Fritz-Haber-Institut der Max-Planck-Gesellschaft

Physikalische Chemie — Direktor: Prof. Dr. Martin Wolf

MAX-PLANCK-GESELLSCHAFT

Department Seminar:

Wednesday, March 20, 2019, at **11:00** a.m.;
— all are invited to meet at around 10:40 for a chat and coffee —

Asst. Prof. Norio Okabayashi

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Vibrational energies of a single CO molecule in an external force field

PC Seminar Room G2.06, Building G, Faradayweg 4 T. Kumagai

Abstract:

The vibration of a molecule on a surface contains critical information on the bond of the molecule with the surface and within the molecule. Combination of scanning tunneling microscopy (STM) with inelastic electron tunneling spectroscopy (IETS) enable us to investigate vibrational energies at the atomic scale precision [1]. However, it has been known that the intensity of IETS strongly changes between different tips [2] and the vibrational energies acquired by IETS are strongly influenced by the distance between the tip and molecule [3,4], i.e., the force from the tip to the molecule. In order to clear these problems, we have incorporated atomic force microscopy (AFM) into STM-IETS by collaboration with Franz Giessibl laboratory in Regensburg University. By this improvement, we have found that a metallic tip whose apex consists of a single atom provides the stronger IETS signal to a CO molecule on a Cu(111) surface, whereas a metallic tip whose apex consists of multiple atoms provides the smaller IETS signal [5]. We have further found that the higher the tip-molecule interaction, the more the vibrational modes of the molecule are perturbed. These findings have been rationalized by a classical model describing the molecule as a double pendulum, where the presence of the tip weakens the tip-surface chemical bond [6].

[1] B. C. Stipe, M. A. Rezaei, and W. Ho, Science 280, 1732 (1998).
[2] L. J. Lauhon and W. Ho, PRB 60, R8525 (1999).
[3] L. Vitali et al., Nano Lett. 10, 657 (2010).
[4] F. Mahmood, https://purl.stanford.edu/cy977mf7313.
[5] N. Okabayashi et. al., PRB 93, 165415 (2016).
[6] N. Okabayashi et. al., PNAS 115, 4571 (2018).