

Predicting high-aspect-ratio FEBID deposit shapes by incorporating evolving geometry into continuum models

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Continuum models provide a well-established framework for describing focused electron beam induced deposition (FEBID).[1] By accounting for electron-induced precursor dissociation together with adsorption, desorption and surface diffusion, they can predict deposition rates and the lateral profiles of planar or low-aspect-ratio deposits under different growth regimes.[2] However, their application to high-aspect-ratio structures is more challenging because the surface on which deposition occurs evolves continuously during growth. The changing orientation and contour of this surface influence the local growth direction and, consequently, the final three-dimensional shape. Conventional planar-surface descriptions therefore cannot directly predict features such as the sidewalls and apex of FEBID-grown pillars and nanowires.

Here, we extend the continuum model by explicitly incorporating the evolving geometry of the deposit. Using a steady-state ansatz applicable after sufficiently long growth times and sufficiently far from the substrate, we derive the stationary contour of high-aspect-ratio spot deposits and predict their sidewall and apex geometry. The model thereby connects the underlying FEBID kinetics to the final three-dimensional deposit shape.

Predictive access to the contour matters if, for example, one intends to understand the state of a magnetic FEBID tip. Micromagnetic simulations of the remanent state of a FEBID pillar currently take its shape from post-growth tomography, which could be omitted by the employment of the presented model.[3] Furthermore, the use could extend to quantitative Magnetic Force Microscopy (qMFM) where the full magnetic stray field of a given sample can be reconstructed, provided the geometry and magnetic state of the magnetic tip are known.[4] Using FEBID tips would provide both high-quality tips with low apex diameters as well as full knowledge of its geometry. [5]

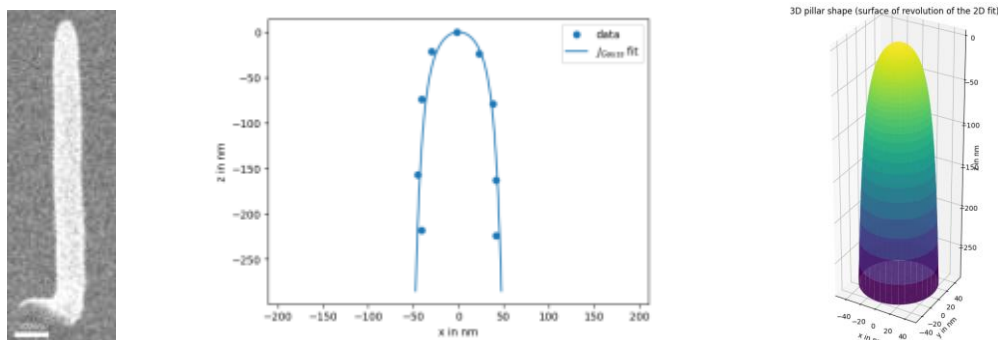


Figure 1. (left) FEBID pillar grown with MeCpPtMe3 precursor, fit provided by the model (middle) and extrapolation into 3D by rotation (right).

References

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