N° 43 • MAY 2006

ESRF Newsletter

Nature inspires technology

European Synchrotron Radiation Facility
http://www.esrf.fr/UsersAndScience/Publications/Newsletter

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ESRF Newsletter is produced for the ESRF by Institute of Physics Publishing Ltd, Dirac House, Temple Back, Bristol BS1 6BE, UK; tel: +44 (0)117 929 7481; e-mail: esrfnewsletter@iop.org; Web: iop.org

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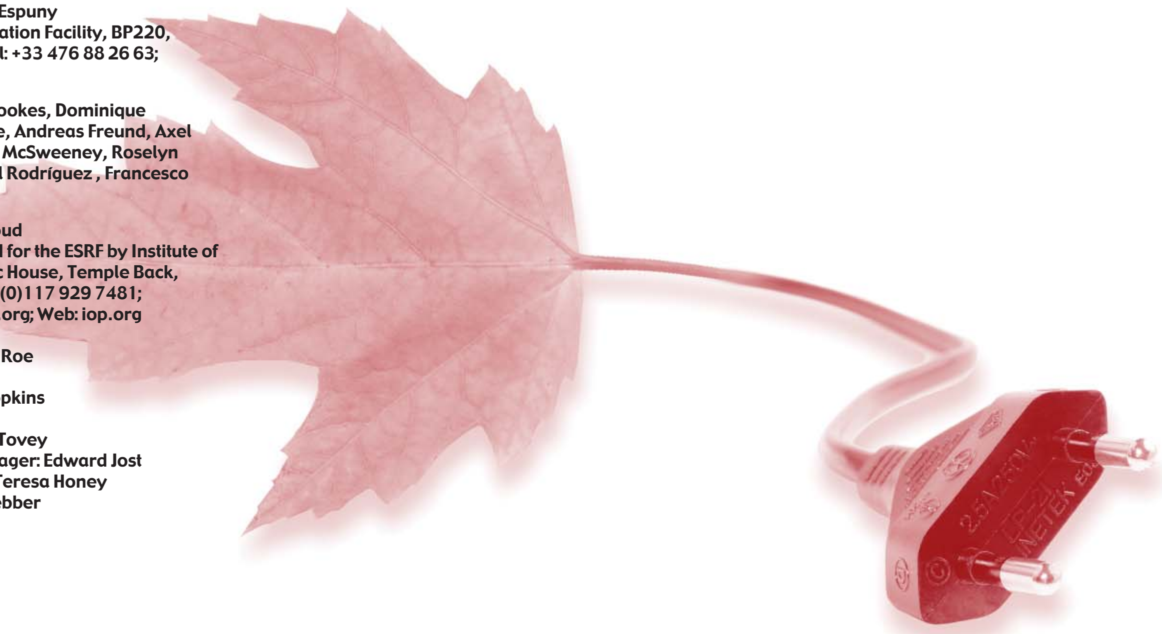
ISSN 1011-9310



Nature inspires science. See pp3–9.
Cover concept: Andrew Giaquinto.

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The ESRF and Institute of Physics Publishing have formed a partnership to produce *ESRF Newsletter*. Institute of Physics Publishing produces *ESRF Newsletter* under contract. The ESRF provides editorial content and retains editorial control, while production, advertising sales, printing and distribution are handled by Institute of Physics Publishing. Institute of Physics Publishing is an experienced STM publisher and produces a portfolio of magazines, including *Physics World* and *CERN Courier*.

Editorial

Guest editor: Christian Riekel,
head of the soft condensed matter group

NATURE INSPIRES SCIENCE AT THE ESRF

This issue gives examples of how synchrotron radiation techniques at the ESRF can help researchers to understand and mimic nature. Biomimetics is the concept of using ideas from nature and implementing them in artificial technologies. In some cases the aim is "simply" to copy nature as closely as possible, thereby capitalizing on aeons of evolution (p4). In other cases, scientists are "bioinspired" by a natural concept that allows them to use alternative materials and technologies to obtain a similar functionality (p5).

The development of artificial materials that mimic biological ones is important for fundamental research and industry. One advantage is that it often delivers environmentally friendly solutions, such as materials that are biodegradable or produce ecologically neutral effluent.

For instance, nature is capable of producing strong fibres, using nothing more than water at room temperature to assist in the process (see p8). This is a dream for polymer scientists, who currently require high temperatures and corrosive liquids to produce fibres with similar properties.

Mimicking natural processes such as this opens up many interesting possibilities. For example, can we harness sunlight more efficiently through a detailed understanding of photosynthesis (p7); will we be able to scale walls like geckos; and will old people be able to retain their mobility via artificial muscles? The only limit is our imagination.

Nature's solutions often provide valuable lessons about miniaturization and integration. The latter implies not only the hierarchical organization of materials on lengthscales from atoms to the macroscopic world but also the ubiquitous presence of biocomposite materials. These exploit the different mechanical properties of their natural components. This is beautifully demonstrated in seemingly simple seashells that are in fact complex biocomposites.

SR provides unique tools

The local structure of such materials has traditionally been studied using electron scattering techniques, requiring ultrathin specimens. The development of micrometre- and nanometre-sized synchrotron radiation beams for spectroscopy, small- and wide-angle scattering, and imaging at third-generation synchrotron radiation sources, such as the ESRF, provides unique "scalpels" for studying complex materials *in situ*. These tools allow us to relate macroscopic function to microscopic models at all lengthscales, both by experiment and by simulation. This will help scientists to develop complex, function-specific materials in a bottom-up assembly process inspired by nature's technologies.

The study of complex natural materials at synchrotron radiation sources requires a close interaction between, say, chemistry and biology. Nano-analytical tools and probes, such as atomic force microscopes and nano-indenters, must be integrated into nanobeam synchrotron radiation experiments. A fascinating by-product is the development of a new level of interaction between scientists and engineers from different disciplines.

Whether it is studying bioinspired materials or taking the first steps towards understanding the structure of natural materials, biomimetics will continue to be a key topic at the ESRF. In many ways we are just beginning a very long journey, because nature still has a lot to teach us. Although we may be a long way from creating functional artificial muscles or developing gecko-like athletic abilities, the ESRF will continue to be at the forefront of this research owing to the unique world-class facilities that it has to offer its users.

Feature news

SCARY MONSTER OR AMAZING SILK FACTORY?

They've got eight legs, eight eyes and are the stuff of nightmares for many. Their appearance may not endear them to us but they are treasured for their silk. Here we investigate one of the merits of spiders.

Spider silk features an unusual combination of mechanical properties, such as high strength and elasticity. As these make it precious, many researchers are seeking to understand and artificially reproduce this natural polymer. Among these are scientists at the ESRF who are focusing on elucidating the process of silk production at a microscopic scale.

Spider silk is about six times as strong as steel (weight for weight) and is about an eighth as dense. It is twice as stretchy as the artificial fibre nylon, extending 30—40% before it breaks. Scientists worldwide began studying the chemical structure of spider silk more than a decade ago, but these remarkable properties have yet to be reproduced artifically.

Christian Riekel, scientist in charge of the Microfocus beamline at the ESRF (ID13), has been at the forefront of the structural analysis of silks. The techniques of small- and wide-angle scattering have proved to be valuable tools in studying the internal structure of spider's silk but the million-dollar question is: how does the spider create such a material?

The aim is now to simulate the protein-aggregation process that goes on inside the spider before the silk is spun. "If we can understand this, then we can use this process as a template for other biosystems," explained Riekel. This will represent an important advance with respect to rheological experiments, which are performed in many laboratories.

ESRF researchers are just beginning to use microfluidic cells to emulate the function of the spinning organ. This is an innovative method that is being developed in collaboration with an Oxford biology group led by Fritz Vollrath. How the pH changes in the solution, what the role of the proteins is and what causes the solidification of the silk are questions that still need to be answered.

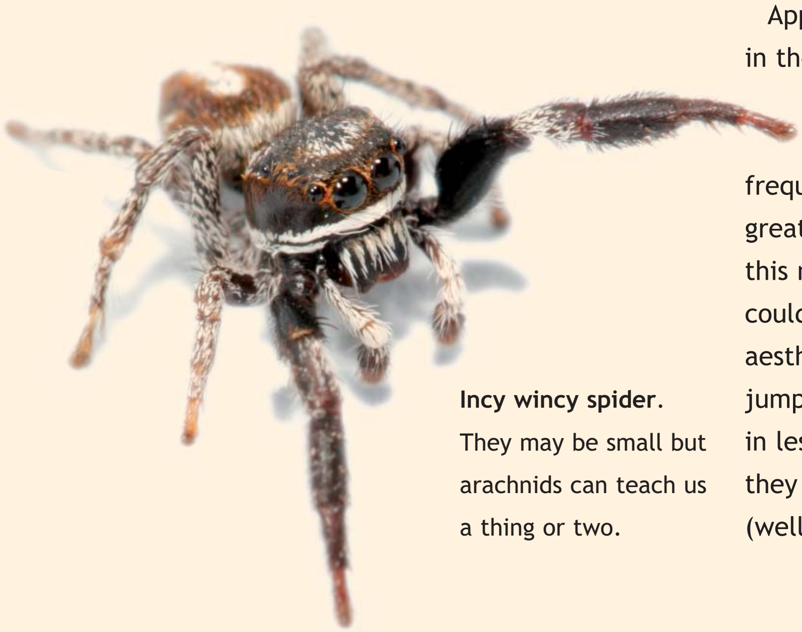
Web of mystery

"Nature is very complicated and we really need to know what happens in depth," said Riekel. Microfluidics is a new tool for carrying out biological experiments and it creates an optimal environment for silk production. "Being able to control the environment of the sample can open doors to applying this technique in other areas," he claimed. "In addition, the ESRF is evolving now to produce nanobeams of light to go even deeper in matter than before, and this will certainly help to answer the questions related to spider's silk," he said.

Despite the mystery that surrounds this material, a number of advances have been made during the last decade. There are already companies that have been able to produce a material that is very close in nature to natural spider's silk.

Applications of spider's silk seem to be concentrated in the medical field, and researchers envisage using a copy of this polymer as a medical suture or in ligament repair, because it doesn't tire when frequently flexed and can withstand regular impact and great pressure. The military sector is also attracted to this material because its ability to dissipate energy could make it ideal for lightweight armour. On a more aesthetic level, we might be wearing spider's silk jumpers sooner rather than later. Riekel estimates that in less than five years they could be on the market. If they carry a label claiming "made from natural fibres (well, almost)", their success is surely guaranteed. •

MC



Incy wincy spider. They may be small but arachnids can teach us a thing or two.

FUTURE OFFERS ROBOTS WITH BONE AND MUSCLE

The *Terminator* is a cybernetic organism (an android with living tissue grafted onto a metal endoskeleton) that exists only in science fiction. Yet now technology is emulating cinema in drawing inspiration from the design of the human body, and materials modelled on our own bone and muscle may soon be commonplace.

Our bones carry our bodies. As the "scaffolding" that helps to hold everything together, they have to prove very tough and at the same time pretty stiff. Their toughness comes from their deformability, which means that, as with rubber, a lot of energy is required to break them.

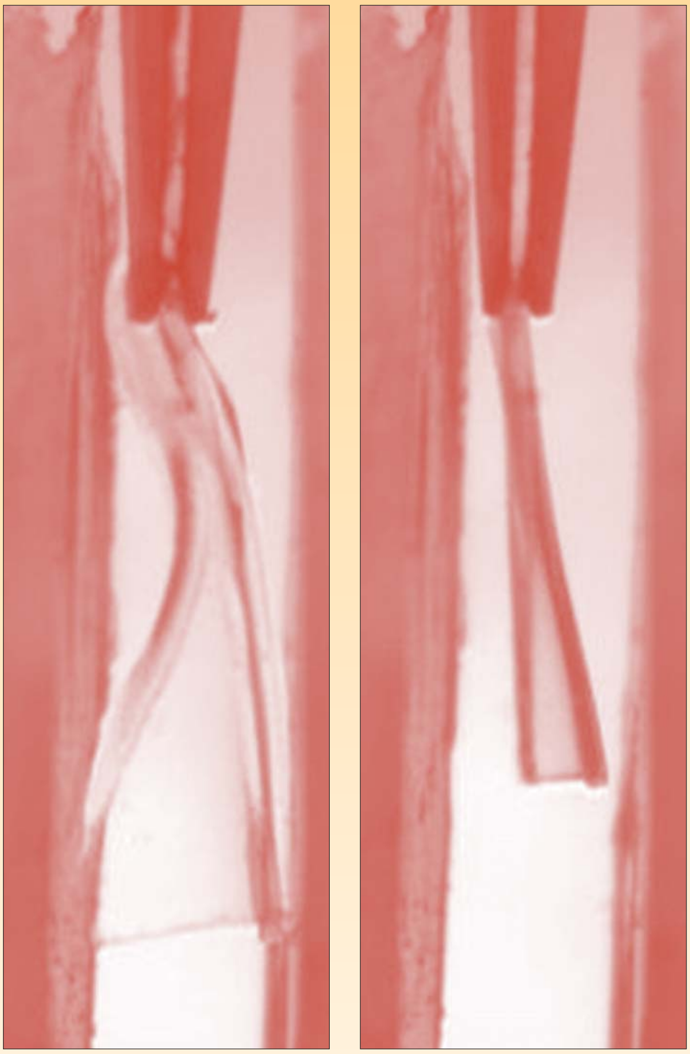
On the other hand the stiffness of bones is necessary to allow them to carry heavy loads without being deformed, like ceramics. The secret of bones is in their complex structure: the combination of a biopolymer (collagen) and mineral nanoparticles. Researchers from the Max Plank Institute (MPI) of Colloids and Interfaces in Germany are studying both the hierarchical structure of bones and their mechanical behaviour. Synchrotron radiation has become an essential technology in their research, which they deploy alongside other complementary tools.

Boning up on bones

What is the use of studying bones? The aims of the scientists are twofold: "We would like to know how bones deform to assess the effect of diseases, so the medical implications of our research are very important," said Peter Fratzl, who is director of biomaterials at MPI Colloids and Interfaces.

"On the other hand," he added, "we also try to use the principles of bones to implement them in polymer hybrids." Simply copying what nature has already achieved is not the team's target, however. "If we copied nature there would be some drawbacks, because we can't do it in exactly the same way. We just want to get inspired by it, get the concept and develop new materials," explained Fratzl.

Meanwhile, scientists from the University of Sheffield in the UK have also been inspired by human anatomy and, more specifically, by our musculature. Muscles are powered by chemical potential: they transform the chemical energy kept in the body's energy store (adenosine triphosphate) into mechanical work. Human muscle is a scaleable "technology" and will work at the level of a single protein molecule. The aim of these researchers is to create a wholly synthetic muscle using the self-assembly of a pH-responsive triblock polymer.

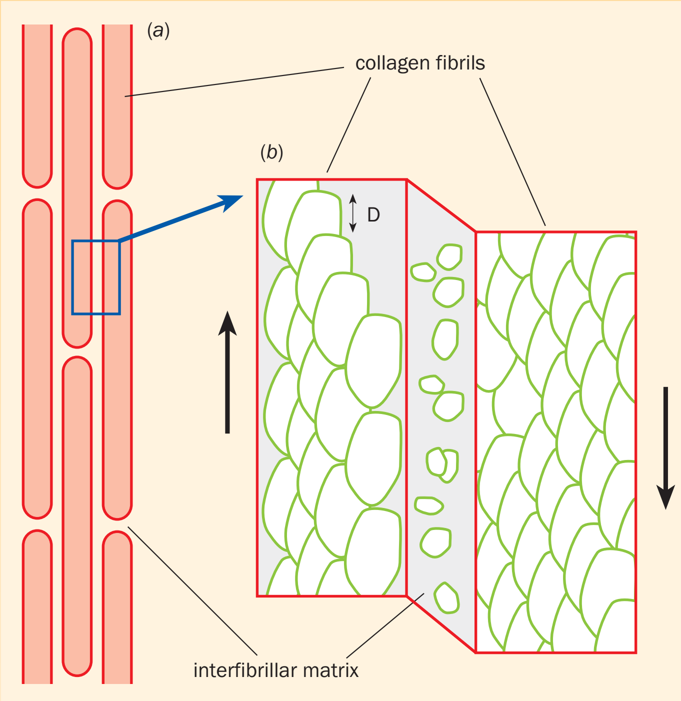


Jonathan Howse

Muscle power. The macroscopic structures of the artificial muscle in the collapsed (left) and expanded states, induced by the reaction mixture at pH 3.5 and pH 7.0 respectively.

The self-assembled nanostructured polymer contains poly(methacrylic) acid, which changes molecular configuration as it goes from an acid to an alkaline environment, and it exerts a mechanical force as it does so. This innovative approach has allowed the team to construct a simple chemically driven artificial muscle using a reaction that continuously changes the acidity of the surrounding solution.

The researchers came to the CRG Dutch Belgian beamline BM26 at the ESRF to test their "muscle" and thereby determine its ability to contract and expand at a nanoscale level. The large, macroscopic contractions of human muscle, which are clearly visible to the human eye, are the sum of billions of microscopic single-molecule contractions. The team's material, which produces 20 mW/kg of power, is a weakling compared with biological muscle and it has only a 10 000th of the strength of a typical skeletal muscle. It is also slow and takes several minutes to expand and contract. The new "muscle" is "still very preliminary and it doesn't produce a huge amount of power," said Tony Ryan, the head of the team, "but it is a step forward, and we are taking further inspiration from nature and looking at bundles of small fibres made from the same polymer."



Nanometre-level model for bone deformation. The black arrows indicate the direction of the relative motion of the fibrils under applied tensile load in the vertical direction. The parallelogram between the fibrils shows the direction of shear stress in the extrafibrillar matrix (the magnitude of shear strain is hugely exaggerated for the sake of visual clarity).

Human body parts to car components

Research into bones has already led to the development of bioinspired synthetic materials. For example, the nanocomposite structure of bone can be artificially produced using clay particles in a polymer. The next time you look at a car, you could be looking at just such a material. That's because, for the past several years, car companies have been using nanocomposites instead of plastic to fabricate a number of vehicle components. In 2001, for example, Toyota began using these materials to produce bumpers for their cars.

The number of products inspired by bones is still small, although Fratzl believes that "there is a lot of potential". In the future we might be able to see bone-inspired paints or other coverings, for instance.

The best way to carry out this research is by using a synchrotron source. The UK and German teams both focus on the way in which their samples function at the nanolevel. They mainly use the techniques of diffraction and small angle scattering in beamlines such as the microfocus beamline (ID13) or the Dutch-Belgian beamline (BM26). "Ten years ago it was impossible to carry out this kind of experiment, but now we are advancing very fast," enthused Fratzl.

MC

Chantal Argoud

Secrets in the Sun. We need to understand how leaves are able to maximize the amount of energy that they absorb from sunlight.

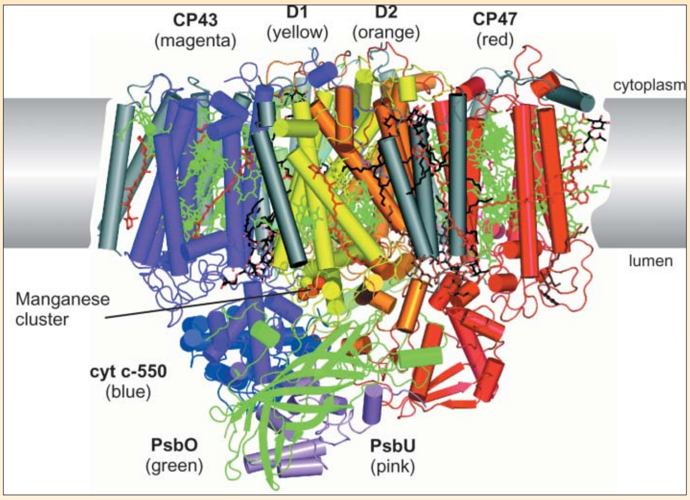
POWERED BY THE SUN: PLANTS CAN SHOW US HOW

Our attempts to tap in to the Sun's energy to power our daily lives have fallen far short of the efficiency levels that we need to achieve to take the pressure off fossil fuels. Understanding how plants exploit sunlight may hold the key to our use of solar power.

Using sunlight to power our homes and offices worldwide is an unaccomplished dream owing to the still-inefficient technology that we currently use to capture and utilize solar energy. The study of photosynthesis in plants and cyanobacteria could provide new clues by explaining how they absorb almost 100% of the sunlight that reaches them, and how they transform it into other forms of energy.

Three teams from Berlin have used the X-ray source at the ESRF to investigate the molecular structure of the machinery of photosystem II and the kinetics of the photosynthetic process that converts water into atmospheric oxygen as well as electrons and protons that finally reduce carbon dioxide to carbohydrates.

In plants, algae and cyanobacteria, photosynthesis is initiated at photosystem II (PSII), a large complex comprising proteins and pigments that are embedded in a membrane. By capturing sunlight, PSII produces the energy required to power the oxidation of water to atmospheric oxygen. It contains four manganese atoms and one calcium atom, which are known to be at the centre of the catalytic reaction. Five intermediate states have been proposed in the process of photosynthesis – described by the "Kok cycle" – but,



PSII occurs as homodimer. The structure of one monomer looking along the plane of the membrane. The main protein subunits are shown: α-helices as cylinders, chlorophylls (green), carotenoids (red) and lipids (black) as wire models.

till recently, the existence of only four had been proved.

Having isolated PSII from spinach, Holger Dau's group from Freie University has identified the missing state with the help of the ESRF. This is particularly important because it is directly involved in the formation of molecular oxygen. Furthermore, the team suggests an extension of the cycle with an additional intermediate and proposes a new reaction mechanism on a molecular basis for the release of dioxygen. This gives new insight into the mechanism of photosynthesis.

To complement this view, and using the completely different technique of macromolecular crystallography, two other teams – one preparing and crystallizing PSII and one carrying out crystal structure analysis – have presented the most detailed model of PSII yet.

A complex of 20 protein subunits and 77 pigments was revealed in near-atomic detail, which completed and partly corrected earlier models. The researchers concluded that a high degree of flexibility is required for the protein function and that this flexibility is "lubricated" by a number of organized lipid molecules.

"This new view of the spatial arrangement of the different components of PSII furthered our understanding concerning the electron- and energy-transfer mechanisms," explained Athina Zouni of the Technical University and Wolfram Saenger of Freie University, the heads of the two teams.

Intermediate state is identified

In both studies the use of synchrotron light was crucial: "A very intense and stable X-ray beam is necessary to study the kinetics of such a complex, highly diluted protein present in the investigated spinach sample," explained Pieter Glatzel, head of beamline ID26, where the experiments on fluorescence were carried out. They flashed the sample with a laser and registered the change using X-ray fluorescence every 10 μs to find out how different oxidation states developed. When carefully analysing the reaction kinetics, they observed a time delay before the O_2-evolving step that unambiguously proved the existence of the long-searched-for intermediate state.

In the case of the structural team, much effort was spent to improve the purity of PSII isolated from cyanobacteria with the aim of extending the resolution of the X-ray diffraction as far as possible. Even at the achieved resolution of 3.0 Å the manganese and calcium atoms are not clearly resolved. A resolution of 2.8 Å or even higher will ultimately be required to satisfy the chemists' view of PSII.

How far are we from using the Sun's energy to sustain us? Michael Haumann and Bernhard Loll, the main authors of the publications generated by this work, claimed: "These are important results that will have an impact in the photosynthesis community. They help our understanding of how solar energy is used in plants and contribute to the efforts to produce more efficient solar cells for our needs." •

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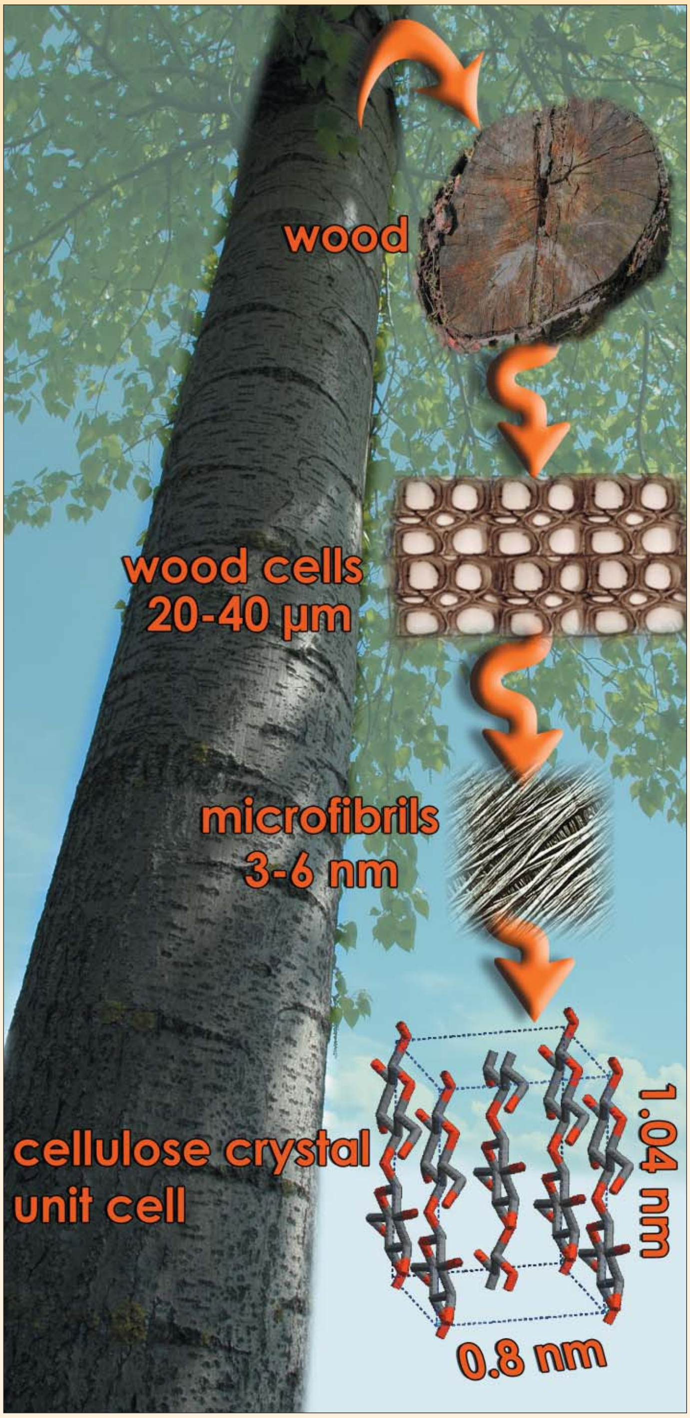
WHAT GIVES WOOD ITS EXCELLENT MECHANICAL PERFORMANCE?

Despite thousands of years of use and many years of research, scientists still don't fully understand the mechanism of wood, and some of them come to the ESRF to study its structure at the micrometre scale.



Strong but flexible. Thanks to wood's hierarchical structure.

Wood is a complex nanocomposite structure with excellent mechanical performance. We use it for numerous purposes and scientists study the material because of its strength at an extremely low density: at a given stability a wood construction is surprisingly lighter than a steel one. When the wind blows, trees rarely break. Instead they flex and display great strength.

Wood is a biopolymer with a hierarchical composite structure that is based on cellulose fibrils embedded in a softer matrix of hemicelluloses and lignin – a polymer that acts rather like a glue. The cellulose fibrils are actually nanocrystals called "microfibrils", which measure about 3 nm in diameter. The microfibrils are helically wound round the axis of the wood cell with a diameter in the order of 20 µm.

It is well known that the stiffness of wood is largely by virtue of the cellulose microfibrils: they bear the majority of the load on the microscopic scale when tension is applied. The angle of the helical structure, which can vary between different kinds of wood and even inside the same tree, determines the degree of flexibility and strength.

Thanks to the powerful X-rays of the ESRF, scientists have been able to study single wood fibres during deformation. "The ESRF is the only synchrotron where we can study single fibres because we need a microfocus beam that we can't get anywhere else," explained Martin Müller, a physicist from the University of Kiel in Germany. Synchrotron radiation has allowed researchers to determine how the helical structure moves when tension is applied.

Trying to see the wood for the trees

Müller, together with colleagues from Vienna (Austria), Leoben (Austria), Golm (Germany) and the ESRF, recently discovered that the helical structure of the microfibrils deforms like a helical spring and that, after releasing the stress, the original stiffness of the material is recovered.

An important aspect of wood currently being studied at the ESRF is the very different mechanical behaviour of the material depending on whether it is wet or dry. Consider how easy it is to snap a dry twig and yet how supple a live branch is. Wood in a living tree is permanently saturated with water. If used for furniture construction it must first be cut and left to dry.

Müller's team has developed a tensile testing cell where the moisture content can systematically be varied to reproduce the humidity conditions that trees experience in nature. The researchers have observed that, when the wood matrix is wet, it can deform more easily, although there are no changes inside the nanocrystals. This deformability translates into the well known diminution of strength of wood. Researchers are now further refining the experiment to find out more information about the mechanisms on both the microscale and the nanoscale that lead to the different performances of wet and dry wood.

Although it has not yet been possible to fabricate artificial materials that exhibit the same excellent mechanical properties as those of wood, slightly bigger cellulose crystals from algae have been successfully embedded in resins to form reinforced nanocomposites. The studies on wood show that all hierarchical levels of organization have to be taken into account when trying to mimic its structure in the development of novel high-performance materials.

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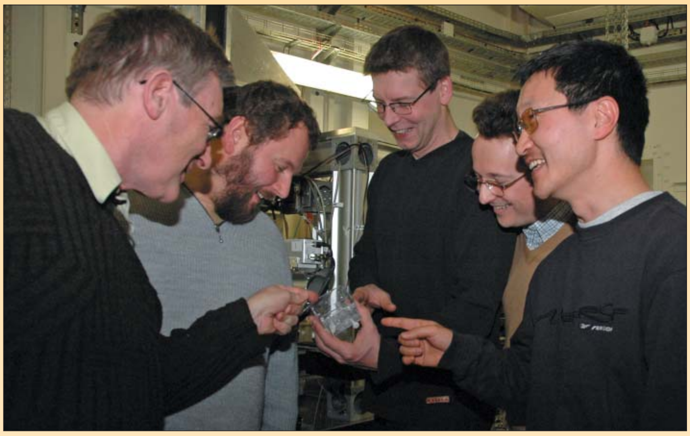
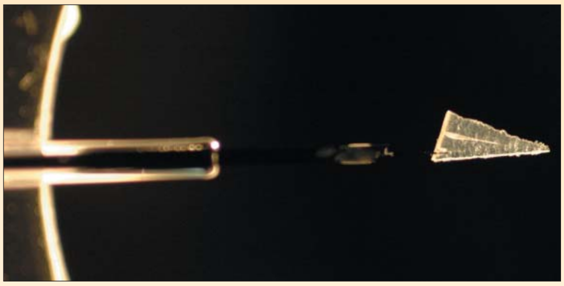
STARDUST MAY HOLD SECRETS OF SOLAR SYSTEM



Chantal Argoud

Chantal Argoud

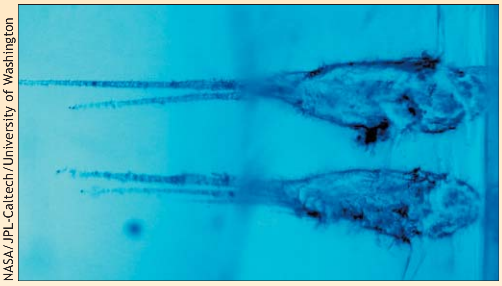
Beam teams. The team from University of Frankfurt and Ghent University (left) did experiments using ID13. The team from the Ecole Normale Supérieure of Lyon and the Institut d'Astrophysique Spatiale in Orsay (right) used ID21 and ID22 for their work.



Philippe Plailly/Eurelios

The secret's keeper. Left: close-up view of a sample investigated at the ESRF. Right: tracks left by two comet particles after they impacted Stardust's comet dust collector.

NASA/JPL-Caltech/University of Washington



The answer to the origin of life might have been at the ESRF. Two research teams from different European countries have been studying samples from NASA's mission Stardust on three ESRF beamlines. The capsule captured cometary materials that could answer questions about the birth and evolution of the solar system.

The mysteries surrounding our solar system might be concealed in specks of dust that are just one-tenth of the diameter of a hair. These grains arrived on Earth thanks to the NASA Stardust mission, which took them from the coma of Comet Wild 2. Stardust encountered the comet 390 million km away from Earth and at a speed of 21 000 km/h – more than six times as fast as a speeding bullet.

The importance of the particles lies in the nature of comets. These are cold bodies and are presumably made up from materials that originated in the outer parts of the solar system. They are thought to be composed of unchanged primitive materials and can give detailed information about the conditions that existed during the earliest period of the solar system. Researchers think that comets brought water and an abundant variety of carbon-based molecules to Earth during the planet's late phase of evolution. They also believe that comets have contributed an essential, if not fundamental, part to the origin of life on Earth.

At the ESRF, scientists from Germany, France and Belgium carried out experiments on ID13, ID22 and ID21 with the aim of studying the chemical composition and crystal structure of the grains, and of material in the particle tracks. The particles were captured in a silicon foam called aerogel, where the paths of the particles are traced.

The researchers mainly focused on the terminating particle, which is the most important. However, they also tried to investigate the particles left all along the path, which are less easy to locate but can provide new information, and that sometimes make up around 90% of the whole mass deposited in the aerogel.

One of the advantages of studying the Stardust particles at the ESRF is that they didn't need to be extracted from the aerogel in order to be studied. "We use 3D methods at the ESRF that let us see all of the particles *in situ*, without destroying them and at very high resolution," said Frank Brenker from the University of Frankfurt. Both teams used mainly diffraction and fluorescence techniques for their research. The work used different beamlines with different specificities, so the resulting data should be complementary.

The preliminary outcome of the experiments at the ESRF shows that "there are some challenging results, which include identification of unexpected minerals by coupled fluorescence, diffraction, speciation and tomography," explained Alexandre Simionovici from the Ecole Normale Supérieure of Lyon. Nevertheless, details cannot be revealed until NASA unveils them.

NASA wanted to make sure that the experiments would be carried out properly on the three different beamlines at the ESRF. Therefore, before entrusting the teams with the samples, they were asked to carry out some tests. These were done with samples from MIR, which were very similar to the ones in Stardust and had previously been studied. The results found at the ESRF coincided with those at NASA, so 10 precious samples could finally be studied at the ESRF. •

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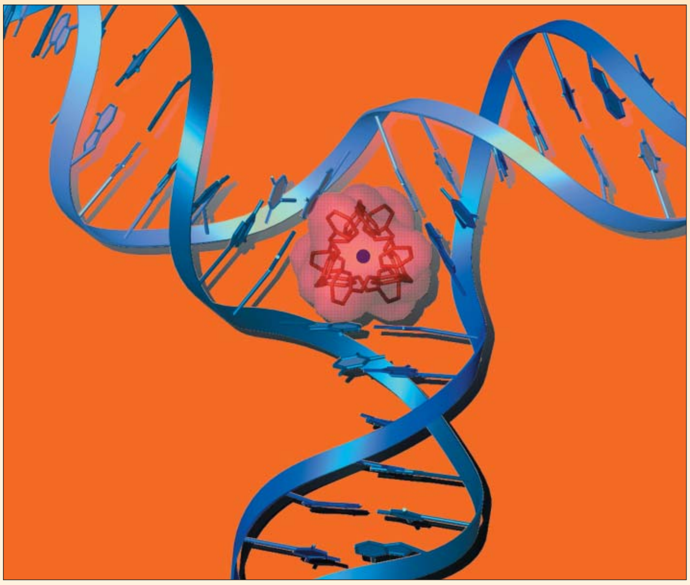
TUMOURS MEET THEIR MATCH IN DESIGNER DRUGS

Researchers from Spain and the UK have found a new way of recognizing DNA that will help them to design drugs capable of attacking genetic material, thanks to the ESRF's X-rays. This could lead to the creation of novel treatments for tumours and other diseases.

To combat disease, all kinds of drug agents are being developed. These normally bind and inhibit proteins, but nucleic acids are also appropriate therapeutic targets. For example, cytotoxic anti-DNA drugs are commonly used in cancer therapy. Until recently there were only three means by which drugs recognized DNA. Now, however, researchers from the Institut de Biologia Molecular in Barcelona and the University of Birmingham, led by Miquel Coll and Mike Hannon, have discovered a fourth way. They developed a synthetic drug agent that targeted and bound to the centre of a three-way junction in the DNA. These junction structures are formed where three double-helical regions join together.

The team discovered the atomic structure of the drug–DNA complex using X-ray crystallography at the ESRF beamline ID14 and Spanish CRG beamline BM16. The binding of the drug to the DNA is successful because the drug, in the shape of a trigonal prism, is positively charged and the DNA is negatively charged. "We have discovered that three-way DNA junctions are especially suitable for drug design: they leave a central cavity where a drug can fit perfectly, and this opens a door for the design of new and quite unprecedented anti-DNA agents," explained Prof. Miquel Coll.



Álex Gómez-Blanco

Achieving a perfect match? Schematic diagram of the three-way junction DNA with a molecule of synthetic drug attached.

The same team discovered the atomic structure of another peculiar DNA form in 1999. They solved the structure of the four-way DNA junction – also called a Holliday junction – but this was rather compact, without cavities that could be used for drug binding. •

MC

Reference

A Oleksi 2006 Molecular recognition of a three-way DNA junction by a metallosupramolecular helicate *Angewandte Chemie* **45** 1227–1231.

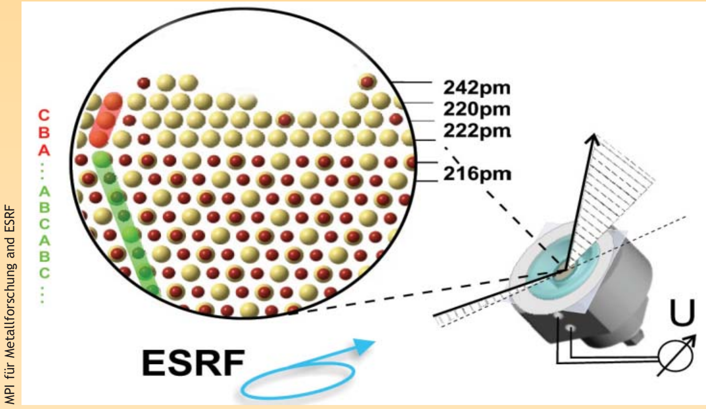
NANOSCIENCE REVEALS SOME GOOD AND BAD SIDES OF CORROSION

Some 3% of the world's gross domestic product is lost through corrosion. However, the chemical attack of metals can result in surface nanostructures that have interesting applications, such as catalysts and sensors. A better understanding of the corrosion process is therefore needed both to prevent it and exploit it.

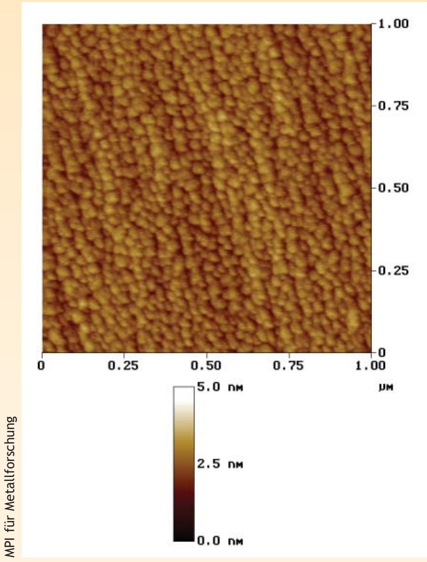
Scientists from Germany and ID32 at the ESRF have highlighted a self-organization process on the surface of a metal alloy that is crucial to determining the response to corrosion of this material. In fact, this study, providing a structural description with atomic-scale resolution thanks to the X-rays, unveiled the chemical composition and structure of a protective surface layer that hinders further corrosion.

Researchers from the Max Planck Institute, the University of Ulm, Germany, and the ESRF used the European synchrotron light source to reproduce *in situ* the onset of corrosion in a gold-copper alloy. Gold is a noble metal that doesn't corrode; copper is less noble and thus more prone to chemical attack. At the onset of corrosion, the alloy protects itself with a very thin gold-rich layer. This has an unexpected crystalline and well ordered structure. When corrosion begins, the alloy layer transforms into gold nano-islands of 20 × 1.5 nm. These develop into a porous gold layer, which may have technological applications. "Understanding and controlling the formation of the first layer and the nano-islands may help to produce nanomaterials with specific properties," said Jorg Zegenhagen.

To carry out these experiments the researchers placed the samples in an electrochemical cell filled with sulphuric acid, to which voltage can be applied, and then monitored the early corrosion process. "We found a vast amount of detail on structural evolution and chemical information by combining detailed 3D analysis of the structure with additional anomalous scattering experiments, before more severe corrosion happened," explained Frank Renner.



Model of the ultrathin passivation layer resulting from the fit to the X-ray diffraction data. (Au atoms: yellow; Cu atoms: red.) The ABC stacking is inverted in the single crystalline overlayer. The two topmost layers are only partially occupied. A schematic of the *in situ* X-ray diffraction cell is included.



Ex situ AFM image (1 × 1 µm) after applying a potential of 450 mV versus Ag/AgCl. In this potential regime the formation of 2–3 nm thick pure Au islands was observed in the X-ray diffraction experiments, which is a typical corrugation of the surface.

These new insights can be applied to a variety of alloys used in corrosive environments and to materials that can exploit such degradation to form porous metals of technological interest. Although understanding the process of corrosion in the gold-copper alloy has only become possible now, the process is many centuries old. Ancient Incan metalsmiths stretched their supplies of precious gold by mixing it with copper then surrounding the alloy with salty substances. This created an acidic environment that dissolved the copper from the top layer, leaving a gold-rich surface ready for polishing. •

MC

Reference

F U Renner *et al.* 2006 Initial corrosion observed on the atomic scale *Nature* **439** 707–710.

ID03 IS BORN AGAIN: SURFACE DIFFRACTION BEAMLINE IS IMPROVED

After a nine-month gestation, a new beamline is born (or perhaps reborn) at the ESRF. It is a big baby of two experimental hutches, a control cabin and a lab. Its new technical properties will make it more user friendly and offer increased scientific possibilities and it will be welcoming users by the summertime.

ID03, the surface diffraction beamline, was one of the first ESRF beamlines and it began producing data more than a decade ago. Now it has undergone thorough "surgery" and, on schedule, it has become a completely new beamline. Everything has changed: the space in the hutches, the control cabin, the furniture, the lighting and even the colour of the beamline's doors, which went from oppressive grey to a cheerful yellow. The new ID03 also includes a brand-new laboratory for the preparation of users' samples.

The beamline's technical specifications have been updated and will open up new possibilities for experiments. Dedicated to surface science experiments, it will now have a smaller beam than before, which will increase its brilliance. It will specialize in characterizing reactions in real conditions. In addition, the beam can be delivered directly to the sample without crossing any windows, so scientists will be able to use the coherence of the beam fully.

Another feature of the beamline that is greatly appreciated by its staff is the increased space in the hutches. "The advantage of having more space is that now we don't need to become contortionists when setting up experiments," explained Helena Isern, one of the beamline scientists.

In addition to all of the new features of the beamline, further changes are anticipated. "We will have a new catalysis chamber and we will soon modernize our big diffractometer," explained Roberto Felici, who is responsible for the beamline. "There is still a lot of work to do," he concluded.

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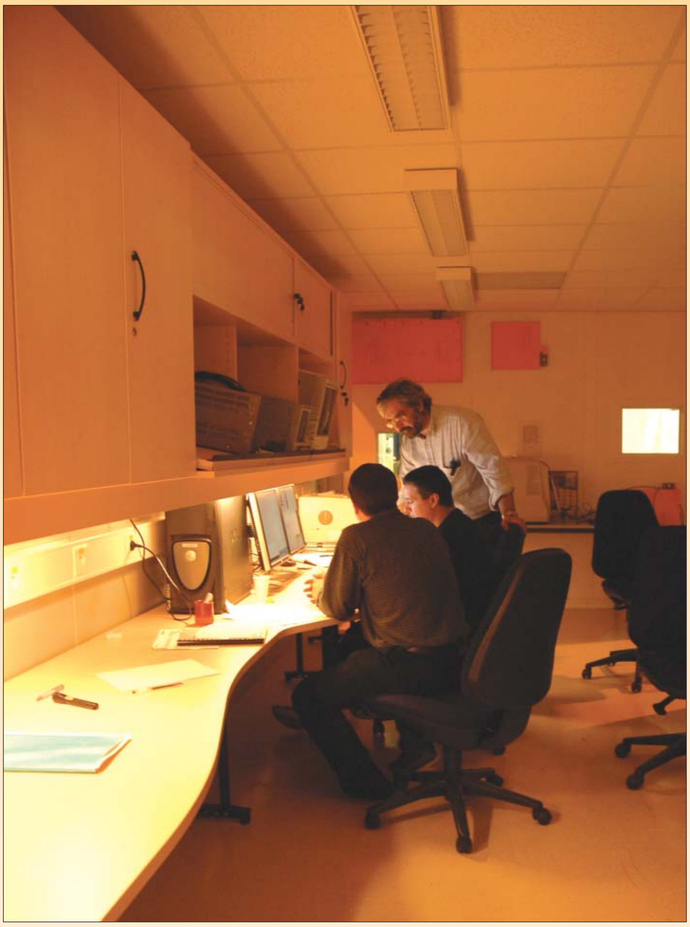

Extreme makeover. The new control cabin of beamine ID03.

Chantal Argoud

A man who likes to keep busy. Philippe Duru leads a full life, at both work and play.

"It's important to learn not to feel lost when things don't go as expected at work, on holiday or in any other situation."

PHILIPPE DURU: LIFE WHEN THE BEAM SLEEPS

He is probably at his busiest during the regular shutdown periods that take place at the ESRF. He can often be spotted running about with a look of concentration on his face. He coordinates the activities planned by all groups involved in the machine when the beam gets a rest. At 50, Philippe Duru hates sitting in front of a PC for hours on end. He enjoys his work, his family and plenty of hobbies, which, he says, help to keep him active.

How many people are involved in a shutdown?

Around 70 are involved, from the machine group, technical services, vacuum, cabling and fluids groups — that's quite a few.

You must be very organized to be able to coordinate everything

I believe that experience of coordinating major works is very important. In a previous job, for example, I supervised the installation of mechanical equipment during dam constructions. It's not so much organization as the ability to react quickly. I have to plan it beforehand, and afterwards I write a report on what went wrong. When you work ahead of something you don't see the time go by, so I'm surprised when I think of how long I've been at the ESRF — 15 years.

Don't you get tired after so long?

My job is very interesting and in my group there is a nice atmosphere. Admittedly sometimes the work can be a bit repetitive, but from time to time you have to face unexpected problems and I like that. One example is the intervention that we have organized to remove the Litaflex material containing asbestos from the storage ring.

If you enjoy challenges you must be thrilled with the projects of the long-

term strategy, such as the extension of beamlines or the change of the machine

Of course. I very much support the strategy and I believe that this will boost the motivation of everyone.

What was it that brought you to the ESRF?

I had just come back from the US with three children, one just a month old. The company I worked for wanted me to move to Egypt, but I thought we'd had enough of travelling, having been in Africa before that. So I changed job and started managing works in a company called Metareg, which was in charge of the ESRF accelerator equipment installation. I supervised the assembly works of the storage ring and was then invited to apply to technical services to supervise and coordinate the construction of the beamline hutches.

Maybe you should have been a traveller instead

I'm happy in Grenoble, even if I have good memories of my years in Mali, Senegal and Louisiana. I'm lucky to have lived in all of these places. At the ESRF the atmosphere is so international that it also feels as if you are in many places around the world at the same time. Besides, I travel once a year for a month with my partner, our children and the backpack. We have been doing it for many years and it's a great experience. Last year we were in Morocco; next summer we are probably heading to Greece and Eastern Europe. We don't book, so we can improvise – it's more fun.

CLOSED FOR WORKS


P.Ginter/ESRF

A view of the synchrotron during one of the planned shutdown periods.

The ESRF electrons turn day and night. However, owing to the need to make sure that the machine performance is optimal, there are periods of shutdown and machine dedicated time. Shutdown takes place in January, August and mid-December, with a week in March, one in May and another in October. The aim is to carry out interventions in the storage ring for the optimal functioning of the machine. Staff in the machine operation group, like Duru, get the chance to go to the inaccessible storage ring, which is normally blocked by big pieces of concrete. However, it doesn't go smoothly every time. Sometimes very late changes occur in the schedule and some information isn't updated. Once the roof was opened in the wrong cell and it took several hours to "repair" the damage. Duru enjoys his job, though. "It is very challenging, which is what I like," he explained.

The ability to improvise – the same quality you need for your job

Exactly. I think that it's important to learn not to feel lost when things don't go as expected at work, on holiday or, actually, in any situation. You have to be able to react and provide solutions to problems.

You have many hobbies: travel, cooking, DIY and you play the cornet. Is your aim always to keep yourself busy?

You could say that. I learned to cook with my mother, who was very good at it. The music is something that has always fascinated me: it's a wonderful universal language that everyone understands. Four years ago I began to learn the cornet. I've been playing in a small group for two years and I also play at home with my children. •

MC

Scientific highlights

SURFACE AND INTERFACE SCIENCE GROUP

X-ray standing wave imaging of Mn in GaAs

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1 ESRF, 2 WSI Munich, 3 University of Ulm

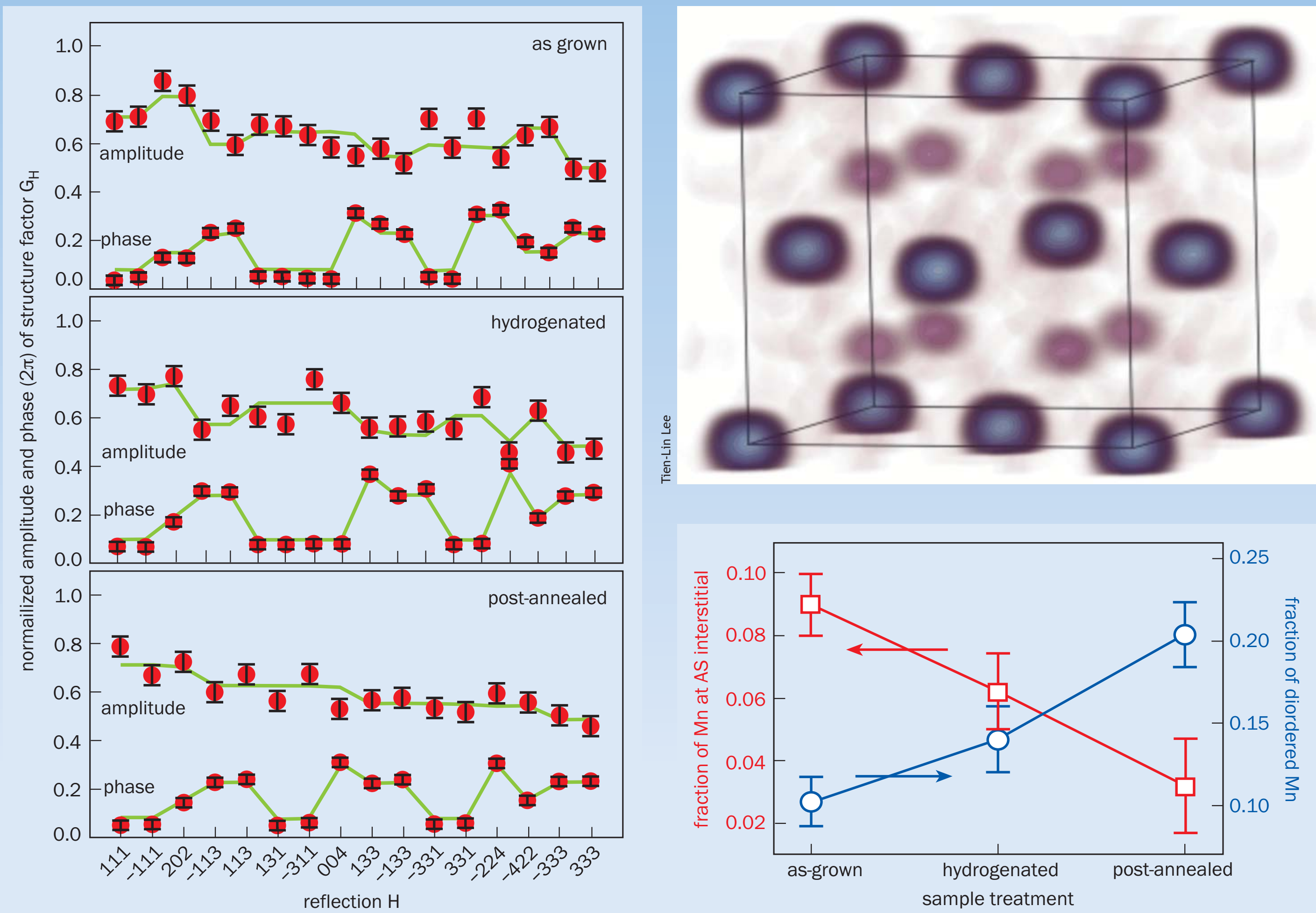

Figure 1. Left: Amplitude and phase (symbols) for all of XSW measurements on three samples and best fit to the data (solid lines). Top right: Reconstructed image of Mn in the cubic GaAs lattice for one of the samples, showing that Mn substitutes for Ga on its fcc sublattice. Bottom right: Result for the Mn distribution in the GaAs lattice after refinement of the fit to the XSW data (best fit on the left). Up to 10% of the Mn is residing on As interstitial sites. Most of the Mn is on Ga substitutional sites.

The dilute magnetic semiconductor GaMnAs is ferromagnetic with a maximum Curie temperature (T_c) of 170 K at 5% Mn concentration. Most of the Mn^{2+} substitutes Ga, leading to hole doping and a local spin moment S of 5/2. Ferromagnetic ordering is mediated by the itinerant holes. However, depending on the growth conditions, small fractions of the Mn may occupy the interstitial sites and act as a donor, resulting in a lower T_c. Reliable data on the Mn site distribution are missing because most methods do not give accurate structural information for such low doping concentrations. Using X-ray standing wave imaging, we have studied three differently treated samples, each containing 4% of Mn in a 4 nm ultrathin epitaxial layer on GaAs(001), by recording the Mn-K fluorescence yields for up to 22 different Bragg reflections (HKL). The result of each scan provides the amplitude as well as the phase of a (HKL) Fourier component of the Mn atomic distribution, allowing the reconstruction of real-space images of Mn in the GaAs lattice. In addition to the majority of Mn substituting the Ga, we found that up to 10% of the Mn occupies the As interstitial sites. •

MATERIALS SCIENCE GROUP

Femtosecond laser near-field ablation from gold nanoparticles

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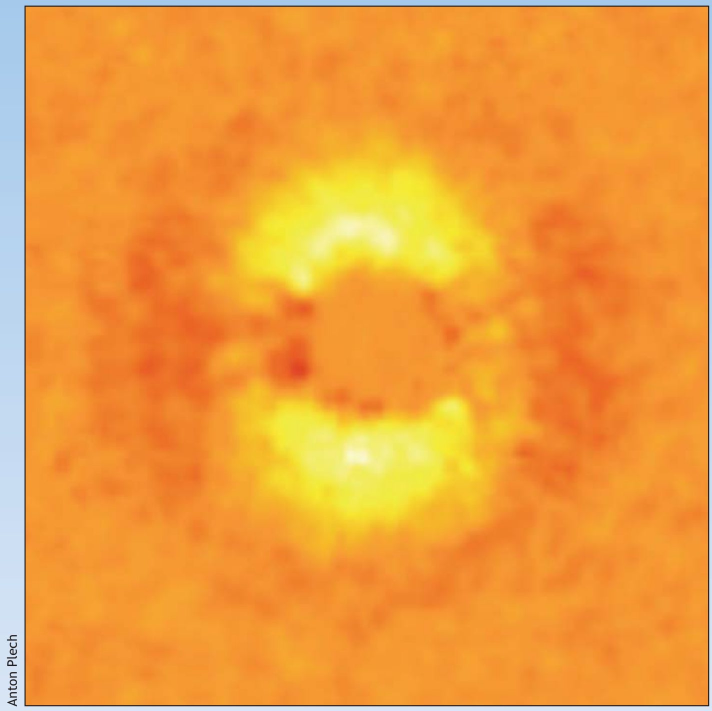

Figure 2. Difference SAXS pattern of a gold particle suspension following laser excitation (2 ns delay) compared with the non-excited sample (yellow corresponds to an increase in intensity; red-brown to a decrease in intensity).

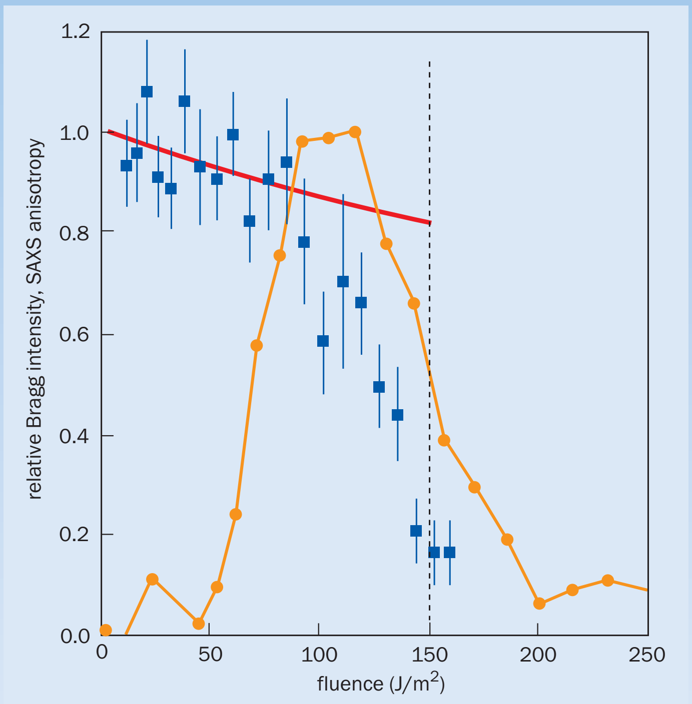

Figure 3. Amplitude of SAXS anisotropy as a function of laser fluence (blue), together with the intensity of the (111) powder ring. The anisotropy disappearance coincides with the particle melting at 155 J/m^2, where the powder scattering disappears.

Laser ablation is an important tool for materials applications. In general the mechanism is connected with an impulsive material heating far above the boiling point. The explosive nature of the vaporization leads to mass ejection from a surface.

In a laser excitation study of gold nanoparticles in water, we have contrarily discovered that mass removal from the gold spheres can be initiated through femtosecond laser irradiation at far below the normal ablation threshold, and even below the melting point of the particles. By combining different scattering methods in pump-probe set-up (time-resolved SAXS and time-resolved powder scattering), it can be demonstrated that an anisotropic shape change of the nanoparticles is initiated on the picosecond timescale. At the same time the powder scattering proves the crystalline state of the particles.

The anisotropy is the fingerprint of the dipolar plasmon excitation of the particle's conduction electrons. The ablation is caused by a very strong transient electrical field at the surface (the so-called near-field), which in this case represents a 12-fold enhancement of the incoming laser field.

The results show that the near-field enhancement can exert strong forces on nanomaterials, especially on those where enhancement factors of up to 10^7 are reported, such as nanoscale substrates for surface-enhanced Raman spectroscopy.

Reference

A Plech *et al.* 2006 Femtosecond laser near-field ablation from gold nanoparticles *Nature Physics* **2** 44—47.

MACROMOLECULAR CRYSTALLOGRAPHY GROUP

UV laser excited fluorescence as a tool to visualize protein crystals mounted in loops

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The field of structural proteomics has promoted the rapid development of automated protein-structure determination through the use of X-ray crystallography. Robotics are routinely employed along pipelines from genes to protein structures. However, a bottleneck still remains in the system.

At synchrotron beamlines the success rate of automated sample alignment along the X-ray beam is limited by the difficult visualization of protein crystals, especially when they are small and embedded in mother liquor. Despite considerable improvements to optical microscopes, the use of visible light transmitted or reflected by the sample often results in poor or misleading contrast.

We have used the endogenous fluorescence from aromatic amino acids to identify tiny or weakly fluorescent crystals with a high success rate. The use of a compact laser at 266 nm, in combination with non-fluorescent sample holders, provides an effective means of collecting high-contrast fluorescence images within the space of just a few milliseconds and with standard camera optics. The best image quality was obtained by employing direct illumination through a viewing system coaxial with the ultraviolet beam.

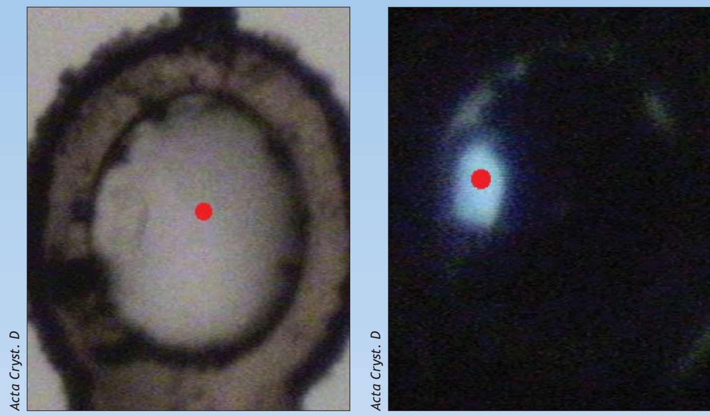

Figure 4. Fluorescence images recorded using the standard experimental set-up. A crystal of cephaminase 2 (~20 µm long) is shown under visible (left) and ultraviolet light (right). Red points show the crystal centre as detected by C3d software.

Reference

X Vernede *et al.* 2006 UV laser excited fluorescence as a tool for the visualisation of protein crystals mounted in loops *Acta Cryst. D* **62** 253–261.

CRG BEAMLINES

Structural study of the site of Mn in Mn δ-doped GaAs

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To determine the local structure of Mn in d-doped GaAs layers we have carried out an X-ray absorption spectroscopy experiment at the Mn-K edge in samples grown by molecular beam epitaxy with and without Be co-doping. Mn-Mn atomic correlations have not been found within a roughly 5 Å radius, ruling out the presence of metallic clusters or local Mn enrichment. In samples deposited at 300 °C, Mn substitutionally occupies the Ga site with a local expansion (ª2%) of the first-neighbour distance with respect to GaAs; the second neighbours remain at a distance very close to that of the host lattice, indicating that the structural

CRG BEAMLINES

Coherent X-ray scattering from two-dimensionally patterned thin-film nanoscale arrays

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Thin metallic films patterned into nanoscale periodic arrays give rise to coherent satellites on either side of the specular reflection when illuminated at grazing incidence with X-rays. We have used grazing incidence coherent X-ray scattering to probe the crystallography of two-dimensional written arrays of permalloy magnetic elements, approximately 600 nm in diameter, written by electron beam lithography followed by thermal evaporation.

Excellent agreement is obtained between experimental scattering profiles and those simulated using a fast Fourier transform method (figure 5). The technique is appropriate to any shape of patterned element. Compared with direct space microscopy techniques, this reciprocal space method provides an improved precision in the measurement of periodicity due to averaging over a large number of elements. As in conventional diffraction, the satellite peak width is determined by the coherent scattering array area and the dispersion in the repeat structure. Although the present instrument resolution does not resolve the intrinsic satellite full width at half maximum, the tails of the satellite fall off more slowly than the instrument function. By matching the intensity in the tails of the satellites, the array correlation length can be determined, providing a quantitative measure of the precision of the array-writing process.

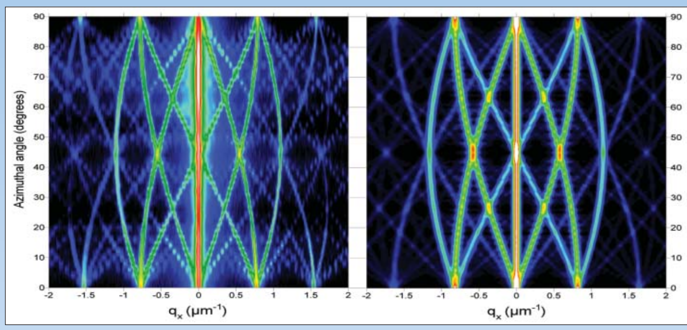

Figure 5. Experimental (left) and simulated false-colour map (right) of the scattered intensity from an array of circular $Ni_{80}Fe_{20}$ elements as a function of the in-plane scattering vector q_x and as the sample is rotated azimuthally.

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perturbation induced by Mn is very localized. *Ab initio* simulation of the X-ray absorption near-edge structure spectra confirmed that Mn enters the Ga, rather than the As, site. Samples grown at 450 °C exhibit a reduction of the first shell coordination number, suggesting the initial phases of MnAs precipitation. In the case of Be co-doping the downward shift of the Fermi energy leads to the appearance of Mn in tetrahedral interstitial sites, of which we provide a previously unavailable local structural description.

Reference

F d'Acapito *et al.* 2006 *Phys. Rev. B* **73** 35314.

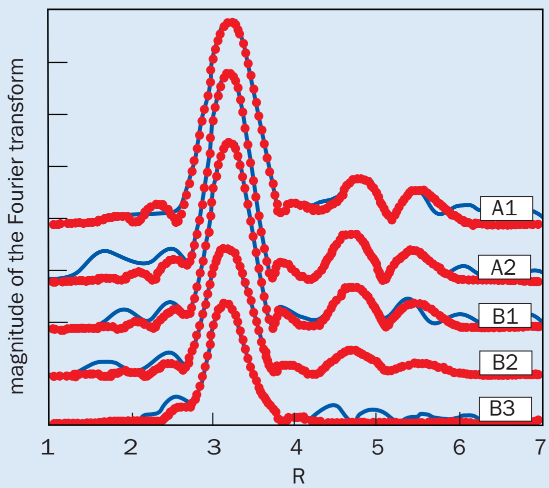

Figure 6. The magnitude of Fourier transforms of the EXAFS spectra (blue lines) in arbitrary units as a function of distance. The best fit is superimposed (red circles). The spectra are reproduced by exclusively considering substitutional Mn with the exception of sample B3, where a 30% contribution from an interstitial site was also used.

HIGH RESOLUTION AND RESONANCE SCATTERING GROUP

Rubber-like dynamics in sulphur above the λ-transition temperature

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1 ESRF, 2 CEA Grenoble, 3 University of Perugia

The high-frequency acoustic dynamics of sulphur across the liquid–liquid λ-transition have been investigated using inelastic X-ray scattering (IXS). The combination of these high-frequency data with lower-frequency literature data indicates that, in the high-temperature, polymeric solution phase, liquid sulphur develops some characteristic features of a rubber. In particular, entanglement coupling among polymeric chains plays a relevant role in the dynamics of this liquid phase.

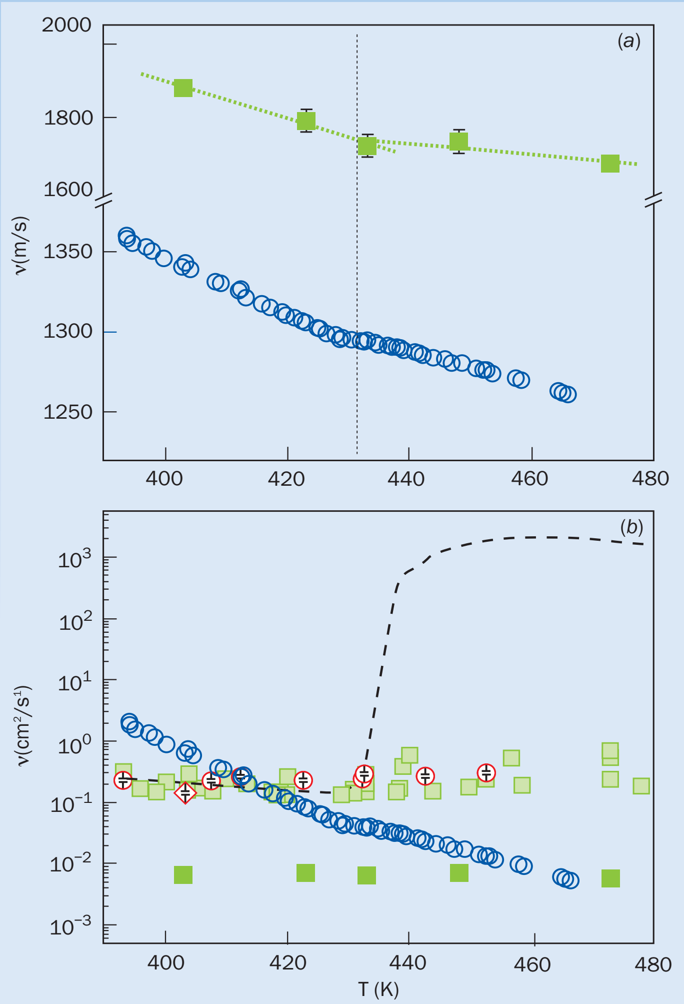

Figure 7. Temperature dependence of a) sound velocity, v, and b) longitudinal kinematic viscosity, ν_λ. Both observables are frequency dependent. The IXS results in the terahertz frequency range (full squares) are reported together with literature ultrasound data in the megahertz frequency range (open symbols). In a) the dotted lines through the IXS data are evidence of the change in the temperature coefficient of the sound velocity at T_λ, indicated by the vertical line. In b) the dashed curve is the zero-frequency, simple hydrodynamics prediction for the kinematic longitudinal viscosity, as calculated from data in the literature.

YOUR OPINION COUNTS

READER SURVEY

The *ESRF Newsletter* team wants to know your thoughts about the magazine to ensure that it continues to meet the needs of its readers.

- What do you think of the *ESRF Newsletter*?
- How could it be improved?
- What do you like most about the magazine?
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Please give a few minutes of your time to tell us your views by visiting the online survey at **http://www.esrf.fr/readersurvey**.

All respondents will be entered into a prize draw to receive a $200 Amazon voucher.

Closing date: **Friday 14 July 2006**

User's view

Montserrat Capellas

Thirsty for knowledge about ice. Harald Reichert spends long periods at the ESRF.

"The ESRF is like a piano with a lot of very different keys, and when you use them all, you are likely to get a nice melody."

HARALD REICHERT: THE CONSTANT USER

He used to go ice climbing when he was a student and was fascinated by the movement of glaciers. Today he enjoys the ice in another way: studying it. His thirst for knowledge about this interesting material, and his desire to find solutions to new challenges, are what motivate Harald Reichert, a research professor at the Max-Planck Institute, Stuttgart, and a regular user of the ESRF.

Do we know everything about ice?

Absolutely not. Ice presents a fascinating structure and it is a real challenge to study it. The contact area between the ice and, say, the soil behaves in a particular way at certain temperatures. At the moment we are concentrating on the influence of roughness on the melting of ice in order to understand sliding friction better.

How can the ESRF help in the study of ice?

High-energy X-rays like those at the ESRF are very useful for the study of buried interfaces. When we come to the ESRF we bring our samples from home in a fridge. We also carry a lot of equipment that allows us to recreate specific conditions. We study not only ice but also a broad range of other materials. I work a lot on alloys and we have built new instruments to improve experiments at the ESRF in this area as well.

Doesn't the ESRF offer enough instruments?

If we use the same instrumentation as everyone else does then we will probably get the same results as anyone else could get. However, if we introduce new instrumentation we can hope to achieve real breakthroughs. The ESRF is such a versatile tool that it offers a very wide range of possibilities for experiments.

Admittedly it can take quite some time for us to develop a new instrument. We have a long-term project with the ESRF whereby we develop instruments and install them on a beamline permanently for free use by other users. This benefits the ESRF as well as us because when we come for an experiment we don't have to set everything up each time.

It sounds like scientific do-it-yourself

When you build an instrument you

must have thought about a project beforehand, and you must have studied it deeply so that you know exactly what you need to solve its scientific mysteries. This system allows us to be the "owners" of a project from the start until the end. We launch a project, make the samples, develop the methods, do the experiment...so we are completely in charge of it.

You are also involved in the beamtime allocation review committees of the ESRF. Do you get special treatment?

No. If there is any proposal that concerns me, I leave the room and the others discuss and decide whether or not to accept it. I could chair the surface and interface panel because at Max-Planck I am not required to give lectures, nor do I have a lot of administrative work, so I can use spare time for this.

Besides, I think it is important to do this kind of job – to help large infrastructures do competitive research and payback for what we get here. At the moment the group I chair accepts about 40% of proposals. Oversubscription is good because it motivates people to think of new ideas for experiments.

Between the instruments, experiments and reviews, you must spend a lot of time at the ESRF

I do. Last year I spent five months here, and I normally drive 10–15 times a year back and forth to Grenoble. I find my periods at the ESRF very enriching, not only because of the experiments but also because of the discussions with researchers. Quite a few projects I am in originated from discussions with scientists from very different domains. In fact, the ESRF is like a piano with a lot of very different keys, and when you use them all, you are likely to get a nice melody.

How do you think the Free Electron Laser in Germany will affect synchrotron sources?

I don't think regular synchrotron users will switch to the Free Electron Laser (FEL). The FEL will allow researchers to concentrate on new scientific problems, different from those studied in the synchrotron community. Besides, the FEL won't be ready until 2010 or 2012, so it's still a long way away. At the moment the community provides the initiators of the FEL projects with ideas for possible experiments.

Apart from your work in science, you also carry out some outreach activities. Do you think they pay off?

If you can strike a chord of interest in one or two children, it's really worth the effort. The Max-Planck Society encourages us to participate in education, explaining to children about the kind of research we do in a simple way. I first test my skills in communicating science with my two children, who are both teenagers. Sometimes someone sends me an e-mail, years after, saying that they will start a degree in science and that my talk helped them to decide.

BREAKING THE ICE

Greenland's water loss has doubled in a decade, owing to the increased crashing of the icebergs into the Atlantic Ocean. This will contribute to an accelerated sea-level rise in the future. Harald Reichert and his team from the Max-Planck Institute for Metals Research in Stuttgart, Germany, are among those researchers trying to understand the melting properties of ice.

At the ESRF, on beamline ID15, the researchers studied how ice starts to melt at temperatures as low as −17 °C. This occurs when it is in contact with SiO_2, which is a material found in soil. Below the melting temperature of ice, a layer much denser than "regular" water forms between the ice and the SiO_2. The team is now focusing on how roughness and impurities influence the melting behaviour of ice. In Stuttgart it operates a walk-in cold room at −20 °C, which is used to grow and prepare ice samples.

We also organize subsidized visits to large-scale facilities for our university students.

With so many activities, no wonder you don't have time to go climbing anymore

I spend a lot of time working. I travel at night as much as I can because I don't need much sleep. Still, work basically takes all my time. But I like it. •

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Visiting a beamline

ID02: THE VERSATILE SMALL-ANGLE SCATTERING BEAMLINE THAT CAN ADAPT TO A RANGE OF USERS

ID02 is a specialized beamline for time-resolved, small-angle X-ray scattering and related scattering methods. It has applications in physics, chemistry, materials, engineering, biology and even medicine.

The distinguishing feature of soft matter and most non-crystalline biological specimens is that they have a microstructure that determines their properties and functions. Often there can be multiple levels of ordering, and small-angle X-ray scattering (SAXS) and related techniques are ideally suited to elucidating these hierarchical structures.

"SAXS is a low-resolution method compared with crystallography, but the key advantage is that a sample can be investigated in real-life conditions," explained Narayanan Theyencheri, who is the scientist in charge of the beamline.

The majority of these experiments (those conducted in house as well as those by users) involve combining scattering/diffraction with other methods (i.e. mechanical, chemical/biochemical probes). As a result, advanced sample environments are essential components of the set-up. Quantitative scattering experiments in real time in these different conditions are often challenging.


Chantal Argoud

ID02 opens its doors. The beamline team comprises ten staff. Left to right, first row: Stéphanie Finet, Michael Sztucki, Emanuela Di Cola. Second row: Alexandre Gierczak, Peter Boesecke, Jacques Gorini, Pierre Panine, Pierre Van Vaerenbergh, Armando Solé, Narayanan Theyencheri.

Dealing with diverse samples

The samples investigated range from biological tissues to cosmetics, and from detergents to nanomaterials. Soft matter is a common link between these diverse fields. The ultra-small-angle X-ray scattering set-up allows us to explore relatively large-scale structures, from a few microns down to tens of nanometres. SAXS probes characteristic structures in the range of several hundreds of nanometres down to a nanometre, and the complementary information in the subnanometre scale is provided by wide-angle scattering.

To handle the range of experiments, the five scientific staff at the beamline have different fields of expertise. "The user community is very diverse," said Theyencheri, "that's why we need to talk to them in their own scientific language in order to understand the subtleties of their experiments."

Dealing with such a diverse community causes some inconveniences. The changes in the experimental set-up are very frequent and user-supplied equipment often needs to be rapidly integrated. This requires a lot of effort from the team. In addition, the data analysis is usually very time consuming.

The beamline is oversubscribed and can accept fewer than one in four proposals, but the team tries to accommodate as many as possible. At present there are six beamlines similar to ID02 under design/construction at new synchrotron facilities in Europe. This indicates a growing demand for this type of experiment.

It is not only academic researchers who come to ID02. Industrial users such as Unilever, Procter & Gamble, Pfizer and some other pharmaceutical companies are also users. Thanks to the industrial income, the beamline has now another postdoctoral researcher. •

MC

Gallery of events

Chantal Argoud

Paying attention. The audience listens intently during a plenary talk at the annual Users' Meeting, held at the ESRF in March.

USERS GET TOGETHER AT THE ESRF ANNUAL MEETING

The 16th annual Users' Meeting was held in February and attracted 240 participants from 18 countries.

On 8 February, after reviewing the past year's activities relating to beamlines and the machine, W G Stirling and the research directors presented plans for the medium- to long-term strategy for the facility at the annual meeting. They identified increasingly pressing requests for nanofocusing and nanotechnology with beamlines; time-resolved experiments; increased support for special sample environments; beamline automation; increased capacity for imaging and materials science experiments; and also for biology and human health programmes.

Plans were presented for upgrades to the machine and to a third of the beamlines, for instrument and detector development, and for an increase in computing capacity. They were also outlined for a series of new long beamlines, and for the reconstruction of the experimental hall, including additional laboratory and office space.

Participants then broke out into parallel group discussions to debate these proposals and define special needs in their areas. In a second session, the series of results presented by users was well received.

Two workshops were held: one on dynamical phenomena in soft matter and the other on high pressure and synchrotron radiation.

Chantal Argoud

New in the chair. Marco Grioni (left) presents Laszlo Vincze, who succeeded him as chairman of the Users' Organization.

The 2006 Young Scientist prize was awarded to Paul Tafforeau for the application of X-ray synchrotron imaging to studies in paleontology.

The next day, Tafforeau gave a presentation on studies that he had carried out using the ID19 and ID17 beamlines. First he presented the fossilized teeth belonging to a 35 million-year-old primate and discussed what the primate's diet was likely to have been. Then he showed small fossilized eggs (those of either a dinosaur or a bird) and displayed images of the skeleton that remains inside each egg. •

ROSELYN MASON


Chantal Argoud

Learning the ropes. Participants in the new users' school. Sine Larsen (third from right) is one of the ESRF directors of research.

NEW USERS GO BACK TO SCHOOL AT THE ESRF

Using the synchrotron for the first time can be pretty daunting. However, would-be users who joined the 3rd Synchrotron Radiation School for New Users on 6-9 February were able to break themselves in gently.

Around 30 new users from 11 different countries signed up as students of the ESRF's new users school this spring, with the aim of learning how to use the machine with ease.

"I have never been to the ESRF before and, until now, it has been difficult to plan experiments here because I didn't really know how to perform them," said Yael Diskin-Posner, postdoctoral researcher at the Weizmann Institute in Israel. However, after the four-day course she felt "ready to carry out experiments at the ESRF".

A different view was that of Daniele Fioreto, who is a professor at the University of Perugia, Italy. He's a regular user both of the ESRF and Elettra (the Italian synchrotron), which he uses to perform experiments in physics. He joined the biology programme to help to further a collaborative project with colleagues of other disciplines at his university. "We are trying to get together physicists, chemists and biologists and to understand how we can work together, and we would like to exploit the possibilities that synchrotron radiation offers us," he explained.

The school included general information about the ESRF and the operation of the machine, and lectures about the use of synchrotron light for imaging, scattering, spectroscopy and diffraction experiments.

A second part of the school gave participants the opportunity to choose a biology- or physics-oriented programme. This allowed them to see examples of the science of different beamlines within their chosen field. They also visited the beamlines to see how experiments are carried out there.

The school's teachers were mainly ESRF scientists and their efforts were very much appreciated by the pupils. "Most of the presentations included examples, which is a really good way to see how theory applies to practice," said Alejandro Alija, a Spanish participant. However, he also had some constructive criticism. "Some of the explanations we had were too technical, even for scientists who have already used the synchrotron for their research," Alija added.

The course took place alongside the ESRF Users' Meeting (p27), so participants had the opportunity to attend this event at the same time. "The Users' Meeting gave me the opportunity to follow discussions of users in my field and keep updated on the strategies planned for the future of the ESRF," said Alija. •

MC

A SYMPOSIUM ON MAGNETISM IN SOLIDS WILL REMEMBER THE WORK OF PAOLO CARRA

Former head of the theory group, Paolo Carra, will be remembered by a symposium on magnetism in solids.

A symposium is being organized by the ESRF and the ILL to honour the scientist and our friend Paolo Carra, head of the ESRF Theory Group in the Joint ESRF-ILL Theory Group, who passed away on 18 October 2005. The aim of the event will be to highlight the solid-state physics field of magnetism in solids. This is a very active field today, partly owing to its potential for practical applications.

The symposium will address some of the physics concepts of relevance to the magnetism in solids. The presentations will highlight challenges for the future in this area and give a special emphasis to the important contributions that Paolo Carra made.

The event will take place on 14–15 September at the ESRF. For more information, visit http://www.esrf.fr/NewsAndEvents/Conferences/PaoloCarraSymposium. •

THE ORGANIZING COMMITTEE

HERCULES GOES FROM STRENGTH TO STRENGTH

The 16th Hercules course welcomed scientists from all over the world to Grenoble this February.

The five-week Higher European Research Course for Users of Large Experimental Systems (Hercules) offers training in condensed matter studies for students, postdocs and senior scientists from European and non-European labs in the field of neutron and synchrotron radiation. It covers a range of disciplines, such as biology, chemistry, physics, materials science, geosciences and industrial applications.

Thanks to support from the European Commission, three more one-week courses are planned this year. •

MC

ESRF SHOWCASES ITS BEAMLINE AT BIOXHIT

The second annual meeting of the BIOXHIT project gave participants and reviewers a chance to witness the progress made in automating our beamlines.

BIOXHIT is one of 15 European Commission projects funded by FP6 in which the ESRF participates. The aim of the project is to develop, assemble and create an integrated platform for the high-throughput structure determination of biological macromolecules with synchrotron radiation. As part of BIOXHIT the ESRF and all other European synchrotron radiation facilities are participating in the technology and software developments that are necessary to create this platform.

The successful automation of the seven end-stations dedicated to macromolecular crystallography, which has been achieved as a result of the joint efforts of staff from the ESRF and the EMBL-Grenoble outstation, represents a significant contribution to the project.

The second annual BIOXHIT meeting was held at the ESRF in January 2006 and gave the other partners and external reviewers the opportunity to see how the ESRF beamlines have advanced.

An important aspect of BIOXHIT is the coordination of the automation efforts between the different European synchrotrons so that a macromolecular crystallographer can mount crystals without worrying about which synchrotron will be used for the data collection. •

SEAN MCSWEENEY

CARL-IVAR BRANDEN BUILDING IS INAUGURATED AND WELCOMES INDUSTRY VISITORS

Eva Pebay-Peroula, director of the Institut de Biologie Structurale and chair of the PSB, cuts the ribbon. The Partnership for Structural Biology and the Institute de Virologie Moléculaire et Structurale held an Industry Day on 12 January, with the official opening of the Carl-Ivar Brändén Building a day later. Biotechnology and pharmaceutical companies were invited onto the Grenoble site for a first-hand view of the facilities being developed and science being carried out.