Röntgen Ångström Cluster

NEWSLETTER 13 | JUNE 2016

MAX IV ©Lunds Universitet

EDITORIAL

Are you superstitious? Then read no further... this is the 13th issue of the Röntgen-Ångström-Cluster Newsletter. Do you avoid the number 13 for fear of bad things happening to you? As a scientist, you are most likely NOT influenced by beliefs which by their very nature lack a scientific basis. On the contrary, you will show determination to come to the essence of phenomena not yet explained in facts and figures. Below, you can read about past and present recipients of RÅC funding who demonstrate just that: a keen interest in pursuing goals that no one before them has achieved.

However, science and popular customs can be combined, as we can see in Lund. MAX IV has chosen to open the world's brightest X-ray source on a symbolic day: Swedish Midsummer. It's the brightest and longest day of the year and heralds the season of fertility. In this sense, we send our warmest wishes to the South of Sweden and are looking forward to reporting about research results in the near future.
As always, we have a few announcements for you. Events which you might like to attend?

Enjoy our thirteenth issue!
The editors.

Aerial view of MAX IV (Photo: Perry Nordeng, MAX IV)

NEWS

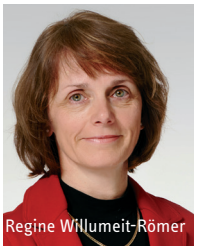
INAUGURATION OF MAX IV IN LUND: "THE BRIGHTEST MOMENT IN THE YEAR TO OPEN THE BRIGHTEST X-RAY SOURCE IN THE WORLD"

"We will open the brightest X-ray source in the world on the brightest moment in the year", predicted Christoph Quitmann, Director of MAX IV in Lund, two years ago in an exclusive interview for the Röntgen-Ångström-Cluster Newsletter. As it turns out, he was right. The research facility MAX IV in Lund celebrated its inauguration on 21st of June, 2016, shortly before Midsummer Day in Sweden. Among the guests to attend the celebration were the Swedish King and Prime Minister.
At present, the team is focused on completing the MAX IV Phase I project and on serving first commissioning users later this year. During an intense commissioning block lasting from August 2015 to February 2016, the machine team had the task to breathe life into the sheer endless accelerator components comprising the 3 GeV ring. It was the first time that anybody tried to get beam into an accelerator using the innovative multibend achromat (MBA) concept – a special magnet lattice designed for brilliant synchrotron light. The good news is that it works! The 3 GeV ring is expected to very soon deliver performance good enough to start commissioning the beamlines. The hardware for the 1.5 GeV ring is almost fully installed. The last piece, the transfer line, will be finished in a shutdown in September 2016, meaning beamline commissioning can start in early 2017.
The beamlines are progressing in parallel. New components arrive almost daily and installation and testing is on-going. The current estimation is that at least BioMAX and NanoMAX will have photons on a sample by midsummer. Others might make it as well or will follow shortly after.
The inauguration of MAX IV consisted of three main events:

- 18-19 June: Open House, welcoming the general public
- 20 June: Science Day, informing users
- 21 June: Inauguration, celebrating with staff, founders, and colleagues

FAILURE IN BIODEGRADABLE METAL IMPLANTS: INTERVIEW WITH ANN WENNERBERG AND REGINE WILLUMEIT-RÖMER


Ann Wennerberg


Regine Willumeit-Römer

Ann Wennerberg, Professor and chair of the Department of Prosthodontics, Faculty of Odontology at the Malmö University, gives an insight into the project "Failure in biodegradable metal implants". On the German side Regine Willumeit-Römer, Head of the division „Metallische Biomaterialien" is responsible for the project.

Could you briefly summarize what your project „Failure in biodegradable metal implants" is about?
Biodegradable implants (screws, nails, bone plates) are of major interest as biomedical devices since they do not need a second surgery for removal after the bone defect is healed. This is of great importance for many indications, especially for children and for compromised elderly patients. Beside polymeric materials also biodegradable metals as Magnesium (Mg) are suitable for implant production. The great challenge here is to tailor the degradation to such an extent that it guarantees immediate fixation of the implants, which have to deliver load bearing properties directly after the surgery, and a relatively fast degradation after healing is completed. A prerequisite to this is an understanding of the dynamic processes, which are evolving in the corrosion layer. So far, this interface and its properties are hardly studied in a living organism, mainly due to the insufficient resolution of available techniques. In this project, we aim to understand how implant degradation and failure mechanisms work for a biodegradable Mg implant where corrosion processes and (bio)chemistry form a complex network of interactions in the living system. We will study the following issues with highest spatial and elementary resolution by synchrotron X-ray tomography techniques and nanometer focus scanning SAXS/WAXS: (1) How is this interface changing over time within the animal? (2) Do the properties of the interface contribute to proper bone formation and structure? and (3) What fatigue mechanisms occur when the implant is pushed out of the bone?

In which areas of medicine would Magnesium-based implants most commonly be used?
In orthopaedic surgery for bone reconstructions and bone fracture healing.

What benefits do magnesium implants offer over traditional metal implants?
It is biodegradable, see point 1.

Have Magnesium based implants been patient tested?
Magnesium is a common material in our bodies needed for example for bone formation so the material is nothing new but the application is.

Hopefully we can identify factors of importance how to manufacture implants that degrade at the same speed as the new bone is formed thus replacing the implant and at the same time having sufficient strength to carry a load.

Do you expect a high demand for biodegradable Magnesium implants in the future?
If these implants function as intended there will be huge advantages using these materials.


Biodegradable magnesium implant in form of a screw (photo: Carsten Neff, NEWS & ART)

C3 – THE CONSORTIUM FOR CRYSTAL CHEMISTRY


Kristina Edström

Kristina Edström, Professor at the Department of Chemistry, Uppsala University, has been recipient of the Röntgen-Ångström-Cluster fund until this year. Below, she sums up what her efforts have led to.

The Consortium for Crystal Chemistry is a collaboration between the universities of Uppsala (coordinator) and Stockholm with IFW Leibniz in Dresden and in some cases also with PETRA III in Hamburg. The consortium started five years ago, and here are some examples of what C3 has achieved so far.

A special furnace was developed for studying synthesis reactions using in operando X-ray diffraction in transmission mode. This was tested for the crystallization process during the formation of a cathode material for a Li-ion battery. The synthesis can be followed up to ca. 600 °C. This was developed at Uppsala University.

Another example is a novel approach to obtain metallic glass-matrix composites with tensile ductility by flash Joule heating. This was applied to Cu(47.5)Zr(47.)5Al(5) (at.%) metallic glass using a new technique developed for in situ measurements of the sample while simultaneously controlling the heating rate and current density. This work was conducted at IWF Leibniz Dresden and published in "Nature communications" (see https://doi.org/10.1038/ncomms8932).

A third example is a comprehensive study of the complex crystal chemistry of Prussian blue, a dark blue pigment used as cathode material in water-based batteries. This work was performed in collaboration between Stockholm and Uppsala Universities. A number of different techniques such as X-ray diffraction, EXAFS, neutron scattering and Mössbauer spectroscopy have been used to understand the subtle structural changes during battery operation. The battery could be a "green" alternative for applications where large energy storage per volume is of minor importance.

The consortium has also been involved in PhD course training and in yearly workshops together with the Röntgen-Ångström consortium MATsynCELL. The next workshop is held in Uppsala during 6-7 October 2016.
(Photo: Uppsala University)

NON-EQUILIBRIUM THERMODYNAMICS OF BIOLOGY STUDIED BY TIME-RESOLVED SMALL-ANGLE X-RAY AND NEUTRON SCATTERING (TT-SAS)

Gergely Katona, University of Gothenburg, and Manfred Rößle, Lübeck University of Applied Sciences have been awarded funding in the context of the Röntgen-Ångström-Cluster. This year, they have started their project titled "Non-equilibrium thermodynamics of biology studied by time-resolved small-angle X-r ay and neutron scattering". Below, the Swedish and German scientists outline their research ambitions for the next few years.

The proposed research has two complementary goals, firstly to visualize the "unmeasurably" fast biochemical reactions that progress faster than millisecond time scales. To achieve this time resolution we will trigger the conversion of biochemical species in a reaction by a temperature jump which will change the equilibrium of most reactions. As the system approaches the new equilibrium, we will visualize the progress by X-ray and neutron scattering that reveal the location of electrons and atomic nuclei in the proteins, respectively. Among the biochemical reactions, we are particularly interested in protein-protein encounters and protein shape changes associated with their function.

The second complementary goal of the research is to identify which frequency of electromagnetic radiation exerts a non-thermal effect on the studied reactions. We are interested in how the reaction is altered in contrast to the expected thermal response and whether the path leading to the biochemical conversion is altered. We will focus our search on the terahertz region of electromagnetic radiation which lies between microwaves and infrared radiation. This type of radiation is difficult to produce at high intensities and even more difficult to handle, nevertheless it is a very important frequency region that coincides with the collective motions of proteins and thus expected to influence protein function.

As one of the most ambitious aims of the proposal we plan to visualize the collective molecular vibrations as they occur in real-time, not only through their biochemical consequence. For this purpose a very short THz pulse will be generated at the FemtoMAX beamline of Max IV which will be probed by equally fast X-ray impulse, revealing changes in electron density as the vibration displaces atoms of the protein.
The aim of the Röntgen-Ångström collaboration is to bring together the knowledge about time-resolved synchrotron technologies of Petra III and MAX IV. Both the German and Swedish partners (EMBL Hamburg and Lübeck University of Applied Sciences; University of Gothenburg, Max IV and ESS) are interested to study biochemical systems to which the proposed combination of methodology provides new insight.


Gergely Katona © private


Manfred Rößle,© FH Lübeck

ANNOUNCEMENTS

RACIRI SUMMER SCHOOL IN RUSSIA

Currently, the fourth RACIRI Summer School is being prepared. RACIRI 2016 will take place in Repino near Saint Petersburg during 21-28 August 2016. This year´s focus theme will be „Convergent Science and Technology for the Society".
The RACIRI Summer School addresses senior master's degree students in the final phase of their study programme (master or diploma), PhD students and young scientists (Postdocs). It is driven by scientific frontier themes and challenges in the field of materials sciences with a strong connection to current and future research infrastructures (synchrotron radiation and neutrons) in the Baltic region.
The RACIRI Summer School is held every year under a special focus theme. Its venue rotates annually among the three partnering countries Germany, Sweden and Russia.
Here's the link to this year's programme:
http://www.raciri.org/sites/site_raciri/content/e203194/e268177/ProgramRACIRI2016.pdf

JOINT C3 AND MATSYNCELL WORKSHOP UPPSALA

The next joint workshop of the two Röntgen-Ångström consortiums C3 (Consortium for Crystal Chemistry) and MATsynCELL (focusing on porous materials) is held in Uppsala during 6-7 October 2016.

BUNSEN DISCUSSION MEETING ON NEUTRONS IN CHEMISTRY

The meeting at Bielefeld University will take place from July 25 to 27, 2016. It is organized by Prof. T. Hellweg (Bielefeld University), Prof. M. Ballauff (Helmholtz-Zentrum Berlin), Prof. Dr. G. Eckold (Göttingen University) and Prof. Dr. R. von Klitzing (Technical University Berlin). Due to the unique properties of neutrons, neutron scattering is an outstanding tool in material science, (bio-)physics and chemistry. With the up-coming European spallation source (ESS) in Lund new experiments and science will be possible and new user communities will get attracted. Therefore, it is necessary to review the state of the art of present experiments and to develop new ideas and future experimental challenges.
Registration is required via the conference website:
http://www.uni-bielefeld.de/chemie/neutrons_in_chemistry/registration.html

NEW PETRA III HALLS WILL BE NAMED

Now almost on the home straight... The naming ceremony for the two newly built PETRA III experimental halls is expected to take place at DESY in Hamburg on Wednesday, 14 September 2016.

NEWS

NEW WEBSITE:
RÅC ONLINE BOASTS NEW FACE AND FEATURES

Come visit us at www.rontgen-angstrom.eu. Our website has been relaunched and features new content and an archive storing past projects and newsletters.

The OTHER News

TALKING ABOUT TRISKAIDEKAPHOBIA

As you are reading the thirteenth issue of our newsletter, you might either be very brave or you might just not care about the symbolic meaning of the number 13?
Triskaidekaphobia – that is the fear or a phobia concerning the number 13. It is also being referred to as 13-digit phobia because of its Greek origin where "tris" means "three", "kai" means "and", "deka" means "ten" and "phobia" means "fear". How or when the number thirteen got its bad reputation is impossible to say due to a number of theories on the topic. Some attribute it to the Bible - the Last Supper was attended by 13 people, and the 13th person at the table was Judas, who later betrayed Jesus. Another theory is that the fear of number 13 is caused by its ungrateful closeness to the number 12 which is the number of perfection: 12 months in a year, 12 zodiacs, 12 hours in a clock ... It may have also affected the Vikings: It is believed that Loki was the 13th god in the Norse pantheon who arrived at a dinner party in Valhalla, upsetting the balance of the 12 gods already in attendance, which later lead to the death of Balder.
Today many companies avoid the number 13 to avoid complaints from customers: hotels and hospitals skip the number 13 in floors, corridors and rooms, and airlines do not have row 13 on planes. However, the irrational fears of the number 13 are a primarily Western construct: In China and other Asian cultures the number 13 is not considered bad, but instead the number 4 is considered unlucky. This fear – tetraphobia – is why the number 4 is not being used much in private or public life, due to similar sounds in the Chinese language for the words for "four" and "death".
By the way – the Western fear about the date "Friday the thirteenth", which occurs once to three times a year, has its own name: It is called paraskavedekatriaphobia.

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