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Counterintuitive temperature dependence of ion beam shaping of Si nanopillars

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Silicon nanopillars down to a diameter of ~20 nm and up to an aspect ratio 3 have been exposed to high-fluence irradiation of 50 keV Si^+ ions. When the pillars are kept at room temperature (RT) they change their shape drastically under 10^{16} Si^+cm^{-2} irradiation: They become bell-shaped, i.e. their heights decreases and their diameters increases strongly. To understand this shaping we performed 3D simulations using the program TRI3DYN [1] which show clearly that this shaping cannot be explained by sputtering effects. The shape change originates probably from ion-induced viscous flow [2, 3]. During irradiation at RT the Si becomes amorphous which allows a plastic deformation.
Surprisingly, under irradiation at 400℃ the bell-like shaping disappears completely. The nanopillars become thinner without a substantial reduction of their height. This agrees nicely with predictions of our 3D TRI3DYN simulations, i.e. sputtering is at 400℃ the dominating mechanism. At high-T irradiation viscous flow is blocked as the Si pillars remain crystalline.
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Autor: HEINIG, Karl-Heinz (HZDR)

Co-Autoren: GHARBI, Ahmed (CEA-LETI); ENGELMANN, Hans-Jürgen (HZDR); VON BORANY, Johannes (HZDR); BISCHOFF, Lothar (HZDR); BÖTTGER, Roman (HZDR); MÖLLER, Wolfhard (HZDR); XU, Xiaomo (HZDR)

Vortragende(r): HEINIG, Karl-Heinz (HZDR)

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