ADDITIVE MICROMANUFACTURING AND DYNAMIC CHARACTERIZATION OF COPPER MICROLATTICES

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Microfabrication technologies are vital for the manufacturing of computer chips, electronic devices and microelectromechanical systems (MEMS). The most common methodology for microfabrication is using ultraviolet (UV) based expose-and-etch based lithographic methods. This method, though ubiquitous in several industrial applications, is only suited for fabricating 2.5D architectures and true 3D architectures such as springs, helices or lattices cannot be obtained. In this presentation, I will introduce a recent additive micromanufacturing method that is based on localized electrodeposition of microscale metal droplets. [1] This technique enables the fabrication of full metal complex 3D microarchitectures such as dog-bone shaped micropillars, microsprings and microlattices. A case study of copper microlattices with honeycomb and octet designs will be presented. The structural characterization of the printed microlattices was achieved via focused ion beam based slice, view and reconstruct methodology and showed that the lattices have been fabricated without noticeable porosity in the struts and nodes. The microstructural characterization of the as-built microlattices was carried out using a combination of electron backscatter diffraction (EBSD), transmission kikuchi diffraction (TKD) and transmission electron microscopy (TEM) analyses. These analyses showed that the copper microlattices are ultrafine grained with an average diameter of ~160nm with a significant number of growth twins. Subsequently, using a piezo-based *in situ* micromechanical testing setup [2], the mechanical properties of the copper microlattices were identified as a function of strain rate from 0.001/s to 100/s. A high strain rate sensitivity was identified from the stress-strain signatures of the compressed microlattices. The rate-dependent microstructural evolution of the microlattices was again identified using a combination of EBSD, TKD, TEM, and TEM based orientation image mapping (TEM-OIM). Furthermore, using the model developed from the slice and view reconstruction of the microlattices, a finite element simulation was conducted to understand the structural evolution of the microlattices under high strain rates and the effect of strut-node connectivity on the mechanical properties.

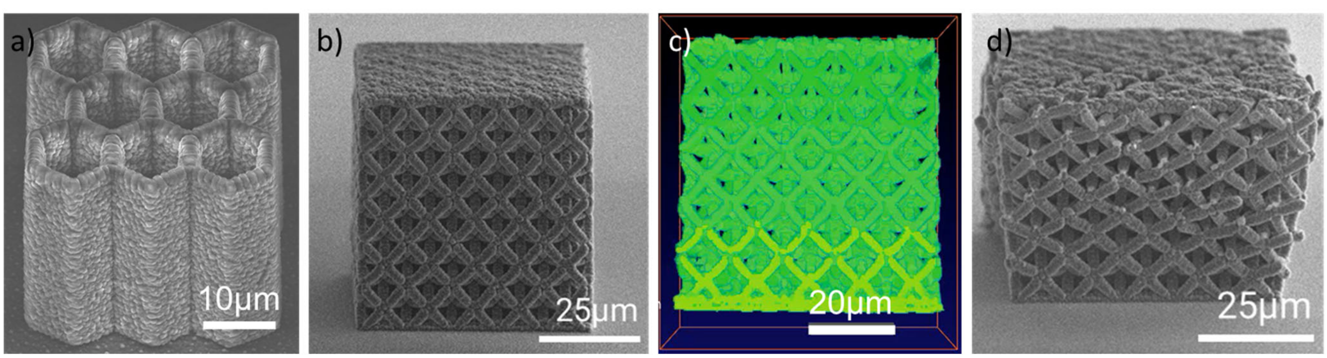

Figure 1: a) Copper honeycomb lattice. Copper octet lattice b) in the undeformed state, c) 3D reconstructed using FIB based slice and view and d) after deformation.

References

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