Award Achievements

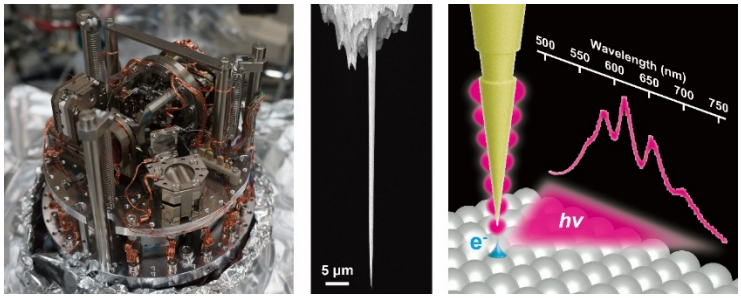
The 3rd Heinrich Rohrer Medal –Rising Medal–

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.