Atomic-scale control of molecular contacts

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The transport of charge through a conducting material depends on the intrinsic ability of the material to conduct current and on the charge injection efficiency at the contacts between the conductor and the electrodes. Exploring the single molecule limit in experiments requires control of the junction geometry. Scanning tunneling microscopy (STM) provides here a way to probe this parameter with atomic scale precision.

Using STM we will see that the current passing through a single molecule can be probed while changing, one by one, the number of atoms in the electrode that are in contact with a single molecule [1]. We show quantitatively that the contact geometry has a strong influence on the conductance. For C_{60}, this revealed a crossover from a regime in which the conductance is limited by charge injection at the contact to a regime in which the conductance is limited by scattering at the molecule. Thus, the concept of ”good” and “bad” contacts, commonly used in macro-and mesoscopic physics, can also be applied at the molecular scale. In a second step, the transport properties of small chains made of two C_{60} trapped between the tip and the surface of a STM will be presented [2]. Here the orientation and electronic states of both molecules was characterized before connecting them with atomic-scale precision. The experimental results are complemented by first-principles transport calculations which give access to the distance-dependent nature of the inter-molecular electron transport and predict the evolution of the transport properties with molecular chain length. Finally, the properties of photons that are emitted at junctions bridged by a single metallic atoms [3,4] and the perspectives that it opens for molecular contacts will be evocated.

References

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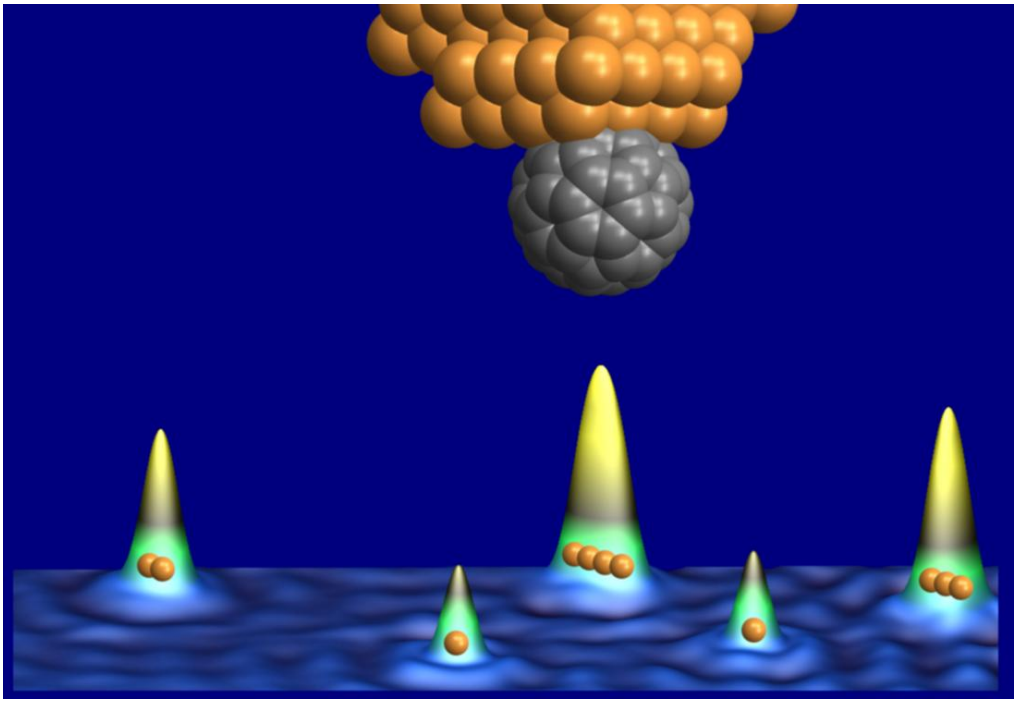

Figure: Graphical representation of a scanning tunnelling microscope tip with a C_{60} molecule fixed to its apex, above a copper sample with five atomic scale electrodes engineered atom per atom.