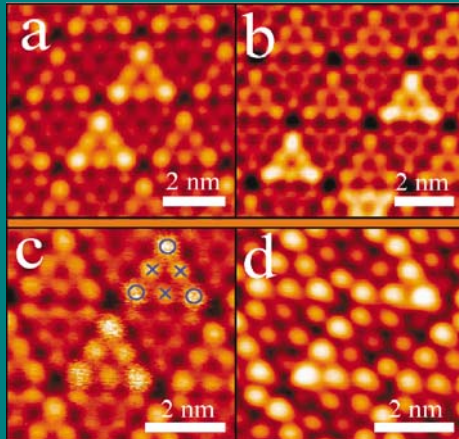
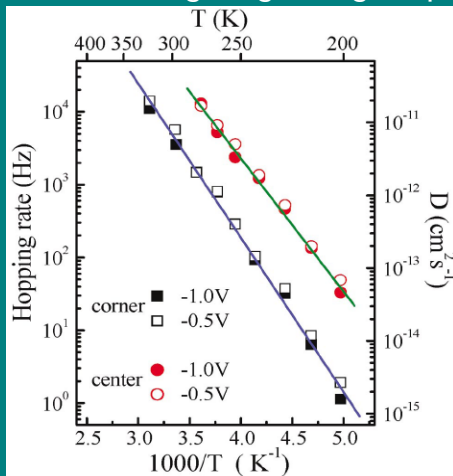


# Time-Dependent Tunneling Spectroscopy for studying Surface Diffusion Confined in Nanostructures

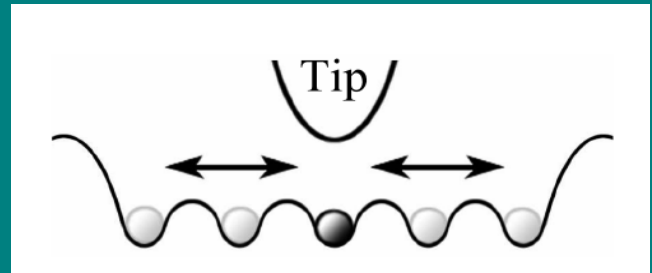
Phys. Rev. Lett. **94**, 036103(2005), Kedong Wang, Chun Zhang, M. M. T. Loy, Xudong Xiao



Typical STM image of (a) Au, (b) Ag, and (c) Cu on Si(111)-7×7 at room temperature, the triangle patterns in each faulted half unit cell are caused by single metallic atoms. (d) the structure of (c) *in situ* cooling down to 77 K, with the triangle patterns becoming single bright spots.



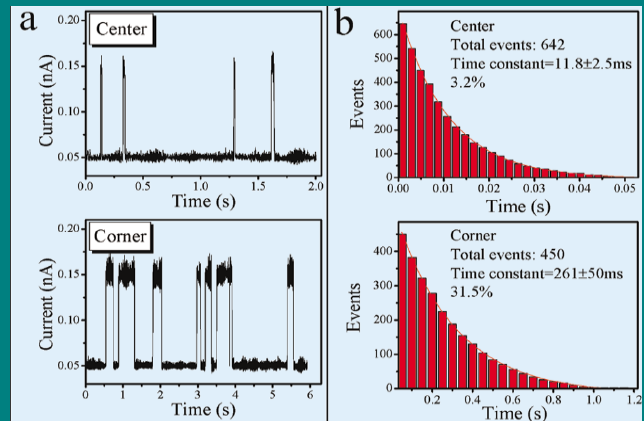
Arrhenius plot of the hopping rate,  $\Gamma$ , for the Cu atom from 200 to 320 K.



A Sketch of operational principle for diffusive hopping measurement using a stationary STM tip.

$$P(t) = \exp(-\Gamma t)$$

$$\Gamma = \Gamma_0 \exp(-E_a / k_B T)$$



(a) Time-dependent tunneling spectra taken above a center and a corner Si-adatom site. A high current level represents a Cu atom moving to cause the respective sites to be brighter. (b) the bar distribution of the events with their resident time longer than the given time in the horizontal axis. The solids lines are exponential fits. The example was taken at 280 K with bias of -0.5V.

The newly developed time-dependent tunneling spectroscopy for surface diffusion study has a dynamic range for hopping rate from 1-10<sup>4</sup> Hz, ~3 orders of magnitude faster than those accessible by the exiting methods based on STM. As demonstrated for single Cu atoms diffusing in FHU of Si(111)-7×7, this method is site-specific in addition to the fast speed. It can also measure the residence time at given sites which allows deduction of the relative adsorption energy.