Cooperative Function in Atomically Precise Nanoscale Assemblies

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We use molecular design, tailored syntheses, intermolecular interactions, and selective chemistry to direct molecules into desired positions to create nanostructures, to connect functional molecules to the outside world, and to serve as test structures for measuring single or bundled molecules [1-3]. Interactions within and between molecules can be designed, directed, measured, understood, and exploited at unprecedented scales. Such interactions can be used to form precise molecular assemblies, nanostructures, and patterns, and to control and to stabilize function. We selectively test hypothesized mechanisms by varying molecular design, chemical environment, and measurement conditions to enable or to disable function and control using predictive and testable means. Critical to understanding these variations has been developing the means to make tens to hundreds of thousands of independent single-molecule measurements in order to develop sufficiently significant statistical distributions, while retaining the heterogeneity inherent in the measurements. We measure the electronic coupling of the molecules and substrates by measuring the polarizabilities of the connected functional molecules [4]. The next step in such devices is to learn to assemble and to operate molecules together, both cooperatively and hierarchically, in analogy to biological muscles [5]. We discuss our initial efforts in this area, in which we find both interferences and cooperativity [3].

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