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Electron confinement and long-range interactions in 1-D atom chains[1]

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In nanostructures, when electrons are confined to reduced dimensions, the geometry of the confinement leads to the formation of quantized electronic states. In turn, these quantized states determine the energetic stability of a particular geometry. For systems that are self assembled, where thermodynamics and the cohesive energy can play a key role in the formation process, this interplay between the geometry of the confinement and the electronic states leads to the formation of nanostructures with "magical sizes." Gold deposited on Si(553) leads to self-assembly of 1-D atomic chains, which are broken into finite segments by defects. Scanning tunneling spectroscopy measurements of the differential conductance along the chains revealed quantized states in isolated segments with differentiated states forming over the end atoms. These "end states" are the zero-dimensional analogs of the two-dimensional states that occur at a crystal surface[1]. Scanning tunneling microscopy was used to investigate the distribution of chain lengths and the correlation between defects separating the chains. The length distribution is not that for random defects, but exhibits oscillations that indicate changes in the cohesive energy as a function of chain length. We observe two separate components of the interaction and suggest a possible interpretation in terms of the electronic scattering vectors at the Fermi surface. The correlation function shows long-range correlations that extend beyond nearest-neighbor defects, indicating coupling between chains[2].

1. J. N. Crain and D. T. Pierce, Science **307**, 703 (2005).

2. J. N. Crain, M. D. Stiles, J. A. Stroscio, and D. T. Pierce, Phys. Rev. Lett. **96**, 156801 (2006).

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