Reduced Metallic Properties of Ligand-Stabilized Small Metal Clusters

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Low-temperature ultrahigh-vacuum scanning tunneling microscopy was employed to analyze the electronic behavior of Au$_{55}$ clusters stabilized by $[\text{P(C}_6\text{H}_3)_3]_{12}\text{Cl}_6$ ligands. At 7 K, the actual arrangement of the C$_6$H$_5$ rings of the ligand molecules could be imaged. Spectroscopic data reveal discrete energy levels with an average spacing of 170 meV that can be attributed to the Au$_{55}$ core. Additionally, characteristic charge-quantization phenomena were observed. Energy and charge quantization both support the view that the clusters consist of a metallic core extending slightly beyond the first close-packed shell of Au atoms.