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Characterization of Hybrid Electronic Materials for Molecular Based Device Electronics

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Nanoscale device development, as an exercise in electronic materials fabrication, comes down to essentially one of two approaches—"top-down" or "bottom-up." In the former, the drive is to retain the macroscopic properties of the materials involved while shrinking toward ever diminishing device geometries. The latter approach attempts to control individual molecules and/or quantum-level structures, during the course of fabrication, in order to ultimately realize device functionality. This bottom-up design and control of molecular assemblies has united device engineers and scientists in testing new combinations of materials, both organic and inorganic. As a result, an entirely new class of nanoscale electronic structures and devices has emerged to create the field of hybrid electronic materials or HEMs[1]. HEMs have shown promise as the basis for exciting device applications ranging from quantum computing to unique drug delivery methods. Although theoretical proposals of unimolecular transport began as early as the 1970s, it has been within the last decade in particular that research has yielded significant results in terms of nanoscale electronic applications for HEMs[2]. However, many unresolved fundamental issues of electronic materials remain in this field. It is for this reason that in this talk, I will discuss a selection of HEM components (e.g.- self-assembled monolayers of n-alkanethiols, porphyrin molecules), their characterization, and their propensity for future nanoelectronic device development. 1. James R. Heath and Mark A. Ratner, Physics Today, May 2003; 43-49. 2. Mark A. Reed and Takhee Lee (Eds.), "Molecular Nanoelectronics," American Scientific Publishers, Stevenson Ranch, CA, 2003.