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Molecularly Templated Nanofabrication for Nanoelectronic Circuits

Integrated circuits have achieved increased speed and computing power through the reduction of feature sizes and the corresponding increase in component density. While optimization and evolution of existing technologies can yield improvements in the short term, the exploration of revolutionary methods, which have the potential to achieve significant gains in miniaturization, is becoming an increasingly attractive pursuit. An intriguing transformative alternative to conventional techniques is to use individual molecules as templates for the directed self assembly of nanometer-scale structures.

This talk describes the efforts of an interdisciplinary research group at Brigham Young University, ASCENT (ASsembled nanoCircuit Elements by Nucleic acid Templating), to develop DNA-templated nanocircuits. Efforts are focused on the development and refinement of four key technologies: (1) solution-phase molecular circuit assembly, (2) high-resolution chemical surface patterning, (3) high-resolution metallization of molecular templates, and (4) chemically directed assembly and integration of molecular circuits on surfaces. Complex circuit templates can be achieved through the use of folded DNA "origami," which has been shown to be a robust and simple method for designing patterned shapes (P.W.K. Rothemund, *Nature* **440**, 297, 2006). We recently enhanced DNA origami by devising an approach for the formation of DNA origami having different sequences and scaffold strand lengths through PCR amplification, and constructing asymmetric square junctions in branched origami designs that have largely open space with thin (~10 nm) connecting features. These characteristics are ideal for use in nanoelectronic circuits. Metallization of origami by two different electroless plating procedures has been demonstrated. The interaction of the plating processes with DNA origami has also been characterized and optimized to produce the desired metallic structures. Several different methods for chemical patterning of surfaces have been explored and developed. These methods will be useful for the placement of circuit templates and for local circuit wiring. We are also developing methods for massively parallel placement of active nanotube circuit elements across metallic gaps. Together, these results represent an important step forward toward the realization of nanoelectronic circuits formed via self-assembled molecular templates.

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