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Probing the Unique Size-Dependent Electronic and Structural Properties of Nanoclusters

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Materials in the nanometer size scale exhibit properties different from their bulk counterparts and these properties depend on particle size and shape. This forms the basis for nanoscience and nanotechnology. In our laboratory, we use the bottom-up approach to probe the unique electronic and structural properties of atomic clusters as a function of size from a few to few tens of atoms. Atomic clusters are produced using a laser vaporization cluster source and are studied by photoelectron spectroscopy in combination with quantum calculations. In this talk, I will focus on our recent studies on small boron and gold clusters. One of the most interesting features of elemental boron and many bimetallic boron compounds is the occurrence of highly symmetric icosahedral clusters. I will present experimental and theoretical evidence that small boron clusters in fact prefer planar structures [1-3], completely different from bulk boron. We also found that these planar boron clusters exhibit properties of aromaticity, i.e., electron delocaliztion similar to common aromatic organic molecules. Gold is very different from boron. But small negatively charged gold clusters have also been shown to assume planar structures up to 12 atoms. I will discuss joint photoelectron spectroscopic and theoretical efforts to confirm the planarity of small gold cluster [4]. The discovery of a unique 20 atom tetrahedral gold cluster [5] will be presented, and its novel properties and potentials for catalytic applications will be discussed. Recent effort to synthesize the tetrahedral Au_{20} cluster in solution will also be reported [6].

References

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