

Nanoscale Surface Chemistry – Physical Chemistry with Single Molecules and Near-Field Chemistry in Plasmonic Junctions

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Seeing is believing—scanning probe microscopy (SPM) provides a unique opportunity to directly observe surface chemistry and physics at the single-atom/molecule level [1]. We have studied nanoscale surface chemistry using low-temperature SPM. I will discuss physical chemistry with single molecules in tautomerism of porphycene on metal surfaces, which occurs by various external stimuli, namely heat, electron, light, and chemical interaction, or quantum tunneling [2–7]. I will also discuss near-field chemistry in plasmonic SPM junctions and show our recent studies on plasmon-mediated chemical reactions [8], plasmon-assisted resonant electron transfer [9], engineering gap-mode plasmon [10], and tip-enhanced resonance Raman spectroscopy [11]. References [1] W. Ho, J. Chem. Phys. 117, 11033 (2002). [2] Phys. Rev. Lett. 111, 246101 (2013). [3] Nature Chemistry 6, 41 (2014). [4] ACS Nano 9, 7287 (2015). [5] Nano Lett. 16, 1034 (2016). [6] Nature Chemistry, 8, 935 (2016). [7] J. Am. Chem. Soc. 139, 12681 (2017). [8] Nano Lett. 18, 152 (2018). [9] Nano Lett. 19, 3597 (2019). [10] Phys. Rev. Lett. 121, 226802 (2018). [11] Nano Lett. 19, 5725 (2019).

Dr. Kumagai received his PhD degree from Kyoto University, Japan, in March 2011, with theme “Visualization of Hydrogen-Bond Dynamics using low-temperature scanning tunneling microscopy”. In April 2011, he joined Fritz-Haber Institute of the Max-Planck Society with a research fellowship awarded from Japan Society for the Promotion of Science and collaborated with Dr. Leonhard Grill (currently Professor at University of Graz, Austria). In April 2013 he was appointed a research group leader at Fritz-Haber Institute and has headed Nanoscale Surface Chemistry Group and studied single-molecule chemistry on surfaces using state-of-the-art scanning probe techniques. He has received several awards for early career scientists, including the Inoue Research Award for Young Scientists in 2013 (Japan), the Morino Award for Molecular Science in 2014 (Japan), and the Gerhard Ertl Young Investigator Award in 2016 (Germany).

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