Sulfur-based large honeycomb nanoporous network studied by STM/STS

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Two-dimensional nanoporous architectures have recently attracted interest due to their unique et tunable electronic properties. Such a network can be obtained from sulfur interaction with a (111) surface of Cu (1). At low coverages and at low temperatures (<140 K), a large honeycomb lattice with a periodicity of 1.67 nm was observed. Although this phase was reported long ago, some mechanisms remain unexplained. For example, the factors favorizing the formation and stabilization of an open network over a more compact crystallographic arrangement are unknown. In addition, the electronic properties have yet to be characterized, the structure has to be determined unambiguously (2,3) and the reason for the condensation of the phase at low temperatures has to be explained. To explore those questions, we studied the atomic structure (Figure a) and the electronic properties of the S/Cu(111) system by means of low temperature scanning tunneling microscopy and spectroscopy (STM/STS) (Figure b,c). The porous network was grown by deposition of elemental sulfur on a clean Cu(111) surface under UHV and cooled down at 77K. We have characterized the local electronic properties both on the network and inside the pores. In particular, we show the emergence of an unoccupied electronic state at around +0.7 eV that also fills the open pores. Interestingly, conductance maps show strong *apparent* orbital confinement in pores as also recently observed in nanoporous graphene (4). We discuss the possibility for octasulfur S_8 molecular rings to be the building blocks of the open structure and how it could explain the large periodicity and the low-temperature condensation.

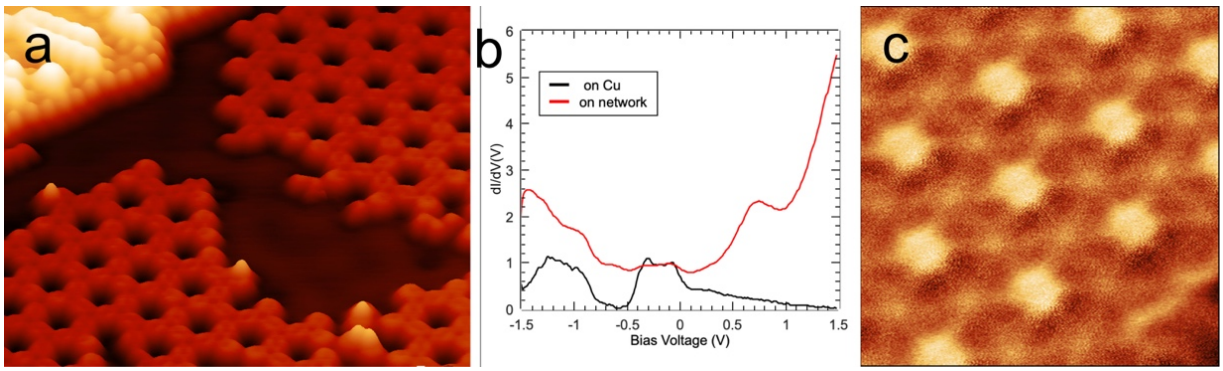


Figure: a) 3D rendering of an STM image of the S/Cu(111) large honeycomb lattice, b) STS recorded on the bare Cu surface next to the nanoporous network and on the network, c) STS conductance map recorded at 0.6V. Size: 5 nm x 5 nm.

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