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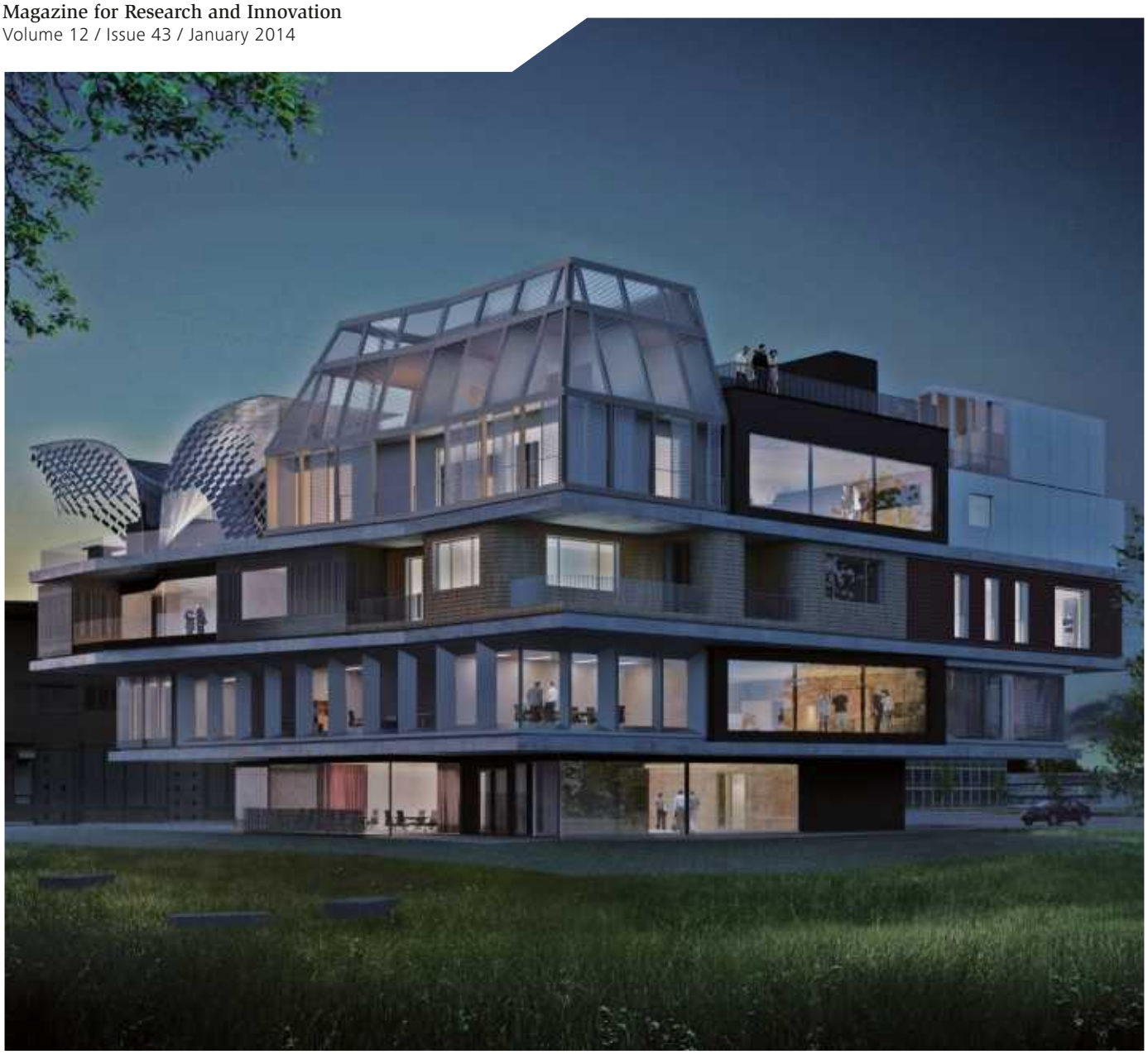

Researching the house of tomorrow

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MICHAEL HAGMANN Head of Communications

The house of tomorrow

Dear readers

We certainly don't have to reinvent the wheel. The same cannot be said of houses, though. NEST, the Empa research and demonstration platform for advanced and innovative building technologies, wants to do precisely that: lay the foundation for housing, living and working in tomorrow's world.

And hopefully soon in the truest sense of the word. The funding – at least for the central backbone – is largely in place; only recently the ETH Board approved a further 5.5 million Swiss francs for what is indeed the most ambitious building research project in Switzerland, if not in Europe. The first units are already being designed by various partners. In this edition of EmpaNews we present them to you for the first time in more detail (see pages 4 – 9).

Textile research is focusing on slightly subtler materials. Empa researchers are using plasma technology to equip fibers and fabrics with highly diverse properties and attributes, "functionalizing" them, so to speak. One of the objectives is smart clothing, wearables. This process results in some astonishing "by-products" – please excuse the expression – like, for instance, the high-quality, golden lace lingerie on page 14, which a resourceful Swiss textile manufacturer would now like to market to (wealthy) ladies. Very much in keeping with the time of the year.

Merry Christmas and enjoy reading!

Glimpse inside the flexible office of the future. The "Meet2Create" module of the University of Lucerne for Technology and Architecture will be part of Empa's research building, NEST. 08

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Cover
Empa research platfom NEST as it will look like in 2015. Read more about the different modules researching work and living of the future at page 04 - 09. Picture: Empa

Reinventing the house

Around half of the energy demand in Switzerland is generated by buildings and every year ten tons of construction materials per capita are being used up. If we want to import fewer fossil fuels and reduce raw material consumption, we simply have to develop and test novel buildings in practice. The Empa research platform NEST has been conceived to do just this.

TEXT: Peter Richner, Deputy Director of Empa / Pictures: Empa

There is scarcely any other sector in the economy, in which it is more difficult to establish new ideas and concepts on the market than the construction industry. The reason: high investment costs that have to be amortized over long periods lead to a reluctance when it comes to taking risks, which is further exacerbated by the sheer volume of rules and regulations. To bring new ideas and concepts more quickly to market, demonstration projects are needed which are constructed, inhabited, used under real-world conditions and accompanied scientifically during this phase – and this is precisely the objective of NEST "Next Evolution in Sustainable Building Technologies".

Research facility for universities and construction industry

Empa and Eawag, its sister institute (for water research), are establishing the research and technology platform NEST – a pilot and demonstration building for the construction solutions of the future – on their joint campus in Dübendorf with the support of the ETH Domain as well as public and private funding; leading corporate partners from the construction industry, universities of applied sciences and various Swiss and foreign universities are involved.

Limited risks – practicable results

NEST will be used, amongst other things, as a guest house for researchers from all over the world visiting Empa and Eawag. The occupants are to use and evaluate the house.

However, NEST not only explores innovative residential and work forms but also energy flows and supply technology for the houses of tomorrow. The research modules are supplied from the central backbone with water, heat, electricity and Internet access. The usage data of the individual modules are evaluated in depth. The backbone is scheduled for completion in early 2015. In parallel, the first research modules are to be installed. Four teams have already started work on their modules. They are presented on the next pages.

In addition to existing partners from science and industry, Empa is constantly on the lookout in the future, too, for innovative companies interested in using NEST to develop novel products and systems. Find out more on the website ***nest.empa.ch*** //

Website
Empa research platform NEST – infos and animated walkthrough
nest.empa.ch

NEST
exploring the future of buildings

City Lifting: urban aggregation by 'topping up' buildings

Urban sprawl in Switzerland is on the rise. That's why the provident handling of undeveloped land and urban aggregation, i.e. a more intensive use of already developed areas, are important topics in Swiss land-use planning. The potential for urban aggregation, for instance by adding roof extensions, is considerable. The City Lifting project would like to contribute to a sustainable construction industry by developing a system for adding roof extensions to existing buildings. There are plans for a sustainable lightweight construction system with a combination of timber and composite elements. The City Lifting prototype is to be implemented as part of the NEST project.

A highly flexible system is needed to accommodate the major differences between existing buildings such as geometry, development, statics and building services. City Lifting uses modular structural elements to distribute the loads over the facade of the building that's going to be topped up. Floors and false ceilings are mounted between the walls. Roof elements span the entire system.

The 60 or 90 centimeter-thick modular elements not only take on a static function. They harbor prefabricated components of various types of infrastructure like stairs, toilets, showers, bathtubs, kitchens, built-in cupboards, closets, bookshelves, and the like. These elements can be used to create living space for students.

The City Lifting unit will be superimposed on the roof at the north-eastern corner of NEST in the spring of 2015.

http://nest.empa.ch/de/innovationen/modulares-bauen/city-lifting/

NEST
exploring the future of buildings

HiLo: the penthouse of the future

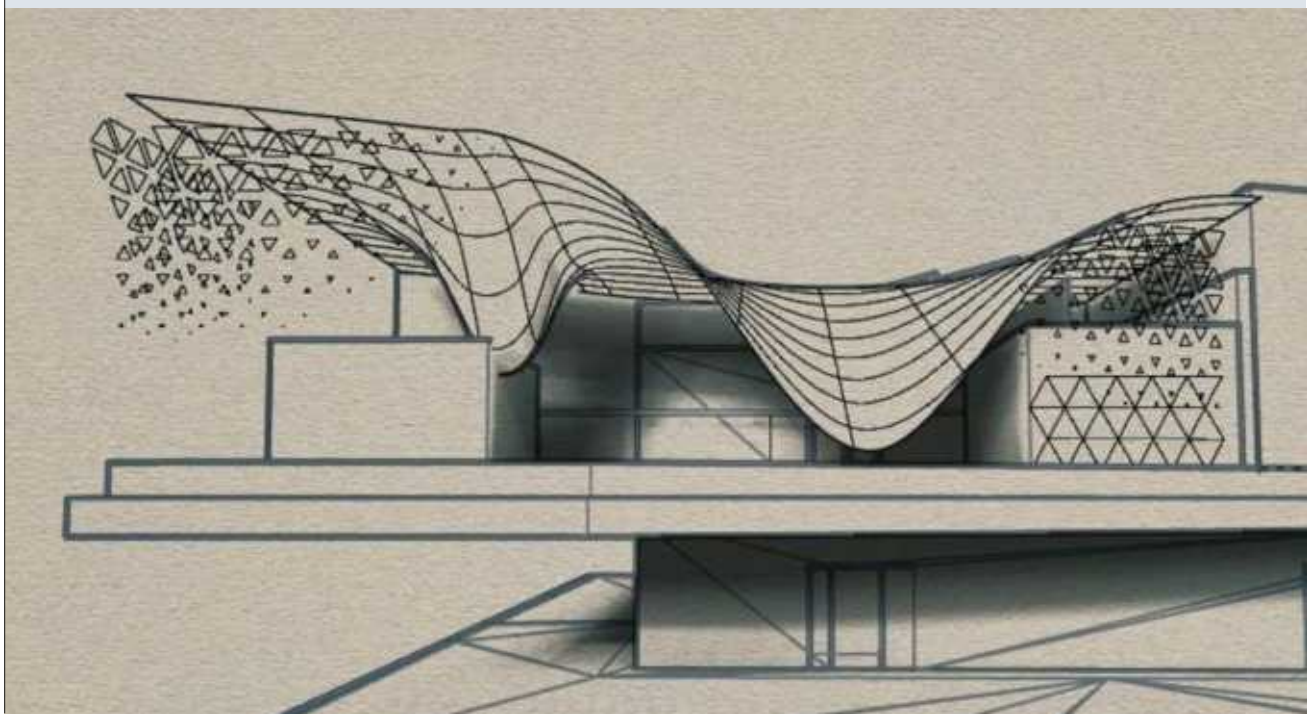
One of the most ambitious construction projects of NEST is currently going to takeing shape on the south-east corner of the uppermost platform: the HiLo module of ETH Zurich. The pProject directors coordinators are Philippe Block and Arno Schlüter from the Institute of Technology in Architecture. They are assisted by the architecture practice offices Supermanoeuvre from Sydney and Zwarts & Jansma Architects from Amsterdam.

The two project directors have a very futuristic take on several aspects of the building's design and technology: a thin, undulating concrete ceiling, just a few centimeters thick, sits proudly on the two-storey loft. It is not poured, as is customary, onto wooden lagging but onto a fabric supporting structure placed over a taut wire cord grid. The result: an organic, self-bearing shape that is both elegant and light. By way of comparison: traditional ceiling constructions are about 30 centimeters thick. The wave-like concrete ceiling will be covered with flexible solar cells at a later stage. The spin-off company Flisom, whose expertise comes from Empa, is currently in negotiations for this project work.

The loft's false floor of the loft also draws on a special lightweight construction system: thin, arched concrete shell elements – similar to the curve of an egg – make up the hollow supporting structure. A level floor is superimposed. The advantages of the hollow construction: firstly, it is 70 percent lighter than a normal ceiling. Secondly, the curved shells offer a large surface area for heating the penthouse efficiently. Lukewarm water, that takes less energy to produce, is already sufficient for heating purposes.

The energy management of the loft on the sun-drenched south-west corner is artful and groundbreaking, too: an adaptive facade, positioned in front of the glazing, aligns its solar panels with the sun's changing position. The movably mountedmobile panels also serve to regulate the interior air conditioning: they provide shade in the living room when there is strong bright sunlight and keep it cool. In the morning and evening they allow more light in to keep the loft warm. This is all done automatically even when the apartment is empty. When the occupants are home, they can work the facade like a blind and allow more or less light in at the touch of a button. The penthouse is designed as a plus-energy module.

http://nest.empa.ch/de/innovationen/leichtbauweise/hilo/



NEST
exploring the future of buildings

Meet2Create: more than just a workplace

An innovative building project such as NEST has to encompass innovative work environments, too. Meet-2Create is the name of a project of the Competence Centre for Typology and Planning in Architecture (CCTP) of the University of Lucerne. It puts into practice the vision of a future working environment. It moves away from the classical individual working space towards an open office landscape conducive to collaboration, networking with external teams and project developments. Individual working places are replaced by diverse 'taskspaces' that lend themselves to flexible use. The spatial structures can be adapted to different team sizes and work processes. Areas can thus easily be created that can be separated off for meetings and presentations or provide more intimate settings for smaller teams. Meet2Create can respond in terms of space and technology to new and changing requirements.

Conventional office buildings are under constant pressure to adapt. If a building cannot keep pace with change, it runs the risk of standing empty – and eventually of being demolished. The goal of Meet2Create is to investigate new opportunities for the use and adaptation of space in order to respond as efficiently as possible to new requirements. An easy-to-use modular interior is the first step towards facilitating concentrated work as an individual or creative cooperation in a team.

Interior design is not the sole focus of Meet2Create, though. The facade must also be conceived flexibly to cater for varying situations and needs. Different types of facade are used in the various areas of the unit. The layered facade will provide different elements like sun protection, daylight control or greened facade components, which can be combined in a variety of ways and moved around on rails. Important aspects of daylight use and the individual adjustment of temperature, light and air are tested in the Meet2Create office landscape. The result should be a creative, pleasant working climate that fulfils individual comfort needs whilst keeping the eco-footprint to a minimum. The Meet2Create unit is scheduled for completion in the spring of 2015 and will offer the NEST development team an inspiring place to work.

http://nest.empa.ch/de/innovationen/bueros-der-zukunft/meet2create/

NEST
exploring the future of buildings

Visionary Wood: surprisingly wooden

In the Visionary Wood housing unit Empa researchers are going to demonstrate that forward-looking solutions for ecological construction and energy-efficient housing can be developed using a very well-tried material: wood. They have set out to prove that wood can offer an excellent combination of appealing design, comfortable living and sustainability.

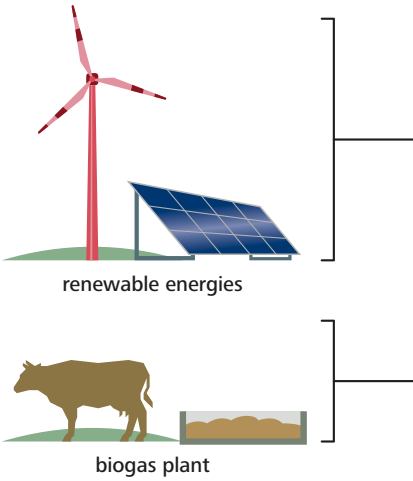
The Visionary Wood module not only draws on proven expertise in modern wood construction, it also takes up the latest wood research findings. New products made from wood-based products are being developed specifically for this module. They aim to help improve insulation or soundproofing. Some elements are even being equipped with novel properties. Some day the Visionary Wood module could boast magnetic wooden pin boards or wood in wet areas, from which water simply trickles off. This opens up completely new prospects for architects and interior designers.

The team around Tanja Zimmermann, Head of Empa's laboratory for Applied Wood Materials, is coming up with the most diverse solutions together with project partners from industry and academia. For instance, acoustic insulation boards made from wood treated with fungi, which are highly efficient in muffling specific overtones, or wood fiberboards for heat insulation that use a timber enzyme instead of conventional adhesives.

Moreover, there will be weather-resistant timber facades, which are water-repellent not only on the surface but also inside the timber structure, as well as mineralized wood components for fireproof, stable frames and facades that are reasonably priced and environmentally friendly, down to timber elements that can change shape depending on air humidity, which may perhaps be suitable as fixtures for solar cells tracking the sun. Furthermore, the Visionary Wood module will also harbor environmentally compatible, UV-resistant flame retardants and textiles like carpets, curtains or mattresses made of biodegradable biopolymers developed by Empa's Advanced Fibers laboratory. The module is scheduled for completion in the spring of 2015.

http://nest.empa.ch/de/innovationen/natuerliches-bauen/natural-living/

www.plavisdesign.it



Interim storage for green electricity

"Power-to-Gas" is a key concept when it comes to the storage of alternative energies. Excess energy from solar cells and wind farms is converted into hydrogen. When combined with the greenhouse gas CO_2, methane can be produced that can easily be stored and distributed in the natural gas grid. Empa researchers have now succeeded in further optimizing this process.

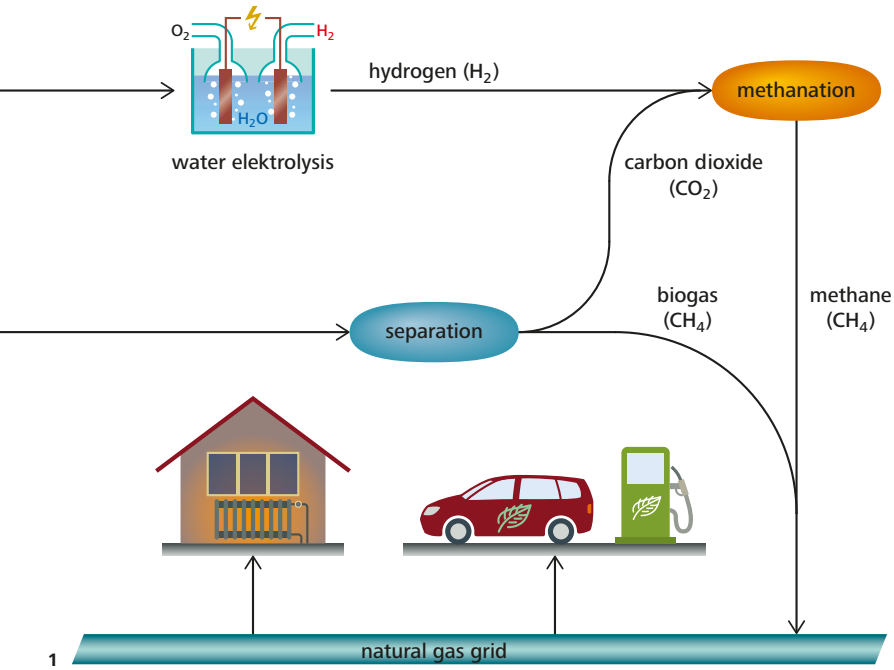
TEXT: Cornelia Zogg /
PICTURES, ILLUSTRATION: Empa

Photovoltaic systems and wind power plants generate large volumes of renewable energy. Depending on the wind and weather conditions there is, however, often a surplus that cannot be used productively. A storage facility for excess energy would help to remedy this situation. Already today excess power can be converted into hydrogen (H_2) by water electrolysis. Hydrogen can serve as an energy reservoir but methane would be an easier option. It is the main component in natural gas and can be produced quasi from "waste products": besides combustible methane the production of crude biogas also yields large amounts of carbon dioxide (CO_2). Before being discharged into the natural gas grid biogas must first be desulfurized, dried and stripped of CO_2. The separated CO_2 is normally released into the atmosphere; biogas is thus a renewable energy source but also a factor in carbon dioxide emissions that shouldn't be underestimated.

The methanization process can use the CO_2 from biogas production. With hydrogen from excess green electricity it supplies "clean" methane that can be distributed easily and cheaply in the natural gas grid, and stored over longer periods, too. This means that a quasi 'fossil' fuel is produced from renewable energies – the basic principle of "Power-to-Gas".

Process optimization using zeolites

The Sabatier reaction, which produces combustible methane from hydrogen and CO_2 , is a well-known process. Now researchers in Empa' laboratory for Hydrogen and Energy have succeeded in further optimizing the process. A catalyst, for instance nickel, is needed to trigger the reaction between CO_2 and hydrogen with as little energy input as possible. On a catalyst surface of this kind, the gas molecules react more readily with one other – the energy input for the reaction is reduced. This is called adsorption catalysis. Empa scientist Andreas Borgschulte and his team have now combined a nanoscale nickel catalyst with a zeolite. Ze-



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1
Hydrogen can be extracted from excess green electricity at certain times of the day (above). It is combined with CO_2 from crude biogas to form methane in a special reactor. A valuable climate-neutral fuel has been made from waste materials and "waste energy".

2
Andreas Borgschulte with the zeolite particles used in the new methanization method.

3
Data from the reactor prototype (on the left), in which methanization takes place, are recorded and analyzed.

olites are crystalline alumosilicates with the capacity to absorb water molecules and then release them when heated.

The principle is simple: during the chemical reaction between hydrogen and CO_2 not only methane (CH_4) but also water (H_2O) is formed. The researchers use the zeolite's "hygroscopic" property to remove water. The chemical balance shifts towards methane. The result: a higher yield of pure methane and, by extension, a far more efficient catalytic process. As soon as the zeolite is saturated with water, it can once again be "unloaded" by heating and vaporizing the water and then be used again.

Wanted: project partners

The process does work but for the time being only on a laboratory scale. It's still a long way to commercial use in large-scale plants according to Borgschulte. Right now, the Empa researchers are looking for project partners in order to build a methanization plant on a larger scale and to use it as a pilot project. At the same time, Borgschulte's team is planning to further optimize the process. The next step involves using four or more adsorption catalysts simultaneously. When one is full, saturated with water, the plant automatically switches to the next "dry" catalyst whilst the previous one is devaporized.

One problem encountered with this cyclic method so far is sulfur, which is also formed together with methane and CO_2 in biogas plants. Sulfur compounds can cause irreversible damage to the zeolite. The researchers are working on ways to absorb the sulfur from the crude biogas and keep the zeolite functioning as long as possible.

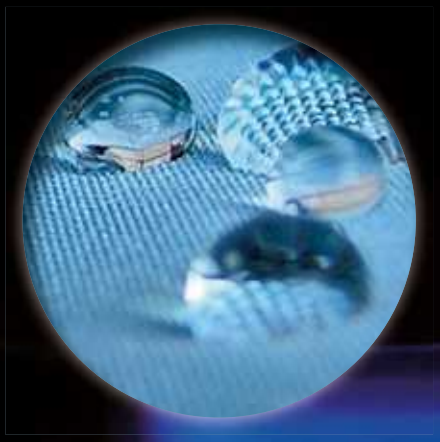
In future Borgschulte thinks that new, more efficient catalytic materials than nickel are feasible in combination with zeolites. They could further improve the Sabatier process. Then the excess green electricity would no longer be a disposable product. //

Zeolites

Zeolites are already being used in many areas for instance as ion exchangers in water softeners, as dishwasher drying agents and as EDTA substitutes in detergents. Moreover, zeolites are suitable for water decontamination because they store metal ions like the nickel used for methanization. In the nuclear disaster in Fukushima researchers tried to use zeolites to bind radioactive cesium and strontium isotopes from the wastewater flowing into the sea.
Another example of zeolite applications is the self-cooling beer keg – the water-absorbing capacity of zeolite produces evaporative cooling, which keeps the beer cold without electricity.

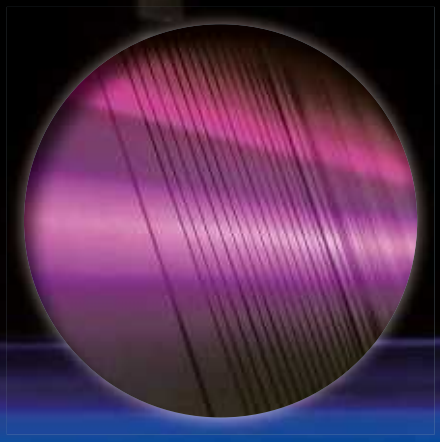
Textiles vs. dirt – 1:0

To protect fibers from water, they are plasma-coated with nanometer-thin siloxane layers. An extremely oleophobic (i.e. oil-hating) fluorocarbon impregnation developed by Empa affords an additional protection against dirt. It doesn't allow ketchup, salad dressing, red wine & Co to penetrate the fabric at all – the offending substance can be simply rinsed off.



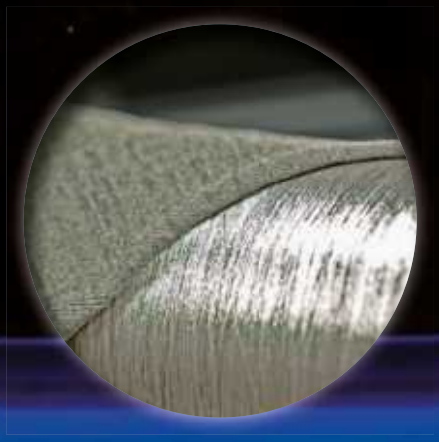
A catalyst against odors

With stable, non-toxic and reasonably priced titanium dioxide as the target material, fibers can be engineered that catalytically decompose attached molecules – for instance from ambient air – after exposure to light. The result: curtains, furniture covers or home fabrics that can neutralize unpleasant smells.



Metalized for the hospital

Metals like silver reflect visible light. They are excellent thermal and electrical conductors and almost impenetrable barriers for gases. In addition to conductive and antibacterial fibers, for instance for use in hospitals, ultra-thin metallic layers on polymer fibers can also be used to manufacture decorative fabrics for fashion applications (see "Hightech for soft skin", p. 14).



Fabrics from the ion ch

Plasma treatment equips fibers and textiles with new properties without a breathability or haptics. The technology is dry and environmentally-friendl activated to a plasma state in a vacuum chamber by an electrical field. Act can either settle directly on the fiber surface or knock out atoms from a ta can then be vapor-deposited on the fibers. The resulting layers are just a f

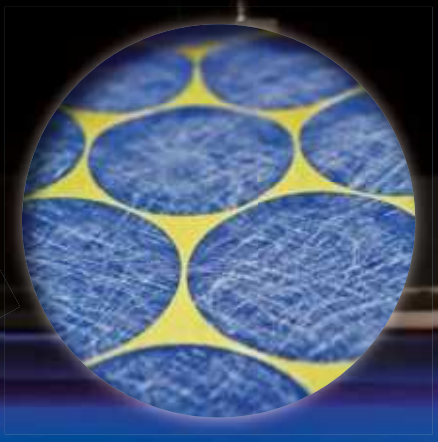
TEXT: Martina Peter / PICTURES: Empa, iStockphoto

Textiles should not “rust”

A thin titanium dioxide layer can also provide protection. It prevents silver coatings on fabrics from corroding. This helps, for instance, patients who have to wear ECG body-surface electrodes for longer periods of time, which have to be moistened and are equipped with conductive silver fibers.

For longer service life

Extremely thin polymer layers can be produced from gaseous hydrocarbons in plasma. Depending on the strength of the electrical field, the monomers cross-link to varying degrees in the plasma chamber. This can reduce the abrasion of fibers and increase protection against wear and tear. Water filters benefit from a longer service life.



Docking station for molecules

Through plasma treatment fabrics and fibers can be fitted with functional molecular groups, for instance with carboxyl or amino groups. This turns them into docking stations for chemical or biological molecules in ensuing subsequent wet chemical process. Color molecules, for instance, adhere better to fabrics or the fibers in a coated wound dressing promote cell growth to support the body’s healing process.

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Hightech for soft skin

A Swiss entrepreneur has created an exclusive lingerie collection using gold-coated yarn developed at Empa. It is proving particularly popular in the Middle and Far East. And soon his female clients will be literally "swimming in gold".

TEXT: Dominique Bitschnau / PICTURES: Rococo Dessous, Empa

Gold is the epitome of luxury. Thousands of years ago princes and kings already adorned themselves with the glittering metal. And it is still a status symbol of the well-to-do even today. The St. Gall entrepreneur Sascha Hertli was quick to grasp this. He is the CEO of Rococo Dessous, a range of lingerie made from gold fabrics – a worldwide first. The products are exclusive: the "cheapest" item in the collection amounts to 1,200 Swiss francs. The prices know no limits and depend only on his clients' wishes. The basis for the luxury products of Rococo Dessous was provided by Empa. In the laboratories in St. Gall a gold yarn was developed, which is soft and clingy and even survives several washing machine cycles without suffering any damage– the prerequisite for wearing the gold yarn on bare skin.

For now Hertli seems to be spot on with his idea. Since he founded Rococo Dessous in May 2013 dozens of lingerie sets have been sold. "The greatest interest has quite clearly been shown in the Middle East", says Hertli. The luxury lingerie is also available in the USA, in Russia and in selected boutiques in Europe. The next market the 29-year-old wishes to conquer is China. Indians are also deemed to be lovers of gold. An up-and-coming middle class there could soon see the demand for precious metal adornment worn on bare skin rocketing. Hertli is ready. He

>>

Video
Debut of Rococo Dessous at the Lingerie Fashion Week, New York.
http://tv.empa.ch/Rococo.mov

How is gold applied to the threads?

Empa uses a technique called magnetron sputtering to anchor gold – or any other metal, for that matter – on yarn. All they need for this is electricity, a gold nugget, a few liters of argon gas and a vacuum container large enough to unwind 4,000 meters of yarn in narrow loops.
Inside the vacuum-plasma coating machine designed by Empa, the piece of gold – called a target – is bombarded with argon ions. Gold atoms fly off and land on a polyester fiber, which is slowly pulled through a machine just a few centimeters from the target.
The exact settings that ensure that the gold adheres to the fiber are, of course, trade secrets.

The first major appearance of the lingerie made from Empa gold yarn: Lingerie Fashion Week, New York, August 2013.

meets his clients in the luxury hotels of affluent cosmopolitan cities and presents his collection at fashion shows around the globe, for instance at the New York Lingerie Fashion Week in August 2013.

Real gold on bare skin

It is all down to Empa that real gold can now encounter soft skin. Gold embroidery was already coveted in past decades but it didn't last long. In the past the yarn was manufactured like the strings of a guitar. Wafer-thin golden wire was wrapped around cotton or silk yarn. The yarn was scratchy and not at all pliable. And you could forget about using a washing machine. The opposite is true of the Empa yarn that Sascha Hertli uses for his lingerie. "You can rub and knead the yarn as much as you like, the gold doesn't budge from the polyester fibers", enthuses the fashion designer. The super yarn can even withstand up to six hours at 80 degrees Celsius in the washing machine. However, hand washing is highly recommended to protect the lace in the lingerie, says Hertli. His clients have no problem with this. "The ladies who purchase our lingerie don't do their own washing anyway."

"Cold vaporization"

To develop a metalized yarn that is as silky as a normal fabric but still non-abrasive Empa engaged in basic research for more than ten years. The method is suited to anchoring various metals on yarn. Antibacterial socks that are less smelly can be produced from silver-coated yarn. Industry, too, uses the Empa silver yarn to weave textile filters, the functioning of which can be monitored by voltage. As soon as the filter tears anywhere, the power supply is interrupted and a technician is alerted.

Up to now gold-coated yarn offered no technical applications. However, the fashion industry is very interested because only Empa can anchor the gold to the thread in a machine-washable manner. The method is as follows: inside a vacuum plasma coating machine there is a fiber and a 24-carat gold nugget. The nugget is bombarded with ions, individual gold atoms fly off. They more or less vaporize at ambient temperature – and land on the fibers. One yarn is made from around 100 of these polyester fibers. The scientists patented the novel method; industry came on board.

Neo-entrepreneur Hertli heard about the gold yarn in the summer of 2012 and saw a huge opportunity in the lingerie market. "Gold is everywhere except in the clothing sector." He hired the New York designer Breanna Lee who had already created underwear for the well-known lingerie company "Victoria's Secret". Together, they developed three different collections. Clients can choose between models made completely from gold or with black or white as the basic color with gold lace. Most of the production process remained in Switzerland. The gold yarn is produced by Tersuisse in Emmenbrücke near Lucerne and further processed in the embroidery atelier Bischoff Textil AG in St. Gall. The final sewing on the garments is then done in New York.

Swimming in gold

Although the lingerie sales are still being established, Hertli has already set his sights on the next product: swimwear. On a white or black sandy beach, by the blue sea is where the future collections will appealingly showcase their wearers. According to Hertli saltwater does not pose a problem for the textile pieces with the Empa gold yarn either. "We are only probing with the right elasticity." Once the solution is at hand, people will be able to admire the Empa innovation on the most exclusive beaches and pools around the globe, too. //

Hangover for catalytic converters

A long-term road trial with six cars revealed that the admixture of (bio-)ethanol to gasoline makes the catalytic converter age faster. The catalytic converter of a gasoline-driven car retrofitted for biogas didn't even last 40,000 kilometers. Overall, the catalytic converters did, however, prove to be surprisingly robust in the practical trial.

TEXT: Rainer Klose / PICTURES: Empa

Test bench measurements after 10,000 km: project leader Potis Dimopoulos Eggenschwiler (right) discusses the damage-pattern inside of the catalyst with technician Mathias Huber.

Without the famous 3-way catalytic converter our air would be far more polluted. That's why Empa took a very close look at this component in a long-term study. The question was: what happens to the sensitive precious metal coating in the course of 40,000 kilometers of normal driving? The catalytic converter not only comes into contact with the combustion gases, which it breaks down chemically and then releases as harmless substances into the environment. Fuel, engine oil and even the engine itself release substances into the exhaust gas, which can "poison" the surface of the catalytic converter: sulfur, phosphorous, calcium, magnesium and zinc stem from burnt engine oil, iron from the mechanical wear and tear of the engine. So how much "toxin" must a catalytic converter be able to bear and when does its efficiency start to suffer? And: do bioethanol and natural gas/biogas place an additional burden on the catalytic converter?

In order to compare various fuel options, the researchers chose as the test subject a widely used mid-range car officially approved by the manufacturer for both gasoline and bioethanol (E5-E85). What's more, in Switzerland this vehicle is also available in a version retrofitted for natural gas. Four of these vehicles were equipped with a catalytic converter and each driven more than 40,000 kilometers in normal traffic. One of the vehicles was powered with pure gasoline (E0), one with gasoline with a 5% ethanol admixture, like the mixture sold at gas stations as Super95. One car was powered with E85 – a mixture of 85% ethanol and 15% gasoline. The fourth vehicle ran on natural gas from the Swiss grid. After every 10,000 kilometers exhaust gas behavior was examined on Empa's motor lab.

In order to also measure the impact of engine oil on catalytic converter aging, two other natural gas vehicles from a different manufacturer were included. One was driven the 40,000 kilometers on normal long-life oil in line with the manufacturer's recommendations. The engine of the second vehicle was filled with a special low-SAPS oil developed for diesel vehicles with a particle filter containing less sulfur and phosphorus (which should protect the catalytic converter). Three Swiss oil producers and the manufacturer of the catalytic converter participated as industrial partners in the project.

The result: eco-fuel clogs up catalytic converters

After 40,000 kilometers the research team took the catalytic converters apart and examined their surfaces using an electron microscope and the deposits using X-ray spectroscopy. The pure gasoline option had done the least damage to the catalytic converter and left behind the least harmful deposits. But already the admixture of 5% bioethanol led to visible changes in the surface of the catalytic converter: the active layer, called the washcoat, was eroded much more. Also, more ash was observed on the surface of the catalytic converter, which partially covered the active layer. The same effects were even more obvious in the case of the vehicle run on E85. At the entrance to the catalytic converter not only the top but also the underlying washcoat layer was partially eroded. In addition, there were compact ash layers on the damaged surface.

The examinations of the converted natural gas vehicle had to be abandoned because the engine control was so unreliable that the catalytic converter already burnt out during the test phase due to overheating. There were holes in the honeycomb structure. The situation was different in the case of the two factory natural gas vehicles: their catalytic converters showed similarly good performance to the catalytic converter of the gasoline-driven vehicle. The researchers merely noted minor ash deposits that could be attributed to the special engine oil. Project leader Potis Dimopoulos Eggenschwiler: "The more oil an engine consumes, the more phosphorus, calcium, magnesium and zinc we found on the surface of the catalytic converter – albeit in amounts that scarcely impact its performance. Bioethanol, by contrast, attacks the active catalytic converter layer directly." The overall damage during the long-term trial was, however, only minor; but the causes will have to be explored in further studies according to the Empa scientist.

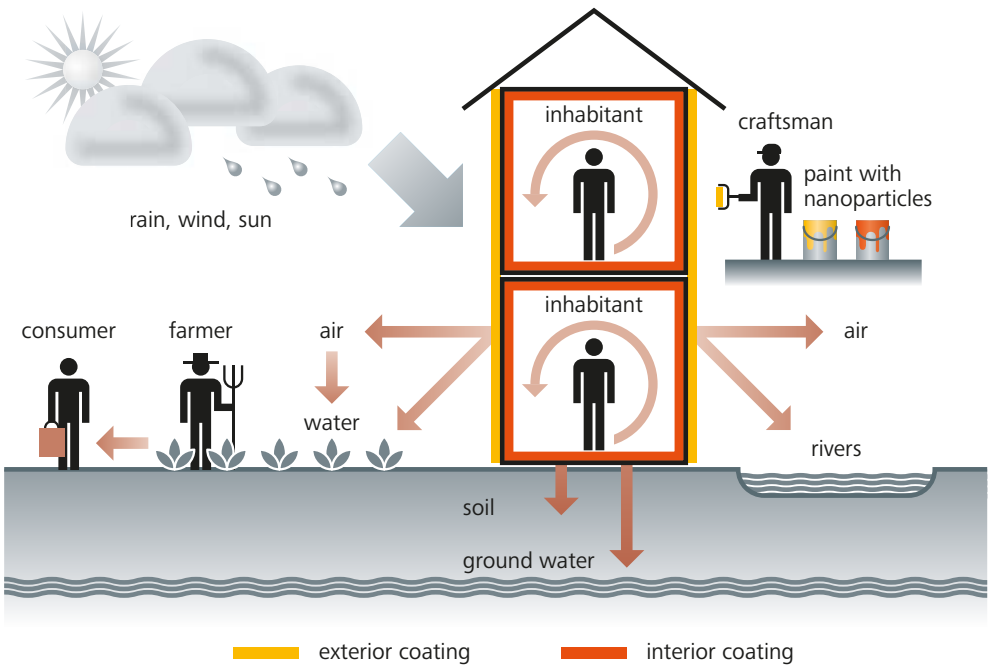
"Long" catalytic converters help

The good news is that the exhaust gas emissions scarcely worsened despite the partially visible damage to the test converters. The reason: damaged washcoat layers and ash deposits were observed above all at the front end of the catalytic converters – where the exhaust gas is the hottest and its passage through the honeycomb structure the most turbulent. Further back all the catalytic converters were intact and could maintain their cleansing performance. The manufacturers are aware of this and they are, therefore, integrating longer catalytic converters than required by the type test. This is the only way of complying with the stiff durability requirements of exhaust gas legislation, which specify that a catalytic converter must last for at least 160,000 kilometers. //

All-clear for nanopaints

After 42 months the EU research project “NanoHouse” culminated in a cautious all-clear. Nanoparticles in facade paint do not constitute any extraordinary health risk. Five research institutes and four industrial partners had jointly investigated the opportunities and risks of nanoparticles.

TEXT: Rainer Klose / ILLUSTRATION: Empa



To determine the opportunities and risks of nano-additives in facade paints, a trust-based solution had first to be found for the four industrial partners. None of the companies wanted to hand over its commercial paints for testing. But reliable risk research can only function when all the paint ingredients are known. The trade secrets of the paint mixtures would have been disclosed. The solution: the paint manufacturers Materis Paints Italia, GFC Chimica, AKZO Nobel Coatings S.A. and PPG Europe BV all agreed to manufacture a standard test paint. This paint, well-suited to everyday use, contains nanoparticles but no company-specific ingredients.

The unique feature of the "NanoHouse" project was that the analysis not only covered engineered nanomaterials straight out of the lab but also aged nanoparticles and those "embeded" in a commercial product. The institutes shared the work: at Empa the test facades were artificially weathered (rain, heat, sun) and the released particles were characterized. The French CEA (Commissariat à l'énergie atomique et aux énergies alternatives) was responsible for the abrasion tests on parts of the facade. The Italian CVR (Consorzio Venezia Ricerche) immersed fresh paint samples aged under UV light in water to measure leaching and the Université Joseph Fourier in Grenoble studied the plant uptake of nanoparticles. They also looked at leaching from construction debris, i.e. aged facade fragments, and emissions in waste incinceration. The analysis of the environmental risks and biological effects of the released particles was again the task of Empa.

Very low emissions

The results of the comprehensive investigation can be taken as an all-clear. Even in the case of nanopaints aged under UV light, only 1 – 2 percent of the mixed-in nanoparticles reached the environment. And these particles are not out and about on their own but mostly bound to larger paint particles. This considerably reduces their nanospecific effect. "We were very surprised by just how few particles escaped", admits Empa researcher Bernd Nowack. In the abrasion tests there were only minor differences between paints with and paints without nanoparticles.

Even in the case of leaching from building debris only a very small proportion of the original particle load is washed out. In waste incineration the facade paints form a solid agglomerate. The nanoparticles remain in the ash and do not even reach the air. And: just like pure nanoparticles (particles of silver, titanium dioxide and silicon dioxide were examined) nanoparticles released from paint did not turn out to be acutely toxic in cell tests.

Future opportunities

Through a survey of companies and in cooperation with the industrial project partners, numerous opportunities were likewise identified for future energy and material savings thanks to the use of nanomaterials, for example the longer service life of easy-to-clean (nano-)facade paints. The Empa team around Roland Hischier also drew up ecobalances on this subject in order to identify which properties the "nanopaints" must possess in order to offer advantages over conventional paints from an environmental point of view.

According to project leader Claudia Som there is currently no cause for concern about nanopaints. However, the results should not be generalized either. Strictly speaking the research findings only apply to the test paints and nanoparticles used. Another research finding: nanopaints are only better than conventional paints in terms of holistic environmental assessment if they offer added value, for instance a considerably longer service life. //

Empa-website of the EU-project NanoHouse: *www.empa.ch/nanohouse*

Anti-ageing for concrete structures

The Middle East has been experiencing a construction boom for some 20 years now. Whilst spectacular skyscrapers like the Burj Khalifa are making the headlines, the question remains: how can such huge concrete structures be kept "healthy" and stable for decades to come?

TEXT: Rainer Klose / PICTURE: Empa

Anyone who takes a look at images of Dubai from 1990 and compares them with today's views will be amazed. Rarely before has a region experienced a construction boom of this magnitude. However concrete – the material used for most of the high-rise buildings – is not designed to last forever. Germany is battling the decay of its "Autobahn" (highway) bridges from the 1960s. Oscar Niemeyer's model city Brasilia, completed 50 years ago, is crumbling away, too.

Expert know-how is needed to ensure that the icons of the Middle East construction boom will still be standing in the long term. Empa construction specialist Massoud Motavalli holds a professorship at the University of Teheran and is a lecturer at ETH Zurich. He champions the exchange of experience between East and West. In September 2013 the second SMAR conference (Smart Monitoring, Assessment and Rehabilitation of Civil Structures) was held in Istanbul. This series of conferences began in Dubai in 2011 and will continue in Antalya in 2015. Its partners are the respective national universities like the American University in Dubai (2011) and Istanbul Technical University (2013 und 2015).

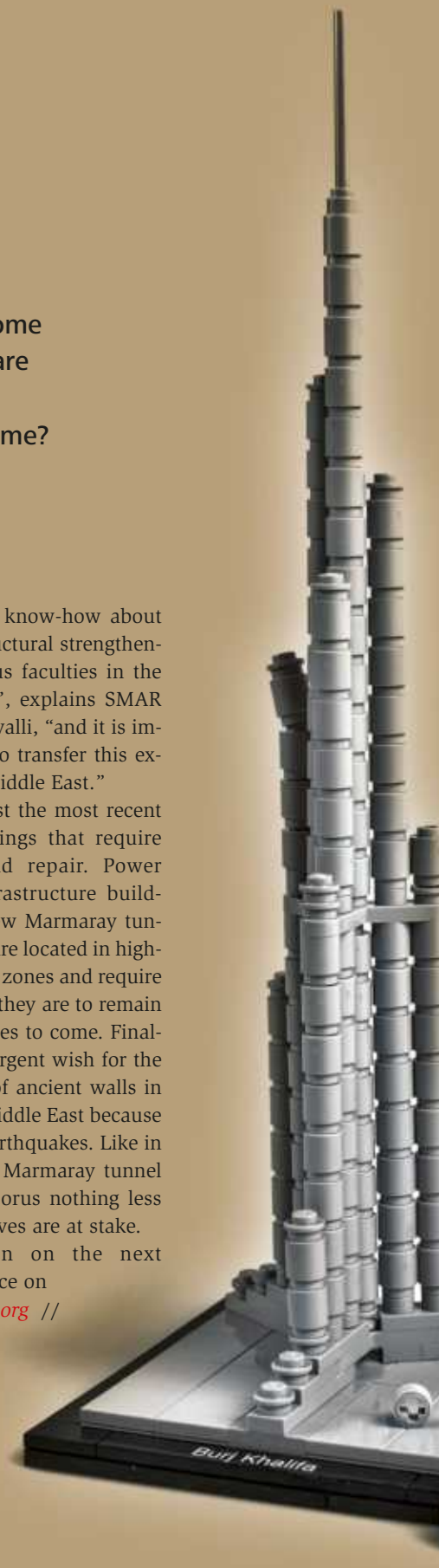
Around 200 construction researchers from 28 countries came to Istanbul for three days to hear the latest news about reinforcement and monitoring techniques for high-rise buildings. One of the main topics was the reinforcement and repair of concrete structures and steel girders using carbon-fiber-reinforced polymers (CRFPs). One of the keynote lectures was given by Urs Meier, former Empa CEO and the doyen of this reinforcement technology.

Transferring expertise

A number of lectures were also given by other Empa scientists, for instance on reinforcing girders made of glue-laminated timber, the wireless monitoring of bridge vibrations and the retro-strengthening of walls. "There is considerable know-how about this kind of structural strengthening in numerous faculties in the Western world", explains SMAR organizer Motavalli, "and it is important for us to transfer this expertise to the Middle East."

It is not just the most recent high-rise buildings that require monitoring and repair. Power plants and infrastructure buildings like the new Marmaray tunnel in Istanbul are located in high-risk earthquake zones and require maintenance if they are to remain intact for decades to come. Finally, there is an urgent wish for the reinforcement of ancient walls in the Near and Middle East because of the risk of earthquakes. Like in the case of the Marmaray tunnel under the Bosporus nothing less than people's lives are at stake.

Information on the next SMAR conference on *www.smar2015.org* //



Burj Khalifa's Lego model could easily crumble away. It will take monitoring and maintenance to keep this shining skyscraper intact.

Chemistry prize for nanocrystal research

Chemistry prize for nanocrystal research
The Ruzicka Prize 2013 was awarded on 4 December to the ETH Assistant Professor and Empa researcher Maksym Kovalenko. The native Ukrainian has been very successful in his research on new nanomaterials for use in electronics, optics and high-performance batteries. Kovalenko finished his PhD in 2007 at the Johannes Kepler University in Linz. In his thesis he examined nanocrystals and their applications in optical infrared (IR) instruments. From 2008 to 2011 he worked as a postdoc at the University of Chicago developing new procedures for modifying the surface of nanostructures in dispersions. With this he laid the foundation stone for new ways of using nanomaterials in electronics or catalytic converters. In 2011 he accepted a position at Empa and ETH Zurich where he has since worked as an Assistant Professor for Inorganic Chemistry in the Tenure Track process.

Maksym Kovalenko (with document) at the award ceremony. With him: Massimo Morbidelli, Roland Siegwart und Christophe Copéret, professors at ETH Zurich (from left). (PICTURE: Barbara Brauckmann / ETH Zurich)

Empa's moisture-buffering plaster on the market

Moisture that forms during cooking, showering or drying wet clothes can settle on the inner sides of facades in cool areas and become a breeding ground for fungi and microbes. Together with Sto AG based in Germany and Switzerland, Empa has developed a special plaster with especially high moisture-buffering capacity. All that is needed to achieve the desired effect is a layer of one to two centimeters. The risk of condensation water on cool wall areas and thermal bridges can thus be reduced, the indoor climate improved. A dry room can be heated more quickly saving energy in the process. In order to release the stored moisture, the room – for instance a windowless bathroom – needs only be ventilated and then reheated. Sto AG will place the moisture-buffering plaster system on the market in February 2014 under the product name Sto Calce Functio.

EmpaNews

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TOUCH THE SCIENCE

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www.empa.ch/Veranstaltungen
Empa, Dübendorf

16. Januar 2014
Klimarelevante Spurengase und Aerosole
für Behörden, Industrie, Wissenschaft, Politik
Empa, Dübendorf

21. Januar 2014
Functional Coatings for Innovative Applications
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21. März 2014
5. VERT Forum
www.vert-dpf.eu
Empa, Dübendorf

28. April 2014
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