DNA-origami mediated self-assembly of nanoelectronic circuits

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Driven by Moore’s Law, performance and density of integrated circuits have dramatically increased over the past fifty years. But conventional top-down lithography fabrication methods are losing their appeal due to rising costs, high energy consumption, as well as physical and technical limitations. Alternatives need to be developed, to overcome a cost explosion and to set a new standard for today’s smart technology world. One promising way is the introduction of bottom-up techniques for the fabrication of nanoelectronic circuits. In particular, smart building blocks can be self-assembled by the means of DNA-Nanotechnology. A common strategy is DNA origami that serves as a molecularly defined “breadboard”, to organize various nanomaterials into hybrid systems.1 Having a self-assembled, programmable framework allows for the development of nanomaterial constructions with control over dimensions, stoichiometry, orientation, shape and composition. Based on the idea of using DNA-origami molds for the seeded growth of Gold nanoparticles (Au NPs)2 our work introduces the self-assembly of semiconducting nanomaterials, e.g. Cadmiumsulfide nanorods (CdS NRs) with 40 nm length and 4 nm thickness (see Figure 1). We also show the possibility to assemble two different materials, namely CdS NRs and Au NPs into one DNA-origami mold structure by the means of different oligonucleotide sequences. In addition, we demonstrate the subsequent assembly of our smart building blocks for the build-up of more complex systems, followed by a seeded-growth procedure that allows for electrical contacting using electron beam lithography. We think that our strategy provides an elegant way towards the development of unprecedented nanoelectronic structures.

Figure 1. TEM images of self-assembled smart building blocks, containing CdS NRs attached into DNA-origami molds.

References


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