The Third Awarding of The Heinrich Rohrer Medals

February 1, 2020
The Japan Society of Vacuum and Surface Science (JVSS)

It is our great pleasure to announce the winners of the third awarding of The Heinrich Rohrer Medals. The Medal was 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 3rd Heinrich Rohrer Medal -Grand Medal-

- **Andreas Heinrich**

    Ewha Womans University, Korea

    "For his ground-breaking development of scanning tunneling microscope methods to study the spin properties of magnetic atoms on surfaces for revealing the quantum nature of the magnetism at the atomic scale"

The 3rd Heinrich Rohrer Medal -Rising Medal-

- **Takashi Kumagai** (born in 1984)

    Fritz Haber Institute of the Max Planck Society, Germany

    " For his outstanding achievements in the field of near-field physics and chemistry in plasmonic STM junctions "

Award Ceremony and Award Lecture

The award ceremony will be held at the 9th International Symposium on Surface Science, ISSS-9 (https://www.jvss.jp/isss9/), on November 15-19, 2020, at Sunport Takamatsu Convention Center, Kagawa, Japan, which is organized by JVSS. The awarding will be in collaboration with Swiss Embassy in Japan. The laureates will deliver the award lectures on their research achievements at ISSS-9.

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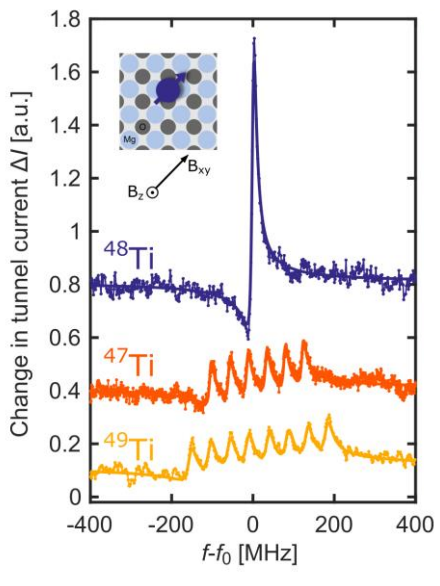
Award Achievements
The 3rd Heinrich Rohrer Medal –Grand Medal–
Prof. Andreas Heinrich

"For his ground-breaking development of scanning tunneling microscope methods to study the spin properties of magnetic atoms on surfaces for revealing the quantum nature of the magnetism at the atomic scale"

Prof. Heinrich is a world-leading researcher in the field of quantum measurements at the atomic-scale in solids. He designed and constructed a low-temperature ultra-high-vacuum scanning tunneling microscope to provide the energy resolution required to measure a spin excitation of an atom and the Zeeman splitting of a free electron. It paved the way for the science to follow: i)Spin Excitation Spectroscopy – a method to measure the energies of spin excitations of an atom or assembly of atoms such as the Zeeman splitting of individual atoms on surfaces, the magnetic anisotropy energy of individual atoms and custom-assembled clusters of atoms, spin-spin coupling in engineered chains, the exchange energy between coupled magnetic atoms, and the ground and excited state spin configurations of chains of magnetic atoms, and the Kondo effect. ii)An all-electric pump-probe technique for measuring the lifetimes of spin excitations of those atoms. He outlined a totally unconventional all-electronic pump-probe scheme that completely bypassed the bandwidth limitations of the STM's current amplifier. The key idea was to use a voltage pulse applied across the tunnel junction to excite the spin (the "pump" voltage pulse) followed by a variably-delayed voltage pulse (the "probe" voltage pulse) to monitor the state of the spin system at a known time after the excitation. He demonstrated the ability to measure the longitudinal spin relaxation time, T_1, of an iron atom on a surface. The temporal resolution of this technique is then limited by fast enough pulses, not by the bandwidth of the amplifier. iii)A novel method that enables Electron Spin Resonance (ESR) measurements of individual atoms with the STM. He demonstrated that radio-frequency voltages applied between the tip of the tunneling microscope and the sample could be used to excite and detect the Electron Spin Resonance of individual atoms on surfaces. As with Nuclear Magnetic Resonance and Electron Spin Resonance, Spin Excitation Spectroscopy could now measure both energetics and dynamics but with single atom spin sensitivity and combined with the atomic-resolution imaging and manipulation abilities of the STM. Its significance is that it opened the door not only to the study of the spin coherence properties of atoms on surfaces, but also the coherent control of atomic-scale quantum systems that are engineered to have desirable functionality and then assembled using the atom manipulation abilities of the STM.

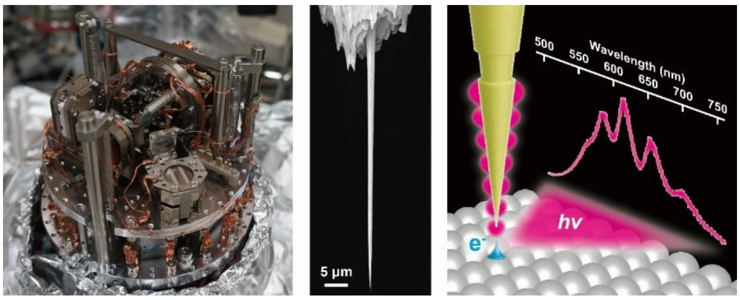


Award Achievements
The 3rd Heinrich Rohrer Medal –Rising Medal–
Dr. Takashi Kumagai

“For his outstanding achievements in the field of near-field physics and chemistry in plasmonic STM junctions ”

Dr. Kumagai is an outstanding and active young scientist leading his international research team at Fritz-Haber Institute and has achieved highly original basic researches on nanoscale surface science using low-temperature STM/AFM. He has developed unique approaches to investigate physical chemistry with single molecules on surfaces, which is well-recognized and acclaimed in the field. In particular, he studied single-molecule tautomerization in a variety of facets, ranging from the influence of an atomic-scale environment to force-induced tautomerization. In his seminal works, he addressed many very fundamental questions in hydrogen-transfer reactions, which opened a new discipline of real-space study of hydrogen dynamics. Recently, he has pursued a new direction of low-temperature STM for studying light–matter interactions on the atomic scale, which will push further a new frontier in the interdisciplinary field of nanoplasmonics and surface science.

He developed a unique combination of low-temperature STM and local optical excitations and spectroscopy. A series of recent publications show these key developments and significant advances to address fundamental questions in nanoscale light–matter interactions in controlled plasmonic STM junctions. He has established a quite unique and sophisticated experimental approach including the development of low-temperature STM with integrated laser optics along with nano-fabricated plasmonic tips using focused ion beam (FIB) milling which enables to modify the plasmonic properties in the STM junction. With these novel techniques, he has carried out precise experiments which lead to the discovery of plasmon-assisted resonance electron transfer, elucidation of microscopic mechanisms of plasmon-induced chemical reactions, and demonstration of tip-enhanced resonance Raman spectroscopy. In particular, nanofabrication of plasmonic tips has a great potential for controlling nanoscale light which can be widely applied in scanning near-field optical microscopy enabling nanoscale spectromicroscopy even down to the single-molecule level.



(Left) Picture of the low-temperature scanning probe microscope for local optical excitation and spectroscopy.
(Middle) Scanning electron micrograph of a silver tip sharpened by focused ion beam milling.
(Right) Scanning tunneling luminescence from a Fabry–Pérot plasmonic tip.