Reconstruction of a focused e-beam profile in amorphous carbon using diffusion of n-alcane molecules along carbon nanopillar sidewalls

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Electron beam induced deposition (EBID) is a versatile technique used to fabricate nanometer structures on solid substrates [1]. Carbon dots and pillars can be grown on various substrates in a scanning electron microscope in the presence of residual hydrocarbons.
To date, mapping of e-beam intensity in a target is performed mostly by simulation. Here we propose an alternative approach in which the layer of adsorbed hydrocarbon molecules diffusing along the pillar serves as a medium sensitive to the spatial distribution of fast electrons penetrating the target.
Solution of the mass transport equation in cylindrical coordinates *r, z* relates the molecule concentration *C* with the current density *j* and the diffusion coefficient *D*. On a conical tip Cj = const, while *C* is proportional to r^2. The cone angle grows with the beam current *I*. Increasing *I* by steps produces a series of *j versus (r,z)* plots at various scattering angles.
The typical pillar shapes are compared with calculated equi intensity contours in Fig1.
Measurements of the pillar growth rate give insight into dynamics of molecular motion and pinning. We have estimated $D \sim 10^{-8}$ cm^2/s at $T \approx 300K$ and consider decane as the most probable species responsible for material delivery to the growing tip. We suppose that the surface roughness rather than the atomic arrangement is a crucial factor determining mobility of long C-H chains.

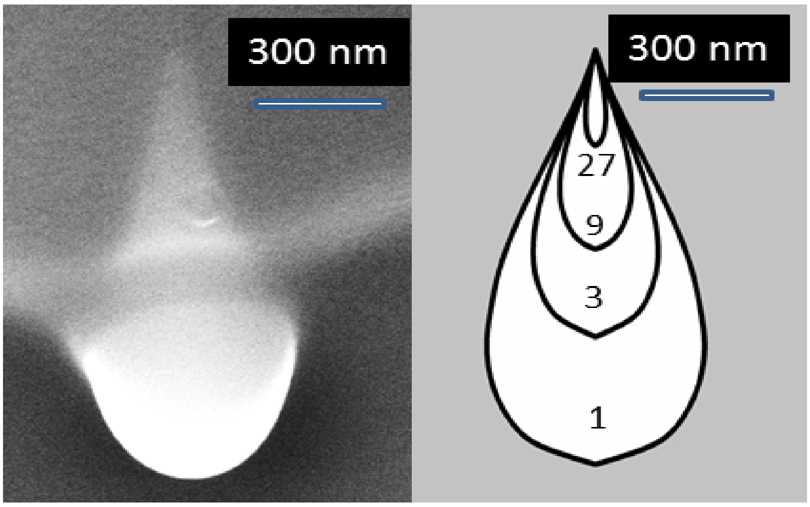

Figure 16: Left: pillars grown on two sides of amorphous carbon film irradiated by a focused 20 keV electron beam; view from the backside, tilt 45^0 . Right: calculated contours of equal current density; figures indicate scattered intensity in arb.units

References

[1] I. Utke, S. Moshkalev, P. Russell: *Nanofabrication using focused ion and electron beams*. Oxford (2012)