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Overview of New Structures for DNA-Based Nanofabrication and Computation

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This presentation provides an overview of recent experimental progress by the Duke DNA NanoTech Group in our efforts to create novel DNA nanostructures for computational self-assemblies as well as for fabrication of functional nano-patterned materials. We have prototyped a DNA tile type known as the 4x4 (a cross-like structure composed of four four-arm junctions) upon which we have deposited metal to form highly conductive nanowires and also are adapting multi-tile 4x4 sets for a variety of computational applications. We have recently described a DNA barcode lattice composed of DX tiles assembled on a long scaffold strand; the system propagates 1-dimensional (1D) information encoded on the scaffold strand into a specific and reprogrammable barcode pattern which is visible in 2D by atomic force microscopy. We have succeeded in demonstrating the first highly parallel computation via DNA tile self-assembly by using a single-layer superstructure made of DX tiles which computes the entire lookup table of pairwise XOR calculations up to a modest size input string length. We have prototyped a 2-state DNA lattice assembly containing actuator components and demonstrated its ability to be controllably switched between the two states. We are currently working on a molecular robotics experiment aimed at demonstrating unidirectional motion of a small DNA fragment along a track constructed of DNA. We have demonstrated a diverse set of novel structures and applications which extend the inherent information carrying capacity of DNA in a variety of novel directions.

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