Scientific recognition for Dr. Ali Sadeghi

A paper by Dr. Ali Sadeghi with his collaborations entitled: “Electron Transmission through Coordinating Atoms Embedded in Metal-Organic Nanoporous Networks” has been accepted for publication in the Physical Review Letters (IF=9.227). The School of Nano Science congratulates this achievement to Dr. Sadeghi, our resident researcher, and his colleagues.

Description:

Two-dimensional electron gas (2DEG), a Fermi gas spatially confined within an ultrathin layer, offers several fundamental physics and interesting applications of condensed matter in reduced dimensions. Quantum Hall effect, e.g., was first observed in a 2DEG created at the metal-oxide-semiconductor interface while 2DEG can also be realized in strictly 2D materials such as graphene or on the surface of materials such as liquid helium, topological insulators, etc. A very special representation of 2DEG is the electronic surface states on the (111) surfaces of noble metals where the free-like electrons can be confined also laterally by designing atomic scatterers on the metal surface. Among the earliest and most notable demonstrations of this model is the so-called "quantum corral" introduced by Grommie et al. in 1993: The surface electrons on the (111) surface of copper were trapped by a circle made by 48 iron atoms arranged on the copper surface by means of an STM sharp tip. In their recent study, Ali Sadegh, a resident researcher of the School of Nano Science, and his collaborators addressed the 2DEG trapped within a periodic array of quantum corrals created by the self-assembly of TPyB molecules on the copper surface. Through an experimental-theoretical-computational combination study, they discovered that transmission channels are unlatched between the corrals if single Cu atoms are embedded into the organic molecule network. By means of STM and angle-resolved photoemission spectroscopy, almost unperturbed free-electron-like states stemming from the rather weak electron confinement were observed. The landscape of the potential barriers developed by the organic network into the 2DEG determined by ab-initio calculations suggests that the molecules are the dominant scattering entities while the coordination metal atoms act as leaky channels rather than scatterers. Only if the coordinating Cu adatoms are located at the suggested strategic positions of the network they spoil the confining. These metal atom transmission conduits facilitate and enhance the coupling among quantum dots, which are prone to be exploited to engineer the electronic structure of 2DEG.

I. Piquero-Zulaica, A. Sadeghi, M. Kherelden, M. Hua, J. Liu, G. Kuang, L. Yan, J. E. Ortega, Z. M. Abd El-Fattah, B. Azizi, N. Lin and J. Lobo-Checa, “Electron Transmission through Coordinating Atoms Embedded in Metal-Organic Nanoporous Networks”, Physical Review Letters, doi: 10.1103/PhysRevLett.123.266805