Accessing the Internal Morphology of Nano-Granular FEBID Materials in 3D Space by Electron Tomography

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Introduction

Focused electron beam induced deposition (FEBID) is an additive, direct-write fabrication technique that enables controlled material deposition of nanoscale structures. Typically, organometallic precursors are used, e.g. MeCpPtMe₃, resulting in nanogranular materials composed of metallic nanograins (e.g. Pt) spatially embedded in carbonaceous matrix [1]. The distances between individual grains, as well as the chemistry of the carbon matrix significantly influence electrical [2] and mechanical [3] properties, which form the basis for potential applications of FEBID structures, such as gas sensing via nanoscale resonators. To find the connection between morphology, chemistry and materials’ properties, scanning transmission electron microscopy (STEM) tomography is used for the characterization of an AD (as deposited) and EBC (electron beam cured) FEBID nanostructure.

Experiment

Sample Preparation ➔ Electron Tomography ➔ Reconstruction ➔ Segmentation ➔ Measurements

Applications & Results

Variable grain-to-grain distances modulate the macroscopic, electric current as basis for sensing applications. This is used in different concepts as shown below.

Applications

Chemical Sensing: Modulation of Dielectric Matrix Properties [2]
Resonant High-resolution Sensing: Surface Adsorption Changes, Resonance Frequency & Stress-Strain Modulation Enables External Readout [3]

Results

Aligned and reconstructed samples: a)AD b)EBC (Visualization: Avizo)

Conclusion

We compared the morphology of an AD and EBC FEBID nanostructure. The cured sample has bigger and less spherical grains and greater distances between the grains in comparison to the AD sample. The grain growth is caused by the fact that they are merging during the curing step, resulting in long grain paths through the deposit, influencing the electrical conductivity. Our work will help in understanding the processes involved in deposition and post-processing of FEBID deposits.

References


Contact

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Acknowledgement

Grainsize (1)
Sphericity (2)
Grain Distances (3)