

ELECTRONIC CONFINEMENT AND BAND FORMATION ORIGINATING FROM A SUPRAMOLECULAR POROUS NETWORK

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The properties of crystalline solids can to a large extent be derived from the scale and dimensionality of periodic arrays of coupled quantum systems like atoms and molecules. Periodic quantum confinement in two dimensions has been elusive on surfaces mainly because of the challenge to produce regular nanopatterned structures capable of trapping electronic states.

We report on the practical implementation of *periodic* zero-dimensional confinement by demonstrating that the two dimensional free electron gas of the Cu(111) surface state can be trapped within the pores of an organic nanoporous network [1]. Thus, these pores can be regarded as a regular array of quantum dots, as observed in Fig 1 a) and b).

Moreover, the periodic influence which the molecular network imposes on the confined electronic states originates new electronic subbands, as shown in Fig. 1 c).. The shallow dispersive character of the lowest subband is indicative of electronic coupling between neighbouring pore states [2]

A consequence of our work is the perspective to engineer these artificially created electronic structures by modification of the dimensions of the molecular network periodicities together with the appropriate choice of the substrate. This will allow the fabrication of related systems with different band structures resulting in '2D electronic metamaterials' in analogy to the well-established optical metamaterials [3, 4].

References:

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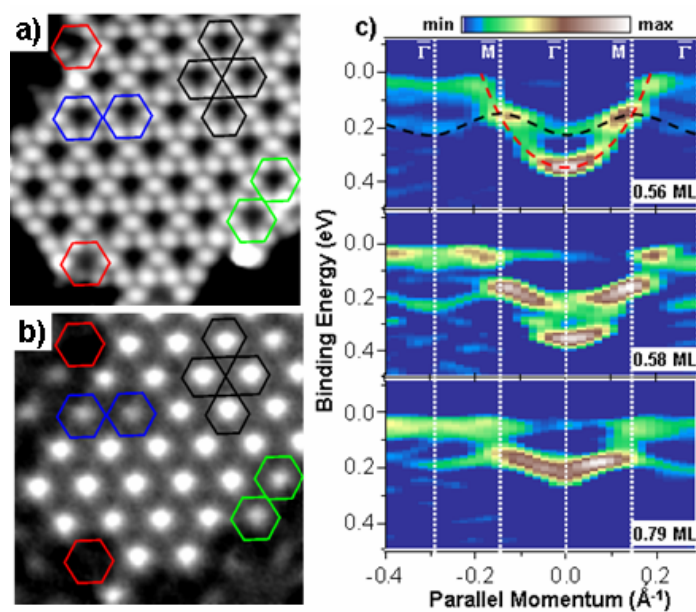


Figure 1 Study of the electronic confinement of the surface state within a porous molecular network.

(a) STM image of the porous network ($13.6 \times 13.6 \text{ nm}^2$, -0.20 V , 70 pA) and (b) simultaneously recorded dI/dV map (LockIn: $V_{\text{rms}} = 8 \text{ mV}$, $f = 513 \text{ Hz}$).

(c) Band dispersion resulting from the periodic influence of the porous network on the surface state studied with ARPES at different molecular coverages. The color scale represents the 2nd derivative of the photoemission intensity