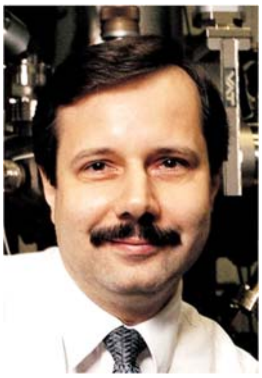
The First Awarding of The Heinrich Rohrer Medals

June 2014, The Surface Science Society of Japan
Masaharu Oshima, President

It is our great pleasure to announce the winners of the first awarding of The Heinrich Rohrer Medals. The Medal has been established after the name of Late Dr. Heinrich Rohrer, one of the Laureates of Nobel Prize in Physics in 1986, for recognizing researchers who have made the world-top level achievements in the fields of nanoscience and nanotechnology.



The Heinrich Rohrer Medal -Grand Medal-

- **Roland Wiesendanger** (born in 1961)

Professor in University of Hamburg, Germany

"For his pioneering and ground-breaking achievements on spin-resolved scanning tunneling microscopy and spectroscopy, bringing about very deep insights in spin-related properties of materials at atomic scale"

The Heinrich Rohrer Medal -Rising Medal-

- **Yoshiaki Sugimoto** (born in 1978)

Associate Professor in Osaka University, Japan

"For his outstanding contributions to manipulation and chemical identification of individual atoms using atomic force microscopy"

The Heinrich Rohrer Medal -Rising Medal-

- **Jan Hugo Dil** (born in 1977)

SNSF Professor in Ecole Polytechnique Fédérale de Lausanne, Switzerland

"For his leading and creative roles in identifying novel spin structures using synchrotron radiation-based spin- and angle-resolved photoemission spectroscopy"

Award Committee Members

- Masaru Tsukada (Tohoku University, Japan, Committee Chair,)
- Heike E. Riel (IBM Zurich, Switzerland)
- Wolf-Dieter Schneider (EPFL, Switzerland)
- Patrick Soukiassian (University of Paris-Sud/Orsay, France)
- Flemming Besenbacher (Aarhus University, Denmark)
- Michel A. Van Hove (Hong Kong Baptist University, Hong Kong),
- Matthias Scheffler (Fritz Haber Institute, Germany)
- Kunio Takayanagi (Tokyo Institute of Technology, Japan)

Award Ceremony

The award ceremony will be held at The 7th International Symposium on Surface Science, ISSS-7 (http://www.sssj.org/isss7/), on 2-6 November, 2014, at Kunibiki Messe, Shimane, Japan, which is organized by The Surface Science Society of Japan. The awarding will be in collaboration with Swiss Embassy in Japan. The laureates will deliver the award lectures on their research achievements during ISSS-7.

Official Collaborators and Sponsors

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Award Achievements

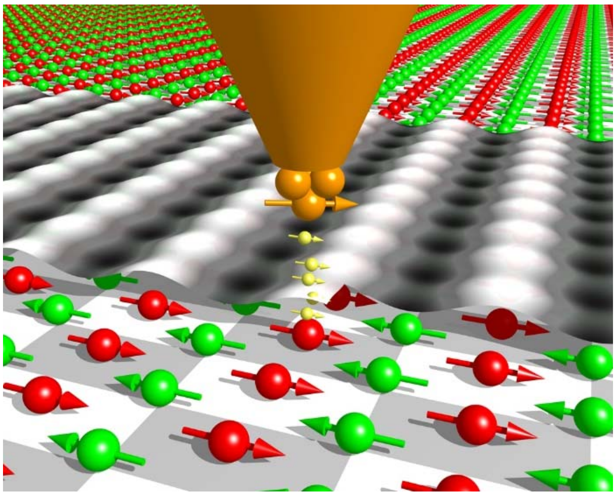
The Heinrich Rohrer Medal –Grand Medal–
Professor Roland Wiesendanger

"For his pioneering and ground-breaking achievements on spin-resolved scanning tunneling microscopy and spectroscopy, bringing about very deep insights in spin-related properties of materials at atomic scale".

Professor Wiesendanger has added the spin-degree of freedom to scanning tunneling microscopy (STM) which Dr. Heinrich Rohrer and his colleagues have developed. Before Professor Wiesendanger's research, magnetic and spin information was not directly accessible by STM. His achievements have opened a door to atomic-scale investigations of magnetism in real space, unveiling hitherto inaccessible atomistic phenomena. His achievements are very important not only for basic physics and chemistry of condensed matter, but also for developing and improving various kinds of magnetic devices in computers and sensors.

He has developed spin-polarized scanning tunneling microscopy (SP-STM) and magnetic exchange force microscopy (MExFM), which enables us to explore magnetic properties of material surfaces down to atomic scale. After the world-first detection of spin-dependent tunneling current in STM using a magnetic tip and a magnetic sample, he achieved atomic resolution in magnetic imaging by SP-STM. His SP-STM even enables measuring single-atom magnetization curves under a magnetic field applied. This 'single-atom magnetometry' made possible to detect directly the RKKY interaction between individual magnetic adatoms, one of the most typical many-body phenomena in materials. Moreover, the spin-polarized current in SP-STM has successfully been utilized to create and delete individual magnetic skyrmions, leading to possible applications in spintronics. He also developed MExFM by using spin-dependent exchange and correlation forces by extending the technique of atomic force microscopy (AFM), enabling atomic-resolution magnetic imaging of a surface of an antiferromagnetic insulator.

Spin-Polarized Scanning Tunneling Microscopy (SP-STM), revealing the atomic-scale spin structure of surfaces, ultra-thin films, and nanostructures. When the spin at the sample surface is parallel to the spin at the tip apex, the tunneling current flows efficiently. When, however, they are anti-parallel to each other, the current flow is reduced. With this phenomenon, the spin direction at each atom on the surface is imaged.



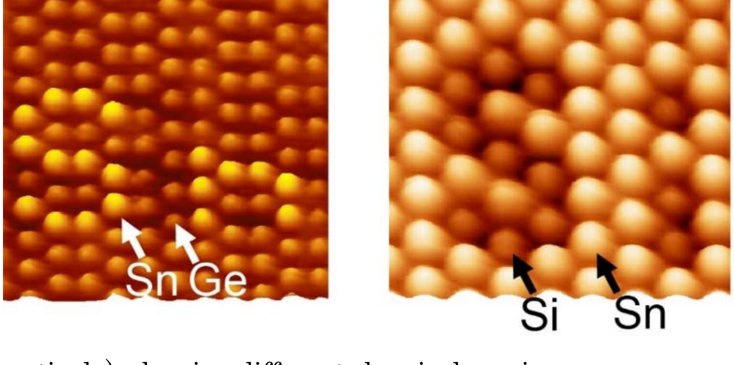
Award Achievements

The Heinrich Rohrer Medal –Rising Medal–
Professor Yoshiaki Sugimoto

"For his outstanding contributions to manipulation and chemical identification of individual atoms using atomic force microscopy".

Professor Sugimoto has succeeded in replacing aimed atoms individually by other atoms at surfaces of crystal lattices at will, and making 'atom letters' drawn with the replaced atoms by embedding and fixing them in the crystal lattice. This method has extended the atom manipulation technique from low temperature to room temperature, showing fabrication of stable artificial atomic structures. Furthermore, he has invented a method to identify atomic species of individual atoms observed in micrographs. These achievements lead to a dream to use individual atoms as building blocks for constructing ultimately small functional devices.

By improving the performance of his atomic force microscope (AFM), he has achieved not only atomic resolution in imaging, but also demonstrated how to manipulate, identify, and characterize individual atoms on surfaces of crystals at room temperature. By exchanging an aimed atom on the surface of sample crystal by an atom at the AFM tip apex, the replaced atom is embedded in the crystal surface lattice, so that the atom stays stably at the fixed lattice point even at room temperature. The AFM tip can be also used to exchange an atom with the neighboring atom on the sample crystal surface, so that the aimed atom can be made shift in position atom by atom by repeating the exchange process successively. This is an important breakthrough of controlled atom manipulation toward practical use because all of the processes are done at room temperature. Since an atom adsorbed on crystal surfaces is quite mobile at room temperature, it is an ingenious idea to embed an atom in the crystal lattice point to fix it. He has also found a method for chemical identification of individual atoms by precisely measuring force between the aimed atom on the sample surface and the AFM tip apex atom.



Atomic force microscope (AFM) images of 'atom letters' ('Sn' and 'Si'), written by atoms arranged and embedded in the crystal surfaces. The atoms composing the letters look brighter (Tin atoms in the left picture) or darker (Silicon atoms in the right picture) than the surrounding atoms (Germanium and Tin atoms, respectively), showing different chemical species.

Award Achievements

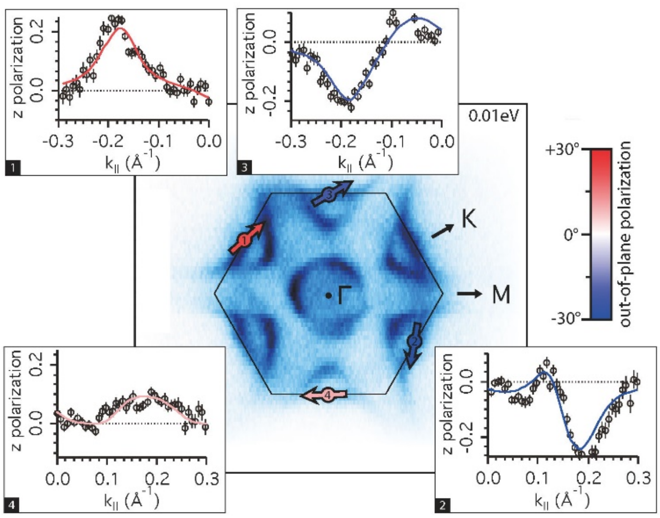
The Heinrich Rohrer Medal –Rising Medal–
Professor Jan Hugo Dil

"For his leading and creative roles in identifying novel spin structures using synchrotron radiation-based spin- and angle-resolved photoemission spectroscopy".

Professor Dil has played a central role not only in constructing a spin- and angle-resolved photoemission spectroscopy (SARPES) apparatus in Swiss Light Source Synchrotron Radiation facility , but also in exploring important physics, using the apparatus, on spin structures of a special class of non-magnetic materials. Photoemission spectroscopy, in which the energy and momentum of electrons, emitted from materials by irradiation of ultraviolet light or X-ray, are measured, has been one of the most powerful experimental methods to investigate the electronic states in materials and their surfaces. The SARPES apparatus that Professor Dil and his colleagues have developed, enables us to analyze spin direction of the emitted electrons as well as the energy and momentum, by which we can obtain a complete set of information of electrons in materials.

The spin is known to be an origin of magnets which are useful in our daily life with e.g., smartphones and computers. But it is recently shown that a group of non-magnetic materials with strong spin-orbit coupling, called surface Rashba materials and topological materials, have electrons which have unique spin arrangements. The group of Professor Dil is the first to clarify such spin states experimentally. Those materials are expected to be useful for new types of electronics devices utilizing spin degree of freedom of electrons.

Specifically, Professor Dil has shown that the asymmetric distribution of the wave function around a heavy atom core on a material surface is important for determining the Rashba-type spin splitting in surface states. The spin texture in surface states of topological insulators and topological crystalline insulators were clarified for the first time by his group. The nature of topological surface states and topological transition, as well as ‘spin interference’ phenomenon, are also clarified by his SARPES apparatus.



The Fermi surface and spin arrangement of a topological insulator $PbBi_4Te_7$ revealed by SARPES. The curves in the four panels show the measured out-of-plane spin polarization, which is combined with the in-plane spin polarization in the spin vectors shown on the figure. The results directly show the helical spin texture of the topological surface state.