. "LifeStrawFamily" is a water filtration device designed to purify at least 18,000 litres of water. Neither "LifeStraw" nor "LifeStrawFamily" require energy supply in the form of electricity or batteries for the filtration process. With this filtration technology even very muddy water can be purified and at least 99.9% of bacteria, viruses and parasites be removed. The user-friendly design allows the filter components and the entire device to be cleaned easily.

More information: [Vestergaard Frandsen S.A.](#) (Switzerland)

products is Bayoxide E 33 from Lanxess. Depending on the arsenic content of the water, this product will be active for 1-3 years and will then need to be replaced or renewed. The technology is also suitable for domestic use, but at present it is primarily used in large treatment plants. In a village in Bangladesh, south of the capital Dhaka, LANXESS - in collaboration with students from Cottbus University - launched the project "Water purification in Bangladesh" in 2006. The specially developed filter systems are easy to use, do not require maintenance and purify water quickly and cheaply.

More information: [Lanxess Deutschland GmbH](#)

## Desalination



The alternative to distillation is reverse osmosis. During this process, sea water is forced through a semi-permeable membrane under high pressure.

The membrane - a kind of plastic film consisting of millions of tiny nanotubes - acts as an ultra-fine coffee filter and only allows certain atoms and molecules to pass through it. Salt, bacteria, viruses, calcium carbonate and toxins, all of which are much larger than a water molecule, are kept out.

More information: [Siemens AG, Water Technologies](#)

## Removal of arsenic from drinking water



For groundwater remediation and the removal of heavy metals from drinking water and wastewater, iron hydroxides with a high number of pores are already in use. For example, fine-textured iron oxide hydroxide for the removal of arsenic compounds is available commercially. One of the typically available

## NanoFUTURE: Water

### Mobile drinking water treatment



Water is mankind's most important food. Today, more than 800 million people do not have sustainable access to safe drinking water.

When natural disasters happen, water is one of the most urgent needed aids. Mobile waterworks are dispatched to help large numbers of people. However, in remote areas, where small groups of people live, there is no specific help. In order to overcome this lack, the Department of Sanitary and Environmental Engineering (DESEE) of the University of Kassel developed a small unit specifically designed to bring relief to small groups, villages etc. by treating pathogenic contaminated surface or well water and provide potable water as a first aid. The unit does not need energy, chemicals or skilled personnel to be operated. It is absolutely robust without any moving parts, transportable by one person and can be airdropped, it does not need any setup time and can be operated even by illiterates, as the whole "operation manual" consists of just four simple pictograms. Until today there are nearly 330 water backpacks in operation worldwide.

More information: [University of Kassel, Department of Sanitary and Environmental Engineering](#)

# 5. Water

“Water backpack”: Source: University of Kassel, Department of Sanitary and Environmental Engineering



Emergency Water Filter.  
Source: Cleanwater Systems GmbH



## Mobile first aid in emergencies

The Marburg based company Cleanwater Systems GmbH develops water filters for deployment in regions hit by crises or emergencies as well as for civilian domestic use to eliminate bacterial contamination. After an earth quake, floods etc. these filters offer portable and completely self-sufficient water filters for the crisis region in the form of an aluminium water bottle. The filters are able to filter out 99.9999 percent of bacteria and other pollutants, benefiting from filter materials made of synthetic nanofibres or nano-ceramics, which were developed in cooperation with various universities. The process requires neither Antimicrobial chemicals nor a supply of energy. Mass production has already started, and the filtration results are currently being analysed by the Max-Planck-Institute for Terrestrial Microbiology for certification according to DIN 58355-3 and ASTM international D3863.

The emergency water filter itself pursues the goal of closing the so-called missing link in Disaster Relief, i.e. providing means of immediately accessible self-sufficient water supply for people who are suffering because of an event which has contaminated all forms of water supply and bodies of water.

Even today, with the most modern Disaster Relief mechanisms and the best possible response times, it is not possible to deploy emergency measures in the crisis areas within the first three days, thus resulting in high mortality rates. The Emergency Water Filter closes this gap.

Managing Director Stefan Oberhansel was awarded the 2010 Founders Award in the category "Innovative business idea".

For domestic use and based on the same technology the company also offers filters for outdoor or camping use as well as and so-called sub-sink water filter systems. The latter are closing another important gap in the area of everyday water supply. In most countries even the tap water is contaminated significantly. As a result, water taken from the tap in kitchen and bathroom (so-called point-of-consumption) is not of drinking water quality. With the help of the Cleanwater filters any relevant water impurities - and most importantly any bacterial contamination - are removed at home immediately before the effluent.

More information: [Cleanwater Systems GmbH](#)

# 6. Construction and Housing

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## Introduction

Setting up accommodation quickly that offers shelter to as many people as possible - this is the challenge relief workers are faced with in disaster areas and hot spots the world over. The most common choice is tents, because they are cheap and easy to transport and set up. The protection they offer against the weather, however, is correspondingly low. In addition, these emergency shelters are not designed for long-term use, and yet many of them are in use for weeks if not months in refugee camps. The task of ensuring an effective protection of houses and buildings against environmental conditions is not limited to the field of Disaster Relief. In fact, every house owner has an interest in protecting his property against the weather as effectively as possible.

This is a major challenge in developing countries in particular, since in many regions the climatic conditions are much more extreme than in our temperate zone: buildings are exposed to extreme heat as well as freezing cold, while elsewhere long rainy seasons alternate with extreme drought. Parasites are also a nuisance to buildings and their inhabitants.

According to experts, emerging economies in particular are currently witnessing the development of a market based on the issue of building protection. For any solution to be successful in this sector, it will have to be both highly efficient and affordable.

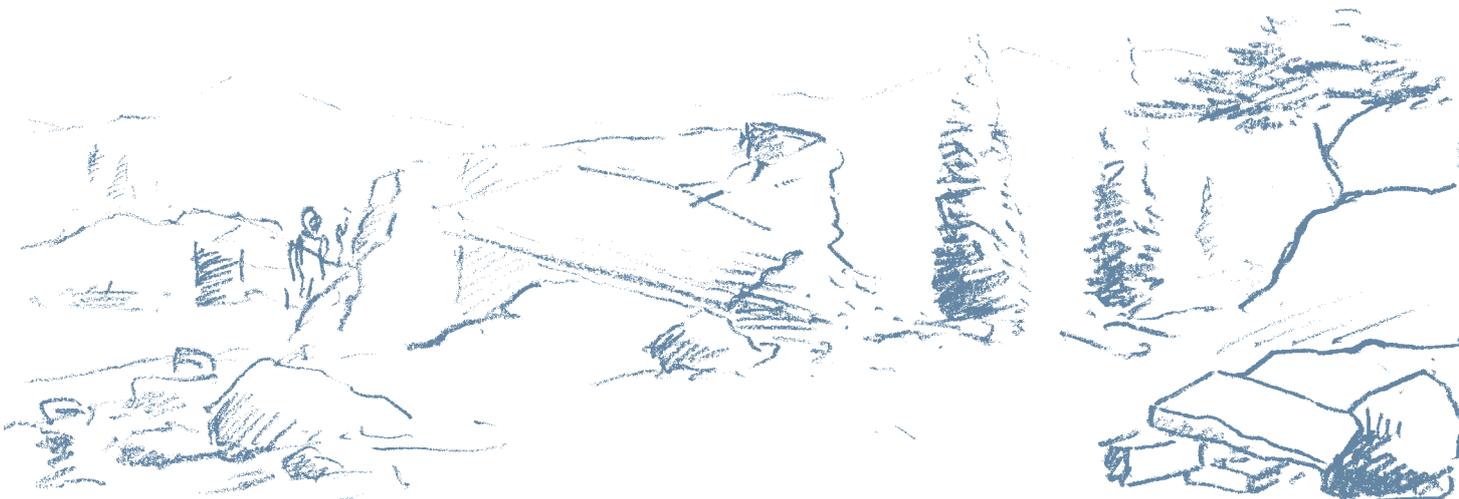
Italian earthquake region, Onna 2009. Source: THW



## 6. Construction and Housing

### “Application Panorama” Humanitarian Relief after an Earthquake

	Sequence of events
Background	Middle Italy in late February at approximately 4:00 am: for 30 seconds tremors measuring 6.3 on the Richter scale are shaking the region. In the small provincial town of Campagnello in the Abruzzi many buildings are collapsing. An electricity crisis looms because the power grid has collapsed. In the surrounding area, the quake is razing several villages to the ground.
Relief Mission	The state of emergency has been declared. Rescue volunteers from all over the country are deployed to the earthquake region, supported by rescue teams from abroad. The area is hard to reach at the best of times but now access roads have been blocked by landslides and rubble. The water supply has been interrupted. Countless people are reported missing, the injured and dead need to be rescued from the rubble and the wounded require medical attention. The local hospital is in danger of collapsing; medical treatment must take place outside. Emergency shelters need to be set up for those affected by the quake.
Mission Follow-up	The extent of the damage is being determined. The cleanup and reconstruction work begins.



## Problems

The situation is confusing and it is difficult to estimate the scale of the disaster. Any buildings that were not destroyed are close to collapsing. Tens of thousands of people are homeless and have to endure freezing conditions outside. Frequent aftershocks cause panic and obstruct the rescue operation. Inside many destroyed buildings, damaged gas pipes are threatening to explode. The telephone network is only capable of bridging temporary power shortages. The failure of communications networks is imminent.

The disaster region lacks the necessary containers or tanks for the transport of large amounts of drinking water. The activities of the different rescue teams need to be coordinated. The tents may be earthquake proof but do not protect from the cold. The emergency shelters are overcrowded. In addition, hygiene issues pose new challenges to the relief teams, not just inside the temporary shelters but also for the supply of the victims with food.

The earthquake was the second within the last ten years. The next earthquake may cause damage at a similar or even worse scale.

## Solutions

- Using fuel cells as energy suppliers, e.g. to provide an emergency power supply for mobile phone networks
- preventive measures for emergencies such as water filters and emergency food supplies containing nutritious solubilisates in special packaging for each household
- Cutting off any gas pipelines automatically

- Coatings for the inside walls of tanks (e.g. of fire engines) and containers to enable the transport of safe drinking water
- Insulation of emergency shelters against the cold
- Zero emissions emergency power generators
- More efficient and longer lasting batteries
- Weather resistant heat-insulating temporary shelters and mobile hospitals
- Anti-bacterial surface coatings in medical areas and shelters

- Earthquake proof reconstruction of the damaged infrastructure, using more resistant and more efficient nano building materials
- Purchase of new, specially coated tanks and germ-resistant water containers which will also be used by rescue and supply vehicles



# 6. Construction and Housing

## Challenges

### Emergency shelters

In the event of a disaster, emergency shelters must be made available to large numbers of people at the same time. Tents usually do not offer sufficient protection from wind, rain or heat and are not designed for permanent use. In Development Cooperation, temporary shelters set up for civil war refugees are often in use for years. Emergency shelters with a much higher durability are much needed, as are possibilities of improving the hygienic conditions in these shelters and thus reducing the risk of disease significantly.

### Flood protection

In many countries of Africa, Latin America or Asia, the default construction materials are clay, bamboo or wood. Countries in these geographical regions are regularly hit by floods or heavy rains. The buildings' untreated construction materials are usually not able to withstand the water and their walls damaged beyond repair. Nano coatings can help make the buildings' walls more resistant.

### Protection from negative environmental effects

Strong UV rays, mould, algae and parasites can lead to the premature ageing of buildings. To prevent this process from happening, materials with integrated protective properties are of great interest for the sustainable protection of buildings.

### Insulation of buildings

With the advent of central heating, emerging markets such as China are attaching more and more importance to the issue of building insulation. Affordable options for external insulation are in high demand.

### Air conditioning

Particularly in the hot and hot-humid climate zones there is a strong demand for cooling systems and air conditioners. The bacterial contamination of these systems, however, is a major problem.

SEEB (Rapid Deployment Unit Search and Rescue) rescue teams in the disaster area. Source: THW



# Nanolutions: Construction and Housing

## Surface protection with long-term effects



Nano coated facades provide permanent protection from the weather and pollution. By significantly reducing the water permeability of facades, damage from frost, rain, moss or algae and fungi can be avoided or reduced. These special facade coatings with a nano-structured surface demonstrate a significantly lower tendency to accumulate dirt yet offer increased colour stability. The coatings create not only durable, but also long-lasting beautiful facade designs.

More information: CAPAROL Farben Lacke Bautenschutz GmbH & Co. KG

## Antibacterial wood polish



Based on the latest nano components, the Offenbach based company Alfred Clouth Lackfabrik GmbH & Co has developed a protective material that suppresses the colonisation of bacteria and fungi permanently on wooden surfaces. Because of its environmentally friendly composition, the possibilities offered by this anti-bacterial coating are wide-ranging.

More information: Alfred Clouth Lackfabrik GmbH & Co. KG

## Using photocatalytic building materials to improve air quality



Research has resulted in the discovery of a way to actively combat pollution levels in urban areas, namely through the use of substances with photocatalytic effects in paving stones. Paving stones with these properties reduce the levels of nitrogen oxide and organic hydrocarbon compounds in the air, thus contributing to the creation of a less polluted environment.

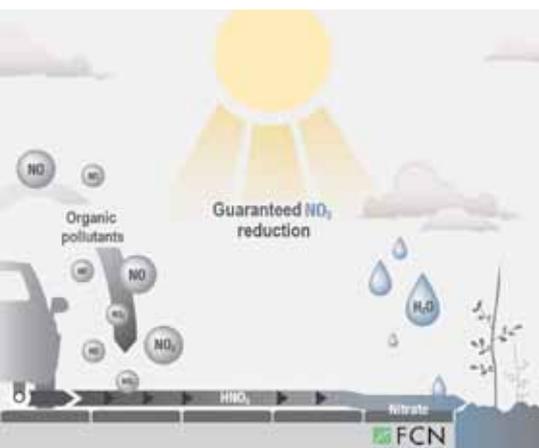
More information: F.C. Nüdling Betonelemente GmbH & Co. KG

## Ultra high-strength concrete



Ultra high performance concrete (UHPC) with nano components is set to open up new possibilities in construction. It is up to ten times stronger than conventional concrete and is thus comparable to steel in its compressive resistance. Its higher strength thus enables weight reduction. In addition, it is far more resistant to corrosion than conventional concrete, so that resource intensive renovations become unnecessary or can at least be delayed by many years. This is made possible by UHPC with NANODUR® by Wiesbaden based Dyckerhoff AG. NANODUR® is a ready-to-use binder which - thanks to the use of nano structured synthetic silica - increases the performance of concrete considerably and reduces construction and maintenance costs.

More information: Dyckerhoff AG



Paving stones with photocatalytic effects reduce the levels of nitrogen oxide and organic hydrocarbon compounds in the air. Source: F.C. Nüdling Betonelemente GmbH & Co. KG

## 6. Construction and Housing

### Multifunctional emergency accommodation



The use of nanotechnology components in textile production also opens up new possibilities for the development of better emergency shelters. ZeroFly, for example, is a plastic sheeting with a nano coated surface which incorporates insecticides. This sheeting provides important and reliable protection against insects during the construction of tents and temporary shelters and thus plays an important part in the prevention of diseases. In addition, textiles featuring nanotechnology components which are used for the construction of tents can be equipped with more weather resistant properties. The addition of an antibacterial nano component could also make these textiles more resistant to bacterial contamination, which would help reduce the risk of epidemics in emergency shelters.

More information: Vestergaard Frandsen S.A. (Switzerland)

### More efficient climate control



Nanotechnology surface coatings and filter systems improve the performance of air conditioners and reduce the level of germs in the air. As their cooling fins get increasingly dirty, the cooling capacity of heat exchangers decreases by 30-50%. Rittal, a system provider for enclosure and housing technology uses the beneficial properties of nanotechnology surface coatings e.g. in system climate control. The application of a thin layer of coating reduces pollution of the cooling units considerably. Aside from reducing costs, the maintenance frequency can also be reduced.

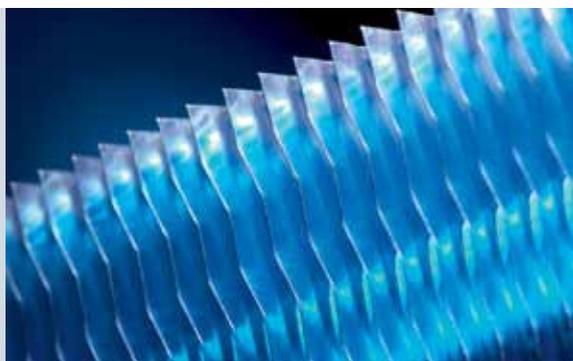
More information: Rittal GmbH & Co. KG

### Concrete canvas shelters



Concrete Canvas offers the possibility of building refugee camps and emergency shelters that are more weatherproof, durable and safe than traditional tents could ever be. Concrete Canvas Shelters are rapidly deployable hardened shelters that require only water and air for construction. Without prior training, the Canvas can be set up in about 40 minutes. The Shelter then requires a further 12 hours until the concrete has dried and hardened.

More information: Concrete Canvas Ltd. (United Kingdom)



## Nanogel used as building insulation



This fascinating material is the best insulating solid material in the world, providing levels of thermal insulation that are about twice as high as those of conventional insulating materials. With its light weight, light-permeability, hydrophobic surface, high porosity and chemical stability this unique material is a suitable candidate for a multitude of applications. Cabot Nanogel GmbH is a subsidiary of Cabot Corporation, founded in 2002. In this new business unit, Cabot manufactures and markets Aerogel under the brand name Nanogel. It is produced in Frankfurt-Hoechst, Hessen.

More information: [Cabot Nanogel GmbH](#)



Slum dweller in Manda/Dhaka. The corrugated iron huts develop a barely tolerable heat inside.  
Source: :response

## NanoFUTURE: Construction and Housing

### Nano foams as insulation materials



Nano-pores are able to reduce the thermal conductivity of materials considerably. The thermal conductivity of nano foam can be reduced by up to a third compared to conventional insulation materials. This is also beneficial to the environment because nano foam results in lower energy consumption and material requirements. BASF SE is currently developing an innovative polymer insulation foam which is intended for use as insulating material in refrigerators, buildings, cars or even airplanes.

More information: [BASF SE](#)

### Heating mats with nano wires



In some regions in Asia, radiators in buildings are an uncommon sight. In these areas, research is now under way into heating mats consisting of fibres and yarns that are able to conduct electricity. The conductivity of the fibres is made possible by nano-carbon compounds which act like a multitude of heating wires. The advantage is that heating mats can be operated with low voltage and are therefore less dangerous. In addition, they work even if some of the fibres have been severed, e.g. due to damage.

## 7. Energy and Communications

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"Off-Grid Lighting" - solar power collected by night brings light at night. Source: OSRAM GmbH

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“The challenges of the energy and communication networks of the future are more complex than ever before. Together with large infrastructure developments in emerging economies and the processes of modernisation in the industrialised countries, a

key issue on a global level will be the development and provision of smart and appropriate solutions for developing countries, to unleash their potential for development.”

Jochen Berner

Project Manager Off-Grid, Osram GmbH

## Introduction

Shrinking resources, rising energy prices and progressive climate change have all demonstrated over the last few years that a fundamental shift in thinking must take place in the field of energy production and supply. What are the alternatives? This is the crucial question; the answers are also of relevance to Development Cooperation and Disaster Relief, because we need to also think about alternatives in these areas. After all, millions of people in developing countries are still far away from being connected to a central power supply. Alternative solutions will have to be found instead, in order to e.g. supply shops or public buildings with electricity.

In the area of emergency protection, access to off-grid electricity is a key issue as power supply must be ensured even if the network collapses. What is needed here are decentralised, small and mobile high-performance power supply units. For both Disaster Relief and Development Cooperation, the question of efficient energy storage mechanisms is also of vital importance.

Mobile phones have become the most important means of communication in developing countries. According to a report by the United Nations

Conference on Trade and Development (UNCTAD), every second person in these countries was already using a mobile phone in 2008. The infrastructure is good - almost every village in Africa has mobile phone reception. Internet penetration is much slower, however.

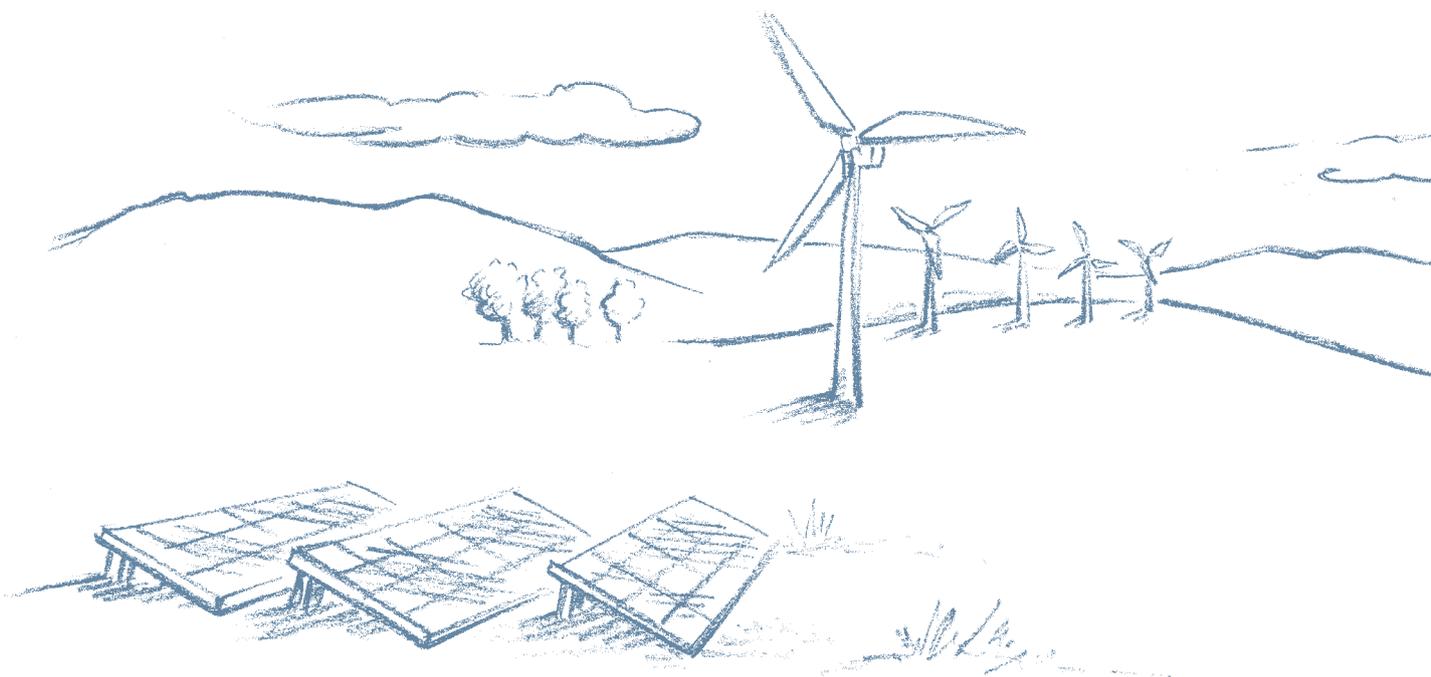
Besides their role as means of communication, mobile phones are an important source of information for people in developing countries, the economic relevance of which must not be underestimated: The mobile phone facilitates trade and promotes economic development.

A question that arises both in Development Cooperation and Disaster Relief concerns the power supply of communication media: How can mobile phones, two-way radios and computers be supplied with power reliably and independently from the grid? In an emergency, the success of the Emergency Response operation hinges on efficient communication between rescue workers. Fail-safe storage units that can, for example, keep telecommunications equipment running even when the power grid collapses, are also of vital importance in an emergency.

# 7. Energy and Communications

## “Application Panorama” Regional Power Failure

	Sequence of events
Background	In the Münsterland region storm, freezing rain and heavy snow make for severe weather conditions. The storm causes the ice covered high voltage power lines to “dance”. The vibrations cause short circuits and wire breaks; pylons break apart. The power supply of an entire region comes to a standstill for days.
Relief Mission	The state of emergency has been declared. The fire brigade and the Agency for Technical Relief head out to clear the roads from fallen trees and branches. The police secures the danger zones alongside the damaged power lines. Employees of the electricity supplier are defrosting undamaged power lines and repairing damaged ones. Warm rooms and food distribution points need to be set up in public buildings.
Mission Follow-up	Reconstruction begins with the repair of the partly destroyed power supply infrastructure.



## Problems

Due to the power cut, supplies such as information and telecommunications services, water supply (drinking water and industrial water) and public transport have broken down or are very limited. In thousands of households the heating systems fail. Auxiliary devices used in domestic care stop working.

Rescue workers only have access to a limited communication infrastructure. A priority plan for the distribution of emergency generators needs to be written. Dependent people who are reliant on technical equipment have to be taken to hospitals or receive emergency power supplies. Cooking facilities are being made available but existing hygiene regulations must be adhered to.

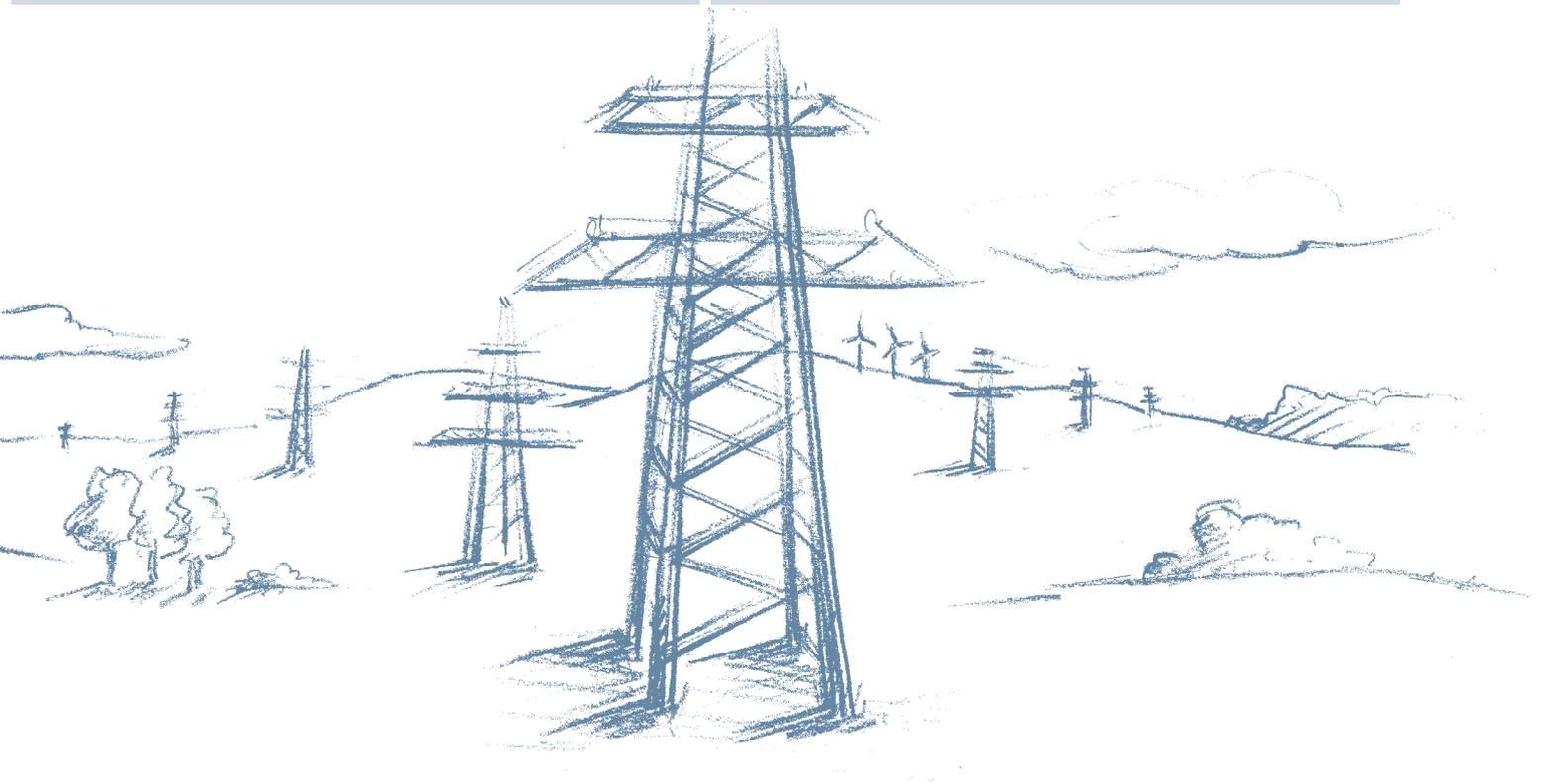
A network-independent backup power supply must be ensured. Power lines may freeze again.

## Solutions

- Stationary emergency generators for public supply systems

- Efficient and mobile emergency power generators
- Mobile kitchens with anti-bacterial coatings

- Fuel Cells and high-performance batteries are replacing less efficient batteries in the emergency generators
- Anti-freeze coatings for power lines



# 7. Energy and Communications

## Challenges

### Photovoltaics

Solar panels open up possibilities of generating electricity even in remote and isolated areas. Two conditions, however, must be met if the technology is to be used in developing countries: low acquisition cost (maximum \$ 500) and low maintenance requirements. It is important to note that energy efficient solar terminals require less space and thus also reduce the cost of PV solar power plants.

### Energy storage

In Africa, solar cookers could be used for food preparation, which would offer a number of benefits: less toxic smoke, less need for firewood (deforestation), using cow manure in agriculture rather than using it as fuel, etc. A project focusing on this issue which was funded by the German Agency for Technical Cooperation failed, however. One key problem is the high cost: in the relevant countries, most families traditionally eat their main meal in the evening - the cooker, however, only works while the sun is shining because this particular model is not able to store the energy it has created.

### Bridging power outages

In the case of power outages, the uninterrupted power supply of telecommunication systems is often provided by expensive and maintenance intensive stand-by units and storage batteries. Fuel cells can offer an alternative in such a situation.

### Off-grid power supply

During Emergency Response operations, power supply is usually derived from generators which are difficult to handle. The work of the rescue forces could be made much easier by using low-emission devices which are even lighter and quieter. Fully charged batteries are a basic requirement for Emergency Response work. Could nanotechnology assist in increasing the storage capacities of these energy sources, extending their durability and preventing self-discharge during storage?

Source: THW



## Energy supply

Almost every village in Africa has mobile phone reception. Many areas, however, are still not connected to the electricity network. In an emergency, there are often no power sources to plug mobile phone chargers into.

## Small, powerful tools and equipment

Rescue volunteers often work with bulky and heavy tools and equipment. There is great demand for small and powerful devices that can ensure effective communication among Emergency Response workers.

## Protection from the elements

As part of the "Desertec" project, huge Concentrating Solar Thermal Power (CSP) plants could supply solar energy directly from the Sahara to Africa and Europe. It will be important to protect these plants effectively against premature wear and the associated efficiency losses caused by extreme environmental conditions such as UV radiation, cold, rain and sand storms.

## Recycling of electronic devices

Unregulated "backyard recycling" of mobile phones and electronic devices - all too common in many developing and emerging countries - releases toxins and is not very efficient. Improved organisational and technological recycling concepts make sense ecologically and economically. The collection and recycling of disused mobile phones - a system which barely works in developed countries - could offer future business opportunities for micro-enterprises whilst simultaneously securing old devices as sources of raw materials.

## Easy usability

Emergency services depend on reliable protective clothing, but as a result the wearer's motor skills are often restricted. Robust and shock-proof displays, which can also be operated with protective gloves, would provide a much needed solution.

## Mobile phones with additional benefits

Mobile phones are widespread in developing countries. The handsets could be equipped to provide additional benefits, for example, health monitoring of the user. There would be a considerable number of potential users. However, the low purchasing power of rural populations in poorer countries sets clear boundaries. Innovative business models can deliver an important stimulus for development, such as the "Bottom of the Pyramid" (BOP) concept. The focus is on the idea of using project and process innovations to develop the currently relatively undiscovered market of almost 3 billion poor people, in order to enable better access to supply and greater economic participation to those living at the lowest yet broadest level of global income distribution. This movement was initiated by C.K. Prahalad and Stuart Hart. They illustrate that the nearly 3 billion people who have to live on two U.S. dollars per day are nevertheless economic participants who offer labour, goods and services and demand goods. The examples of micro-credits or mobile phones show the dynamics that can be created when product innovations tailored to suit a market need are coupled with the most appropriate distribution channels.



Source: GIZ/Shutterstock

# 7. Energy and Communications

## Nanolutions: Energy and Communications

### Improved and more efficient photovoltaic power plants



Thanks to nanotechnology, improvements can now be made to the conventional semiconductor solar cells for photovoltaics, which have long been available on the market. Moreover, nanotechnology methods will accelerate the development of organic solar cells and dye solar cells. With its Nanosolar Utility Panel™ the company Nanosolar has developed the industry's first solar power panel specifically designed for utility-scale deployment. Because of its nanotechnology coatings the panel offers very high reliability and resilience. The nominal output of a Nanosolar panel is 220 Watts, three times higher than that of a conventional thin panel, making it the industry's first high-performance module to have been certified for a system voltage of 1500 VDC.

More information: [Nanosolar GmbH](#)

### Potential for innovation in fuel cells



Nanotechnology-related potential for innovation in fuel cells arises primarily by increasing the electricity yield from the conversion of chemical energy - in particular by using nano-structured electrodes, catalysts and membranes. Hanau-based company Umicore is developing catalysts that are used among other things for the production of fuel cells.

More information: [Umicore AG & Co. KG](#)

Other key components for fuel cells, such as bipolar plates made of graphite composite, are manufactured by Schunk Bahn- und Industrietechnik GmbH in Heuchelheim (Hessen). Schunk Bahn- und Industrietechnik GmbH produces complete fuel cell stacks allowing modular assembly of tailor-made service bundles.

More information: [Schunk Bahn- und Industrietechnik GmbH](#)



Potential for innovation in fuel cells.  
Source: Umicore



Fuel Cell Stack.  
Source: Schunk Bahn- und Industrietechnik GmbH

## Emission-free emergency power units



Superior technical availability and their high ecological compatibility enable fuel cells to replace heavy and maintenance-intensive battery-based UPS solutions.

Fuel cell emergency power units are to be found in many forms and environments as portable and decentralised systems. Rittal is a technology leader in the field of modular fuel cell systems and presents a broad product portfolio for the most varied applications, from mobile fuel cells to infrastructure solutions.

[More information: Rittal GmbH & Co. KG](#)

## Mobile diagnostics



While mobile phone reception works well in developing countries, diagnostic facilities are scarce. U.S. researchers have developed a mobile phone microscope that

creates detailed pictures and is then able to analyse these for the diagnosis of diseases. On this basis the non-profit organisation Grameen, a social business which was founded by Nobel Peace Prize winner Muhammad Yunus, is establishing a system for medical care in rural areas of Bangladesh. Mobile diagnostics thus enables a minimum level of medical care even in remote areas. In this field, nanotechnology are already enabling not only improved battery and storage technology but also energy savings through coated displays that concentrate light or provide a high level of scratch resistance.

[More information: Grameen Phone Ltd.](#)

## Off-grid power supply



Smart concepts for power supply in regions without access to the electricity network are of equal interest to both emergency planning and Development

Cooperation. With its "Off-Grid-Concept", OSRAM illustrates possibilities of providing off-grid areas with electricity in a sustainable manner. The concept was launched on Lake Victoria in Kenya as a globally unique pilot project for producing light independently from a grid-based power supply. At the heart of the OSRAM Off-Grid solution is the solar energy-powered O-HUB™. The most important function of this solar-powered charging station is to recharge battery-powered lamps and lighting systems with energy-efficient compact fluorescent lamps and LEDs, all of which are part of an integrated system. Customers take these so-called O-LAMPS or O-Boxes back to the O-HUB™ where they receive fully charged systems in return. The purchase cost for these lighting systems are covered by deposits funded through a micro-financing system.

[More information: OSRAM GmbH](#)



"Off-Grid Lighting". Source: OSRAM

# 7. Energy and Communications

Children holding home-made fans in the slums of Dhaka (Bangladesh).  
Source: :response



Gold, silver and rhodium are recovered of electronic waste or used catalysts.  
Source: Umicore AG & Co. KG



## Sustainable recycling



Umicore, established in Hanau (Hessen), is a technology leader in the processing and recycling of precious metals. Umicore offers comprehensive recycling services for a variety of products containing precious metals. This includes mobile phones, circuit boards and other components of electronic waste or used catalysts from cars and industry. The recovered precious metals like silver, gold, platinum, palladium and rhodium, as well as special metals such as indium or selenium can be reused in the production of new products.

More information: [Umicore AG & Co. KG](http://Umicore AG & Co. KG)





### High-tech wood stove



The electronics group Royal Philips Electronics is currently testing a product that combines basic technology with modern nanotechnology, namely an energy-efficient wood stove. In most developing countries food is still cooked on wood stoves, thus permanently exposing people to the harmful emissions from burning wood. As a result, about 1.6 million people in the poorest countries of the world die each year from toxic gases emitted by open fireplaces.

The newly developed stove is equipped with a thermoelectric generator which is based on nanotechnology to produce current for ventilation of air to get better burning and which is powered by the heat released by the burning wood. By using this generator, fuel consumption and thereby emissions of toxic gases are decreased by 80 percent compared to conventional stoves. In addition to the immense benefits for human health, the wood stove results in long term financial savings for families because they need to buy or collect less wood.

More information: [Royal Philips Electronics](#)

## NanoFUTURE: Energy and Communications

### Mobile phone microscopes for developing countries



The mobile phone of the future will offer its user more possibilities than just phone calls and mobile internet access. Equipped with smart sensor technology and lab-on-a-chip functionality, it will be able to make a valuable contribution to the user's health. Scientists at the University of California have developed an add-on device for conventional mobile phones which is capable of taking detailed pictures and analysing these to diagnose diseases such as Tuberculosis. For this process, the CellScope acts as a so-called fluorescence microscope which can identify disease markers.

The research objective is for the CellScope to be used in developing countries where diagnostic facilities are scarce but where many people own mobile phones. The researchers stress the fact that in developing countries and rural areas - which are often hundreds of miles away from the nearest hospital - mobile phone reception is usually good. A battery-powered mobile system could thus be turned into a portable hospital. The doctor in charge would be able to look at samples without needing to be in the same place as the patient. The team is currently working on a more robust version of the device which will be used in field tests and clinical trials.

More information: [University of California](#)

## 8. Agriculture and Nutrition

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“Humans should drink about two to three litres of water a day. We need water for our everyday life, at home, in agriculture and in industry. Without water, humans can only survive for about four days, and entire countries and societies are affected if there is a lack in water. Due to climate change we can expect an intensification of extreme

weather conditions. As a result, many regions will be faced with significantly increased risks of natural disasters, which will be additionally amplified by the increasing geographical density of populations.”

Stefan Opitz

Head of Water, Energy, Transport  
Deutsche Gesellschaft für internationale  
Zusammenarbeit (GIZ) GmbH

## Introduction

Around one billion people worldwide suffer from hunger. Rapid population growth, shortages of arable land and global economic conditions are worsening this situation further. Above all, however, it is climate change that will be aggravating the nutritional situation in the poorest regions of the southern hemisphere. Its effects on agriculture are already becoming apparent today. Furthermore, malnutrition - so far mainly a problem in Western industrialised countries - is increasingly becoming a problem in emerging and developing countries.

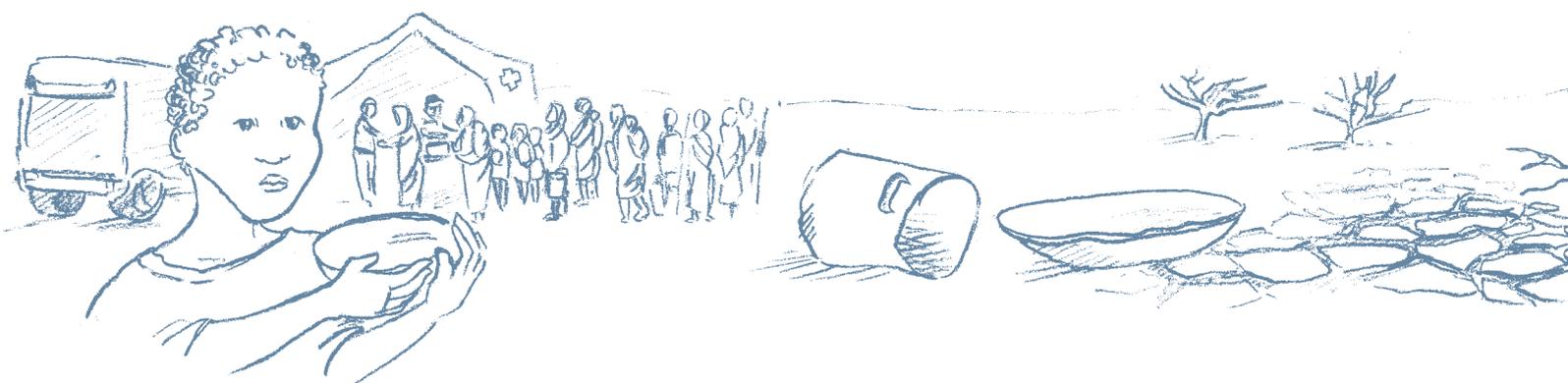
With a view to nutrition, the main challenge for Disaster Relief in the case of an emergency is to be able to supply sufficient amounts of food whilst also adhering to the required hygiene standards. At the same time, the spread of diseases caused by spoiled food must be avoided, e.g. in refugee camps.

Production, distribution and quality of foodstuffs are therefore key challenges for both Development Cooperation and Disaster Relief. In both areas the sufficient production and efficient distribution of available food resources must be ensured. In addition, solutions need to be found that can compensate for possible deficiencies in food quality, such as nutritional additives and supplements.

## 8. Agriculture and Nutrition

### "Application Panorama" Drought and Famine

	Sequence of events
Background	Kenya: after a drought and resulting crop failures in agriculture, the country is on the brink of a famine outbreak which will affect millions of Kenyans. The national food reserves are almost exhausted and the country is dependent on international aid.
Relief Mission	In cooperation with public authorities, relief organisations on site are trying to identify the exact requirements for relief supplies and to launch international aid as quickly and as organised as possible.
Mission Follow-up	The extent of the damage is being determined. It is also important to advance the improvement of agricultural production through different crops, fertilisers and pesticides.



## Problems

The lack of rain has not only caused many surface waters and wells on higher ground to dry up but has also destroyed crops and decimated livestock herds. Watering holes are often not adequately protected. Agricultural residues or faeces of humans or animals can easily get into the water. The national emergency supplies often do not reach remote rural areas. Dirty water and poor hygiene cause many diseases, such as diarrhoea, malaria, worm infections or skin and eye infections, with children being particularly vulnerable. In addition, increasing malnutrition is claiming its first victims, in particular among children, the ill and the old.

The work of the international aid organisations and volunteers on site needs to be coordinated. In addition to the distribution of food, the water supply of the population must be improved. Any existing surface water needs to be purified, and additional wells be drilled. The victims' health problems - caused by malnutrition in recent months - need to be taken care of, and be compensated with a nutritious, balanced and tailored diet.

The improvement of food supply systems during drought periods is not yet sufficiently well organised. This also applies to the stockpiling of nutritional additives.

## Solutions

- Optimisation of agriculture with targeted additives
- Water filtration systems

- Use of nutritionally optimised food additives
- Emergency shelters with insecticide coatings

- Localised water filtration systems for the population
- More heat-resistant drugs



# 8. Agriculture and Nutrition

## Challenges

### Drought

Desertification in large parts of Asia and Africa is a consequence of climate change. Bare and eroded soils can often not retain what little moisture there is; the right conditions for this need to yet be established. Reforestation measures are one option but bushes and trees need water to grow too.

### Fertilisers and pesticides

In many of the world's regions, climate change causes dramatic crop failures. In order to save what can be saved, farmers would have to use fertilisers and pesticides. They cannot afford high quality products but cheap alternatives are extremely damaging to the environment and the health of the population. There is a need for more environmentally friendly alternatives which are more affordable than their Western equivalents.

### Extended shelf life through packaging coatings

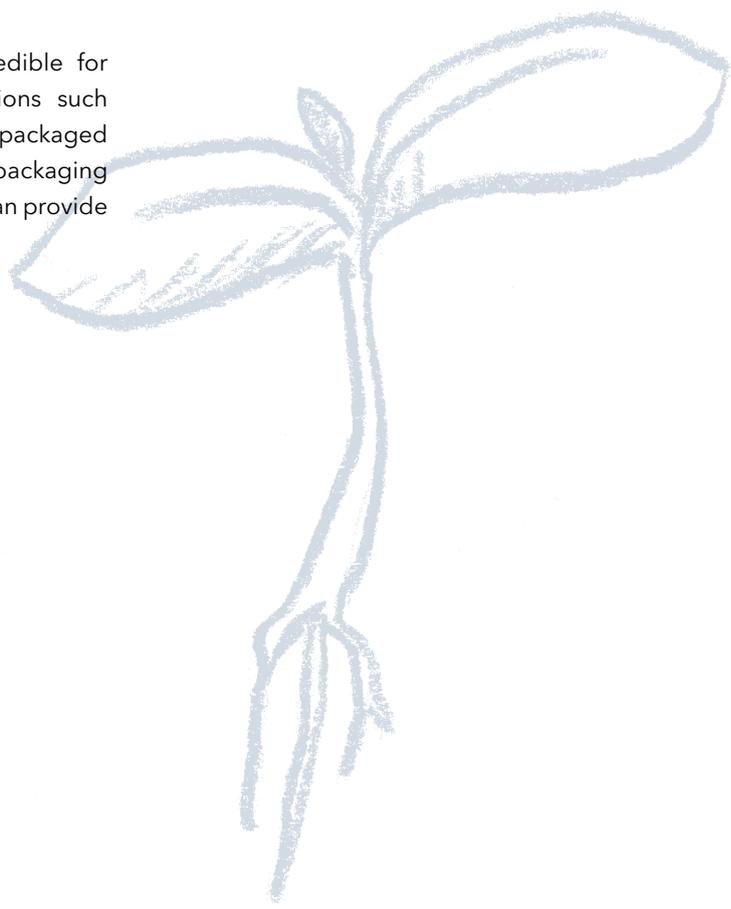
Many foodstuffs could stay fresh and edible for longer even in difficult climatic conditions such as heat or humidity - if only they were packaged appropriately. In this field, nano porous packaging materials and novel sensor technologies can provide some solutions.

### Poor nutrition

In industrialised countries it is common practice to improve and balance an unbalanced diet by taking nutritional supplements such as vitamins or minerals. The innovative power of nanotechnology opens up possibilities for effectively tackling the lack of nutrition or malnutrition in many developing countries.

### Risk of germs

Spoilt meat can be the cause of serious diseases. Nanotechnology can offer a range of solutions, from helping prevent risk from germs at the point of slaughter, to ensuring an uninterrupted cooling chain during transport and storage of meat even in extreme situations.



## Nanolutions: Agriculture and Nutrition

### Water-retaining soil enhancers



Nanotechnology components in soil enhancers can make a specific contribution to stopping progressive desertification. Geohumus is such a soil enhancer. This hybrid polymer made from volcanic rock flour and colloidal silica, has super-absorbent properties. Geohumus increases the water retention capacity of soil by up to 40 times its own weight and releases the water back into the environment or directly to the plant as needed. This process of retaining and releasing can be repeated any number of times. Geohumus is environmentally friendly and stable for a long term period of 3 to 5 years.

Successful projects in Northern Africa and the Middle East have shown that this soil enhancer can make a valuable contribution to the fight against desertification in arid areas. As a result, Geohumus - together with the Menschen für Menschen Foundation - has started a comprehensive reforestation programme with 1 Million trees in the southern Sahara region. Not only do the trees prevent the expansion of the desert - they also bind carbon dioxide and thus contribute to the fight against climate change.

[More information: Geohumus International GmbH](#)



Water-retaining soil enhancers are counteracting desertification. Source: Geohumus International GmbH

# 8. Agriculture and Nutrition

## Targeted use of pesticides and fertilisers



With the help of nanotechnology, it is now possible to use pesticides, growth regulators and seed treatment agents in a more targeted manner. The nano-encapsulated active ingredients are programmed to open only under specific conditions such as heat, sunlight or in the alkaline environment inside an insect's stomach. Nanoparticles thus are designed to ensure a more effective use of fertilisers and pesticides. This not only results in an increased effectiveness of these compounds but also reduces the amounts of agrochemicals needed.

## Multi-functional food additives



Nanotechnology components in food chemistry can actively help to improve the nutritional situation in emerging and developing countries. If staple foods were enriched with trace elements such as iron, zinc, folic acid or vitamin A, poor nutrition could be prevented. In Kolkata, Ärzte für die Dritte Welt - German Doctors e. V. (Doctors for Developing Countries) distribute cooking salt to malnourished children which contains additional vitamins, iodine and iron. By adding this salt to rice, mothers can ensure that all family members receive the necessary nutrients. Compared to vitamin supplements, salt has the advantage that mothers do not need to also give drugs to their children. By using this salt, some consequences of malnutrition can be alleviated.

More information: [Ärzte für die Dritte Welt - German Doctors e. V.](#)



Multifunctional food additives can help to improve the nutritional situation. Source: [Ärzte für die Dritte Welt - German Doctors e. V.](#)



Source: [Ärzte für die Dritte Welt - German Doctors e. V.](#)

## NanoFUTURE: Agriculture and Nutrition

### Polymer nanofibre webs for use in agriculture



The finishing of textiles with electro-spun polymer nanofibre webs promises to keep in store interesting future solutions for agriculture. The Department of Chemistry and the Centre for Materials Science at Philipps-University Marburg are leaders in the field of electro-spun nanofibre webs. For agricultural applications, for example, erodible drug-eluting

polymer nano-fibre webs are extremely promising in the field of biotech crops protection, especially at very low doses. This project is funded by the Federal Agency for Agriculture and Food and is carried out in cooperation with the Justus-Liebig University in Giessen.

More information: [Philipps-University Marburg, Department of Chemistry/Centre for Materials Science](#)



# Appendix

## Companies\*

### Adexano® Spezialprodukte für Gesundheit, Pflege und Prävention GmbH

Bildstocker Strasse 12 | 66538 Neunkirchen  
Phone: +49 (0)68 21-912 77 60 | Fax +49 (0)68 21-912 77 79  
www.bacoban.com

**Contact:** Rolf Zimmermann

**Products/Areas of research:** Bacoban

### Alfred Clouth Lackfabrik GmbH & Co. KG

Otto-Scheugenpflug-Strasse 2 | 63073 Offenbach am Main  
Phone: +49 (0)69-89 007 0 | www.clou.de

**Contact:** Alexander Eisenacher

**Products/Areas of research:** Anti-bacterial wood polish

### BASF SE

Carl-Bosch-Strasse 38 | 67056 Ludwigshafen  
Phone: +49 (0)621-60-0 | www.basf.com

**Products/Areas of research:** Mosquito net Fendona, nano foams

### Caparol Farben Lacke Bautenschutz GmbH

Rossdorfer Strasse 50 | Industriegebiet 1 | 64372 Ober-Ramstadt | Phone: +49 (0) 61 54-710 | www.caparol.de

**Contact:** Dr. Stefan Kairies

**Products/Areas of research:** Hydrophobic primers and waterproofing

### Concrete Canvas Ltd. (Great Britain)

Unit 3, Block A22 | Pontypridd | CF37 5SP | UK  
Phone: +44 (0)845 680 1908 | www.concretecanvas.co.uk

**Contact:** Phillip Greer, info@concretecanvas.co.uk

**Products/Areas of research:** Concrete canvas

### De Cie GmbH

Flinschstrasse 51 | 60388 Frankfurt am Main  
Phone: +49 (0)69-954 302 0 | www.decie.de

**Contact:** Maja Prehn

**Products/Areas of research:** Anti-fog coatings for visors, protective goggles and displays

### Dow Corning GmbH

Postfach 13 03 32 | 65201 Wiesbaden  
Phone: +49 (0)611-2371 | www.dowcorning.de

**Contact:** Bärbel Preussler

**Products/Areas of research:** Silicone-additives for protective clothing

### Dyckerhoff AG

Biebricher Strasse 69 | 65203 Wiesbaden  
Phone: +49 (0)611-676 0 | www.dyckerhoff.de

**Contact:** Dr. Karsten Geisenhauslüke

**Products/Areas of research:** Ultra high performance concrete

### Franz Carl Nüdling Basaltwerke GmbH + Co. KG

Ruprechtstrasse 24 | 36037 Fulda  
Phone: +49 (0)661-83 87 0 | www.nuedling.de

**Contact:** Silvia Füller

**Products/Areas of research:** Photocatalytic paving stones

### Geohumus International GmbH

Carl-Benz-Strasse 21 | 60386 Frankfurt am Main  
Phone: +49 (0)69-444 777 | www.geohumus.com

**Contact:** Dr. Wulf Bentlage

**Products/Areas of research:** Water-retaining soil enhancers

### Golder Associates GmbH

Barckhausstrasse 2 | 60325 Frankfurt am Main  
Phone: +49 (0)69-68 97 46 90 | www.golder.com

**Contact:** Tobias Meyer

**Products/Areas of research:** Decontamination technology

### Grameenphone Ltd.

Level - 5, Delvistaa Tower | Plot 1-A, Road - 113 | Gulshan, Dhaka - 1212 | Bangladesh | www.grameenphone.com

**Products/Areas of research:** Telecommunications services

### Hollingsworth & Vose GmbH

Berleburger Strasse 71 | 35116 Hatzfeld  
Phone: +49 (0)64 67-80 10 | www.hollingsworth-vose.com

**Contact:** Gudrun Schöning

**Products/Areas of research:** Filter technology

### Lanxess Deutschland AG

51369 Leverkusen | Phone: +49 (0)303 33 33  
www.lanxess.de

**Contact:** Silke Jansen

**Products/Areas of research:** Bayoxid E-33

### Merck KGaA

Frankfurter Strasse 250 | 64293 Darmstadt  
Phone: +49 (0)61 51-72-0 | www.merck.de

**Contact:** Alexander Biebel

**Products/Areas of research:** OLED-Materials

### Microdyn Nadir GmbH

Rheingaustrasse 190 | 65203 Wiesbaden  
Phone: +49 (0)962 2001

**Contact:** Werner Rupprich

**Products/Areas of research:** Filtration technology, water treatment

### Nanogate AG

Zum Schacht 3 | 66287 Quierschied-Göttelborn  
Phone: +49 (0)68 25-95 91 0 | www.nanogate.de

**Contact:** Dr. Rolf Danzebrink

**Products/Areas of research:** Weather resistant construction materials made of natural materials

### Nanosolar GmbH

Frankenfelder Chaussee 2 | 14943 Luckenwalde  
www.nanosolar.com

**Products/Areas of research:** Nanosolar Utility Panel

### Opsolution Nano Photonics GmbH (OPN)

Goethestrasse 25-27 | 34119 Kassel  
Phone: +49 (0)561-52141-0 | www.opsolution.de

**Contact:** Hardy Hoheisel

**Products/Areas of research:** NanoSpectrometer

### OSRAM GmbH

Hellabrunner Strasse 1 | 81543 München  
Phone: +49 (0)89-62 13 0 | www.osram.com/offgrid

**Contact:** Jochen Berner

**Products/Areas of research:** Off-Grid Lighting

### Royal Philips Electronics

Amstelvein 2 | Breitner Center | P.O. Box 7790  
1070 MX-Amsterdam | The Netherlands  
Phone: +3120 59 777 77 | www.philips.com

**Products/Areas of research:** High-Tech-Wood burner

### REWITEC GmbH

Dr.-Hans-Wilhelmi-Weg 1 | 35633 Lahnau  
Tel. : +49 (0)64 41-44 599 0 | www.rewitec.com

**Contact:** Stefan Bill

**Products/Areas of research:** Coatings for metal surfaces

### Rittal GmbH & Co. KG

Auf dem Stützelberg | 35745 Herborn  
Phone: +49 (0)27 72-505 0 | www.rittal.de

**Contact:** Martin Rossmann

**Products/Areas of research:** Air-conditioning technology, Fuel cell emergency standby units

### Schoeller Technologies AG

Bahnhofstrasse 17 | CH-9475 Sevelen  
Phone: +41 (0)81 786 08 00 | www.schoeller-works.com

**Contact:** Beatrice Gille

**Products/Areas of research:** Textile coatings

### Schunk Bahn- und Industrietechnik GmbH

Rodheimer Strasse 59 | 35452 Heuchelheim  
Phone: +49 (0)641 608 0 | www.schunk-group.com

**Products/Areas of research:** Carbon technology, environmental simulation and air conditioning technology, metal sintering and ultrasonic welding

### Siemens AG Corporate Technology

Wittelsbacher Platz 2 | 80333 München  
Phone: +49 (0)89-636 520 | www.siemens.com

**Products/Areas of research:** Quicklab diagnostic device

### Siemens AG, Water Technologies

181 Thorn Hill Rd. | Warrendale, Pa. 15086 | USA  
Phone: +1 724 772 0044 | www.water.siemens.com

**Products/Areas of research:** Water supplies, water treatment

### Torglas GmbH

Industriestrasse 26 | 35684 Dillenburg (Frohnhausen)  
Telefon: +49 (0)27 71-330 30 10 | www.torglas.com

**Contact:** Marcus Cremer

**Products/Areas of research:** Scratch protected polymer window panes

### Umicore AG & Co. KG

Rodenbacher Chaussee 4 | 63457 Hanau-Wolfgang  
Phone: +49 (0)61 81-59 02 | www.umicore.de

**Contact:** Werner Appel

**Products/Areas of research:** Precious metal recycling; catalysts

### Vestergaard Frandsen S.A. (Switzerland)

Chemin de Messidor 5 -7 | CH - 1006 Lausanne, Switzerland  
Phone: +41 (0)21 310 73 40 | www.vestergaard-frandsen.com

**Contact:** Peter Bernstorff

**Products/Areas of research:** ZeroFly, LifeStraw, LifeStraw Family

### VTA Deutschland GmbH

Henneberger Strasse 1 | 94036 Passau  
Phone: +49 (0)851-988 98-0 | www.vta.cc

**Products/Areas of research:** Nanofloc (Coagulant for scum)

\* Selection of companies or those mentioned in this publication

## Universities and Research Institutes\*

### Philipps-University Marburg

Chemistry Department, WG Wendorff  
Hans-Meerwein-Strasse | 35032 Marburg  
Phone: +49 (0)64 21-282 59 64 | [www.uni-marburg.de](http://www.uni-marburg.de)  
**Contact:** [wendorff@staff.uni-marburg.de](mailto:wendorff@staff.uni-marburg.de)  
**Products/Areas of research:** Electrospinning

### Philipps-University Marburg

Chemistry Department, WG Greiner  
Hans-Meerwein-Strasse | 35032 Marburg  
Phone: +49 (0)64 21-282 55 73  
**Contact:** [greiner@staff.uni-marburg.de](mailto:greiner@staff.uni-marburg.de)  
**Products/Areas of research:**  
Electrospinning/polymer nanofibre webs

### Technical University Darmstadt

Eduard-Zintl-Institute for Anorganic and Physical  
Chemistry  
Petersenstrasse 18 | 64287 Darmstadt  
Phone: +49 (0)61 51-16 49 45 | [www.tu-darmstadt.de](http://www.tu-darmstadt.de)  
**Contact:** Prof. Dr. Rolf Schäfer  
**Products/Areas of research:** Gas sensor technology

### University of Kassel

Center for Interdisciplinary Nanostructure Science  
and Technology  
34109 Kassel | Phone: +49 (0)561-804 4235  
[www.cinsat.uni-kassel.de](http://www.cinsat.uni-kassel.de)  
**Contact:** Prof. Dr. Frank Träger  
**Products/Areas of research:** NanoSpectrometer

### University of Kassel

Faculty of Construction, Infrastructure and the  
Environment; Department for Urban Water Management  
Kurt-Wolters-Strasse 3 | 34125 Kassel  
Phone: +49 (0)561-804-2869 | [www.uni-kassel.de](http://www.uni-kassel.de)  
**Contact:** Harald Exler  
**Products/Areas of research:** Water Backpack

### Deutsches Textilforschungszentrum Nord-West e. V.

Institute at University Duisburg-Essen  
Adlerstrasse 1 | 47798 Krefeld | Phone: +49 (0)21 51-843 0  
**Contact:** Torsten Textor | [textor@dtnw.de](mailto:textor@dtnw.de)  
**Products/Areas of research:** Tear-resistant Nanosol coatings

### Fraunhofer-Institut IFAM

Fraunhofer-Institut IFAM  
Institut für Fertigungstechnik und Angewandte  
Materialforschung  
Phone: +49 (0)421-2246-0 | Fax +49 (0)421-2246-300  
**Contact:** Prof. Dr. Bernd Günther  
**Products/Areas of research:** Antibacterial silver

### Institute for Textile Chemistry and Chemical Fibers (ITCF) of the German Institutes for Textile and Fiber Research Denkendorf (DITF)

Research area automatisaton, electronics,  
smart textiles and circuitry  
Körschtalstrasse 26 | 73770 Denkendorf  
Phone: +49 (0)711-93 40 279  
**Contact:** Hansjürgen Horter | [horter@itv-denkendorf.de](mailto:horter@itv-denkendorf.de)  
**Products/Areas of research:** "SensProCloth"

### Massachusetts Institute of Technology (MIT)

77 Massachusetts Avenue | Cambridge, MA 02139  
United States | Phone: +1 617 253 1000 | [Web.mit.org](http://Web.mit.org)  
**Products/Areas of research:** Research into protective  
equipment and armours

### Hochschule RheinMain

RheinMain University of Applied Sciences  
Wiesbaden, Rüsselsheim, Geisenheim  
Kurt-Schumacher-Ring 18 | 65197 Wiesbaden  
Phone: +49 (0)611-94 95-01 | [www.hs-rm.de](http://www.hs-rm.de)  
**Contact:** Prof. Dr. Birgit Scheppat  
**Products/Areas of research:** Refrigerator box running on  
fuel cells

### Institute for Textile Chemistry and Chemical Fibers (ITCF) of the German Institutes for Textile and Fiber Research Denkendorf (DITF)

Körschtalstrasse 26 | 73770 Denkendorf  
Phone: +49 (0)711-9340 103  
**Contact:** Reinhold Schneider  
[reinhold.schneider@itcf-denkendorf.de](mailto:reinhold.schneider@itcf-denkendorf.de)  
**Products/Areas of research:** Development of textiles with  
intelligent luminescent properties for safety clothing and  
technical applications "LUMITEX"

### University of California

608B Stanley Hall #1762 | Berkeley, CA 94720 | USA  
**Contact:** Prof. Daniel Fletcher  
[fletch@berkeley.edu](mailto:fletch@berkeley.edu)  
**Products/Areas of research:** CellScope

\* Selection of institutions or those mentioned  
in this publication

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## Further Information and Technical Details

This brochure is designed to give an overview of the current and future possibilities offered by nanotechnology in the field of Disaster Relief and Development Cooperation. For reasons of space, explanations of scientific and technical details about the underlying chemical or physical phenomena or the mechanisms of action have been largely

dispensed with. However, within the series Hessen-Nanotech these details are available in separate dedicated volumes, and they are recommended as further reading. Overleaf is a list of previously published brochures and available topics, all of which are generally available free of charge.



**Atlas** Kompetenz- und Infrastrukturatlas Nanotechnologien in Hessen  
**Competence and Infrastructure Atlas**  
**Nanotechnologies in Hessen**

**Atlas** Kompetenzatlas Photonik in Hessen  
**Competence Atlas Photonics in Hessen**

**Vol. 1** Einsatz von Nanotechnologie in der hessischen Umwelttechnologie  
 Innovationspotenziale für Unternehmen  
**Uses of Nanotechnology in Environmental Technology in Hessen**  
 Innovation potentials for companies

**Vol. 2** Nanomedizin  
 Innovationspotenziale in Hessen für Medizintechnik und Pharmazeutische Industrie

**Vol. 3** Nanotechnologie im Auto  
 Innovationspotenziale in Hessen für die Automobil- und Zuliefer-Industrie  
**Nanotechnologies in Automobiles**  
 Innovation Potentials in Hesse for the Automotive Industry and its Subcontractors

**Vol. 4** NanoKommunikation  
 Leitfaden zur Kommunikation von Chancen und Risiken der Nanotechnologien für kleine und mittelständische Unternehmen in Hessen  
**Supplement zum Leitfaden NanoKommunikation**  
 Innovationsfördernde Good-Practice-Ansätze zum verantwortlichen Umgang mit Nanomaterialien

**Vol. 5** Nanotechnologien für die optische Industrie  
 Grundlage für zukünftige Innovationen in Hessen

**Vol. 6** NanoProduktion  
 Innovationspotenziale für hessische Unternehmen durch Nanotechnologien im Produktionsprozess

**Vol. 7** Einsatz von Nanotechnologien in Architektur und Bauwesen

**Vol. 8** NanoNormung  
 Normung im Bereich der Nanotechnologien als Chance für hessische Unternehmen

**Vol. 9** Einsatz von Nanotechnologien im Energiesektor  
**Nanotechnology Applications in the Energy Sector**

**Vol. 10** Werkstoffinnovationen aus Hessen  
 Potenziale für Unternehmen

**Vol. 11** Sichere Verwendung von Nanomaterialien in der Lack- und Farbenbranche  
 Ein Betriebsleitfaden

**Vol. 12** Nanotech-Kooperationen  
 Erfolgreiche Kooperationen für kleine und mittlere Nanotechnologie-Unternehmen

**Vol. 13** Mikro-Nano-Integration  
 Einsatz von Nanotechnologie in der Mikrosystemtechnik

**Vol. 14** Materialeffizienz  
 durch den Einsatz von Nanotechnologien und neuen Materialien

**Vol. 15** Nanotechnologie in Kunststoff  
 Innovationsmotor für Kunststoffe, ihre Verarbeitung und Anwendung

**Vol. 16** NanoAnalytik  
 Anwendung in Forschung und Praxis

**Vol. 17** Nanotechnologie für den Katastrophenschutz und die Entwicklungszusammenarbeit  
**Nanotechnologies for Disaster Relief and Development Cooperation**

**Vol. 18** Material formt Produkt  
 Innovations- und Marktchancen erhöhen mit professionellen Kreativen  
**Materials shape Products**  
 Increase innovation and market opportunities with the help of creative professionals

**Vol. 19** Patentieren von Nanotechnologien

**Vol. 20** Nanotechnologie in der Natur - Bionik im Betrieb

**Web-Pub 1** Intelligente Materiallösungen zum Erhalt von Werten



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