

## Giant regular arrays via adsorbed organic molecules: Experimental “parallel computing”?

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Experiments using scanning tunneling spectroscopy (STM) have revealed the formation of self-organized giant honeycomb networks on metal crystal surfaces. Perhaps the most noteworthy example is anthraquinone (AQ, C<sub>14</sub>H<sub>8</sub>O<sub>2</sub>) on the close-packed face of copper, for which the hexagonal pores of the network contain 186 exposed Cu atoms. While the formation of the chains and vertices the comprise the network can be readily accounted for in terms of hydrogen bonding between adjacent AQ molecules, the explanation of the largest characteristic spacing is more subtle and elusive, involving the metallic surface states of the substrate face. Our initial interpretation was based on their Friedel oscillations, i.e. on the oscillatory interactions depending on the ratio of the separation of AQ molecules and the Fermi wavelength of the surface states that produce the quantum corrals seen with STM. However, the existence of a similar structure for pentacenequinone on this surface—for which the pore area is the same but the separation of chains larger—invites the novel explanation that each pore accommodates the surface-state electrons into what amounts to two-dimensional closed-shell, noble-gas-like atoms in the second row of a “periodic” table of 2D “atoms.” (Networks of much smaller pores on Cu(111) have been observed for other organics, e.g. dehydro-DPDI.)

The honeycomb network offers many tantalizing applications. As progressively greater numbers of CO molecules are adsorbed within a pore, they take on different conformations. There are preferred adsorption sites linked to standing electron waves in the pore, which can affect how adsorbates meet and react. Remarkably, the COs also diffuse faster. Near saturation a domain wall is forced into existence because of the different boundary conditions at adjacent walls of the hex pore. In the confined geometry, equilibrium constants and reaction rates change considerably. Because the pores are identical, one can simultaneously observe the evolution of many equivalent adsorbates systems, much as one does in simulations involving parallel computing.

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### Biography:

Ted Einstein has been on the physics faculty at University of Maryland, College Park, since 1975, focusing on theoretical problems related to experiments in their world-renowned surface physics group. He served in various capacities on the Executive Board of the MRSEC (1996-2013) at UMD. He is a Fellow of APS and AVS, and was a Humboldt Foundation Distinguished Senior U.S. Scientist Awardee. He has been on the organizing committees of many local and international conferences and held visiting positions at NIST and in Sweden, Germany, France, and Italy. In APS he was Div. Materials Physics he was APS Councillor and (2 terms) Secretary/Treasurer. In AVS he was on the Executive Committee of the Div. of Surface Science twice. He also served as a part-time Program Director at NSF and an expert consultant in a patent case. Since 1996 he has been Chair of the Physical Sciences Program at UMD.