P37: Functional Imprinting: Local Modification of Beam Induced Deposits

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Additive manufacturing of nanoscale structures on almost any substrate type and surface morphology is one of the major unique selling points of Focused Electron/Ion Beam Induced Deposition (FEBID/FIBID). Beyond the direct-write of bulky, planar and simple pillars geometries, the controlled fabrication of even complex 3D nano-architectures have revolutionized this type of nanofabrication [1] due to the current singular status concerning design complexity, predictability / reliability, feature sizes, and functional variability [2]. The latter, however, is often challenging due to incomplete precursor dissociation with notoriously high carbon contents, which reduce or even entirely mask the intended functionalities right after initial fabrication. To improve the material quality and / or tune them precisely according to application requirements, post-processing steps, such as thermal treatments, exposure to gases and/or irradiation with photons/electrons/ions are extremely useful. While typically applied to the whole FEBID object in the past, we here go the next rational step and introduce a selected area modification, denoted as functional imprinting. That way, functional regions with varying designs can be integrated in the surrounding, pristine material, which serves as scaffold with different properties for different purposes.

In this contribution, we discuss two post-processing approaches, that both use a focused electron beam for variable shape imprinting. The first concept is called electron beam curing (EBC), where deposits are exposed to an electron beam under vacuum conditions. Here, the possibilities range from statistical grain growth for electric conductivity tuning [3] over modification of the carbonaceous matrix with mechanical implications [4] towards asymmetric stress-strain for the controlled bending of 3D objects beyond conventional fabrication possibilities [5]. For the second approach, electron exposure in low-pressure, room temperature water vapor is used to remove residual carbon from original deposits [6]. Here, we evaluate this approach by the local material transfer from pristine AuCX composition into pure gold and explore design possibilities, intrinsic limitations and functional properties of transformed areas. By that, we lay the foundation for advanced local material tuning of FEBID / FIBID materials, which might open up new application possibilities down to the nanoscale.

References

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