Mechanical metamaterials based on ion track technology

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Ion track-technology has been widely considered as a unique method for the fabrication of novel nanostructures. Mechanical metamaterials refer to a class of composite materials with artificially designed architectures and exhibit extraordinary mechanical properties that traditional materials do not have. Among them, energy absorption mechanical metamaterials can absorb mechanical energy more efficiently, which requires the material itself to have both high strength and high strain capacity. But in general, there is a trade-off between strength and strain capacity and these two are hardly obtained simultaneously.

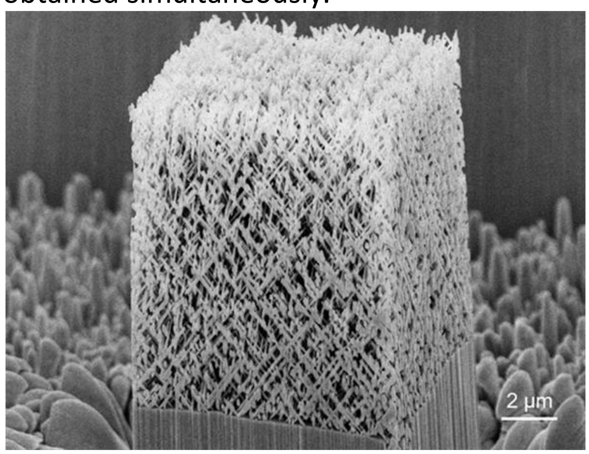

Figure 1. Quasi-BCC mechanical metamaterials fabricated by ion track technology

In this presentation, we will report a new type of nanobeam lattice which is in quasi-body-centered cubic (quasi-BCC) architecture [1]. Such nanolattices with beam diameters as thin as 34 nm were successfully fabricated by ion track technology, using gold and copper as model materials. The mechanical tests show that, even at a relative density lower than 0.5, the compressive yield strengths of the gold and copper quasi-BCC nanobeam lattices exceed their bulk counterparts. Surprisingly, their energy absorption capacities surpass all previously reported micro/nano-lattices. Based on theoretical analysis and simulations, we disclose that such extraordinary properties are ascribed to the synergy of size effect, geometrical architecture, and intrinsic properties of gold and copper. We then used such metamaterials as the anode of lithium-ion batteries. Benefitting from excellent mechanical robustness, high porosity, and low tortuosity of pores, the nanobeam lattice serves well as the "host" of lithium metal anode and the cycle life of anode is therefore significantly improved [2].

Our work may provide a new idea for extending ion track technology to emerging multidisciplinary fields of interest.

Reference:

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