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Ultra-durable rotary nano-motors assembled from nano-entities by electric fields

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Recently, we reported an innovative type of nano-motors consisting of nano-wires as rotors and patterned Au/Ni/Cr nano-disks as bearings. The dimensions of nano-motors were less than 1 μm, and could continuously rotate for 15 hours over 240,000 cycles. To understand the limitation of their lifetime, we systematically investigated the rotation dynamics by analytical modeling and determined the time-dependent torques and forces involved in the rotation. From the forces and torques, the extent of wear of nano-motors was successfully derived, which well agreed with the experimental characterizations. The results also proved that frictional force linearly increases with the loading in such rotary nano-devices operating in suspension, consistent with the prediction of the non-adhesive multi-asperity friction theory. With these understandings, we enhanced the design of nano-motors and achieved an operation lifetime of 80 hours and over 1.1 million total rotation cycles. This research, shining new light on the frictional mechanism of recently reported nano-wire nano-motor with demonstration of the most durable rotary nano-mechanical devices of similar dimensions to the best of our knowledge, could be inspiring for innovative design of future nano-mechanical devices with ultra-long lifetime for practical applications.

Biography

Jianhe Guo is a PhD student in the Materials Science and Engineering Program at The University of Texas at Austin (UT Austin). He received his Bachelor's degree in Materials Chemistry from The University of Science and Technology of China (USTC) in 2012. He has been nominated for the 2015 HHMI International Student Research Fellowship, received 2014 Harris L. Marcus Graduate Fellowship in Materials Science & Engineering and 2014 Graduate Student Professional Development Award by UT Austin. He is working as a Research Assistant in Prof. Donglei (Emma) Fan's Group and he focuses his research on innovative design, manufacturing and applications of micro/nano-electromechanical (MEMS/NEMS) devices such as nano-motors and also synthesis and applications of novel carbon materials including graphene and graphite foam.

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