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DESIGN, ASSEMBLING AND MANIPULATION OF ELECTRIC NANOMOTORS WITH ULTRAHIGH PERFORMANCES

— FOR BIOCHEMICAL DELIVERY, TUNABLE RELEASE, REMOVAL, AND MICROFLUIDIC MANIPULATION

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Abstract

The successful development of nanoscale machinery, which can operate with high controllability, precision, long lifetime, and tunable driving powers, are pivotal for the realization of future intelligent nanorobots, nanofactories, and advanced biomedical devices. However, the development of nanomachines remains one of the most challenging research areas, largely due to the difficulties in fabrication of devices with complex components and actuation with desired efficiency, precision, lifetime, and environmental friendliness. In this talk, I will discuss our recent breakthrough in innovative design, assembling and actuation of a new type of miniaturized rotary motors made from nanoscale building blocks, including nanowires and nanodisks. Arrays of nanomotors can be efficiently assembled and rotated with controlled angle, chirality and speed to 18,000 rpm, the same level of that of jet engine. The nanomotors have all dimensions less than 1 μm and are one of the smallest rotary nanoelectromechanical system (NEMS) devices. They can operate for 80 hours over 1.1 million cycles, the longest device lifetime that have been reported. By exploiting nanoscale magnetic interactions, nanoscale step-motors that can rotate to arbitrary angle positions are developed. By leveraging the distinct interactions between electric fields and materials, reconfigurable micromachine arrays have been achieved. The micromotors are assembled at designated locations in microfluidic channels for pumping and mixing. The nanomotors are further equipped with sensing capabilities into motorized nanosensors, which can actively tune biochemical release, substantially enhance the efficiency of DNA removal, and monitor the processes in real time. These works bring the promises of micro/nanomachines closer to reality for practical applications.