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PRESIDENT'S SELECTION
The Newsletter from the ETH Zurich President

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ETH ZURICH AND IBM RESEARCH ZURICH

Great nanopartnership


Photo: Scanderberg Sauer Photography

Complex equipment, clean and noise-free labs: nanotechnology demands the highest standards.

Top level research requires large sums of investment in highly advanced infrastructure. In order to cut costs and exchange expertise at the same time, partnerships with private research labs offer a good solution, a perfect example being the collaboration in nanotechnology between ETH Zurich and IBM.

Like all universities, ETH Zurich faces increased global competition and in order to maintain its leading position, new strategic fields of science need to be exploited. However, the expense of investing in such futuristic disciplines such as nanotechnology only gets higher. At the same time, public funding does not extend to cover the extra costs of this growth.

How can a university overcome this dilemma? Apart from acquisitions from third parties and donations, a new option is emerging that provides a range of benefits: Public Private Partnerships or PPPs. ETH Zurich already cultivates a number of these partnerships with a variety of organizations including Disney Research, ABB, Alstom, Siemens and Swiss Re.

With the opening of the Nanotechnology Center at IBM Research Zurich, ETH has gained a unique opportunity. It is able to rent a part of the ultra-modern lab where it can conduct its own research and also run joint projects in collaboration with IBM. The aim is for valuable synergies to be created – as innovation is stimulated when researchers from differing backgrounds come together.

Sharing equipment

In addition, expensive research equipment can be jointly financed which significantly lightens each budget. This kind of partnership is also increasingly seen at the University within the different Departments.

As a federal institution, ETH is not permitted to take on a mortgage which makes a PPP with IBM highly interesting as it alleviates the problem of the acute lack of premises. The computer giant has financed the 60 million franc construction in Rüschlikon itself, the technical infrastructure (30 million CHF) is shared, ETH rents lab and office space and contributes to operating costs: a calculation designed to prepare the ground for nanotechnology breakthroughs.

Nanotechnology: started 30 years ago

Nanotechnology is considered the epitome of futuristic technologies. Employing new kinds of effects produced by tiny structures in the range of a few billionths of a meter, this progression into ever smaller dimensions is not bound to classic disciplines and therefore affects all fields of science and technology. Experts predict significant potential for nanotechnology in applications in medicine, environmental protection, energy technology and computer technology. Industrial use was made possible due to the invention of the scanning tunneling microscope 30 years ago by Heinrich Rohrer and Gerd Binnig at the IBM Research Lab Zurich.

EDITORIAL

Doubly inventive

Dear reader

First class teaching and inventive research are essential qualifications for a successful university. These skills alone, however, are no longer sufficient. In order to keep pace with developments in key sciences, new kinds of collaboration models and funding also need to be invented and applied.

The nanotechnology partnership with IBM is a stroke of luck for ETH Zurich. For a fair price, we have access to state-of-the-art labs and instruments – in a relatively short space of time too.

By teaming up with IBM, we are also creating a particularly inspiring environment for research as our scientists can now work at the birthplace of nanotechnology, so to speak.

I hope you find it all as interesting as I do.

Prof. Dr. Ralph Eichler
President ETH Zurich

"QUOTE ... UNQUOTE"

"The scientific investigation of the nano cosmos will lead to a quantum leap."

Heinrich Rohrer ETH Physicist, IBM Research Lab Zurich (1963-1997), Physics Nobel Prize 1986 (for inventing the scanning tunneling microscope with Gerd Binnig)

OPPORTUNITIES AND RISKS

Agile particles

What the most fascinating aspects of nanotechnology are, and where the dangers lie, is explained here by Wendelin Stark, Professor at the Institute of Chemical and Bioengineering at ETH Zurich.

Mr. Stark, what exactly does nanotechnology mean?
The application of the very, very small. With tiny components, we are learning to find better solutions to technical and medical questions.

Can a layperson possibly understand your research?
We produce extremely small particles, usually little spheres of metals, ceramics or polymers. We then re-assemble them like Lego bricks, creating materials with special functions such as a cotton wool–like "bone glue" that is easy for doctors to apply. Inside the patient's body, the soft material transforms itself into hard bone material; or plastic film that cleans itself of bacteria – very useful in a hospital as the germs there are often extremely dangerous.

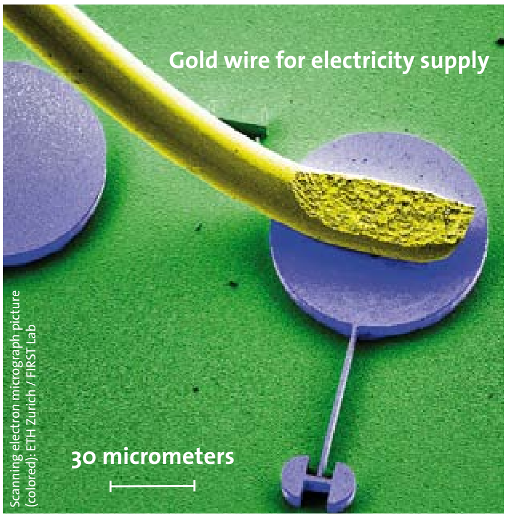
What is it that fascinates you about this work?
Entering the nano world is like starting off on a journey with no orientation and no glasses and then someone gives you a microscope and a telescope. As I said, we build highly useful functions with molecules, leveraging mechanical forces in order to move atoms. This is extremely exciting.

Wendelin Stark.

Nanotechnology also holds dangers ...
Of course, small particles are incredibly mobile. This changes their behavior in the environment or when we take them up. A responsible approach to technology means investigating the positive and negative aspects at the same time and to the same extent. Back in 2004, I set up a test lab where we study the effects on human cells, the results of which have been incorporated into legal regulations. Switzerland is an international pioneer in the safety of new technologies and has had a testing procedure for nanoproducts since 2008.

What is key to avoid risks?
Most essential is that we don't put any persistent (non-degradable) components into everyday goods. This seems to be advisable when we think about the after-effects of persistent gases (ozone hole), chemicals (DDT, fireproof materials) or plastic in the ocean.

SMALLEST LASER WORLDWIDE



30 thousandths of a millimeter small are the two capacitors and inductor (below), the centerpiece of the ETH microlaser.

Flashes of new land

By combining electronics and optics, the world's smallest laser was created at ETH Zurich. Processed by nanotechnology, the light source can shine through formerly impenetrable structures and discover many new facts.

Can we see the water in a maple leaf? Could radio astronomers receive indication of life in outer galaxies? Can skin cancer be identified at an early stage through the water content of cells? Not yet, but maybe soon. This gap in perception, that is laden with potential, is named by scientists "the Terahertz gap" and refers to the region where electromagnetic radiation oscillates with frequencies of a trillion hertz (between infrared and microwaves).

In order to explore this radiation range, a research team led by ETH Professor Jérôme Faist has created a new kind of microlaser. It is clearly distinguished in two points from classic light lasers. Instead of an optical amplifier, an electrical resonant circuit is used, formed of two semicircular capacitors connected via an inductor.

Masterpiece of nanotechnology
In addition, the capacitors are built up of countless ultra-thin semiconductor layers. Such a masterpiece of nanotechnology delivers significant benefits, since the electrons (issuing from the inductor) seem to hop over cascades through the capacitor and send out photons (light particles) after every step, thus causing the laser – via optical mirrors – to flash. This cascade laser is not only much more powerful that a conventional device, but, thanks to the resonant circuit, also contributes knowledge from the Terahertz gap.

IN SHORT

Quantum leap in physics
Led by ETH, a National Center for Competence in Research entitled "Quantum Science and Technology" was set up at the beginning of the year. The aim of the program is to explore the limits between classical physics and quantum physics, with application potential envisaged mainly in IT and Sensor Technology. The subject "Information and Intelligence" also represents one of ETH Zurich's strategic focus areas. With the help of the ETH Zurich Foundation, additional private resources will be raised in order to accelerate research activities.

Quantum computer light
Photons in the microwave frequency range are important for quantum information processors. However, these light particles are 100 000 times weaker than those emitted by an electric light bulb. Nevertheless, a research team from the ETH Department of Physics has succeeded in being the first to produce and detect single photons in the microwave region.

Power from nanowire
Covered in germanium, the silicon wire is 10 000 times thinner than a human hair. When a temperature difference is produced in this semiconductor, electricity flows. Up to now, such thermoelectricity has only functioned in computer simulation which means that the ETH Institute of Energy Technology still has a lot to do until nanoelectricity is produced effectively.

FINAL WORD

Huge nano world
The young female particle physicist was not greatly impressed by the established nanoscientist who, over coffee at a seminar, was proudly telling her all about his manipulations of single atoms. Experiments like his are conducted on the nanometer scale (10^{-9} m) while her experiments with muons take place in the femtometer range (10^{-15} m).

However, the talented postdoc was not brave enough to point out the significant difference to the impertinent professor. Quite frankly, her femto universe, a million times smaller than the supposedly tiny nano world, leaves this colleague looking gigantic.

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