Controlled pore formation on mesoporous single crystalline silicon nanowires: threshold and mechanisms

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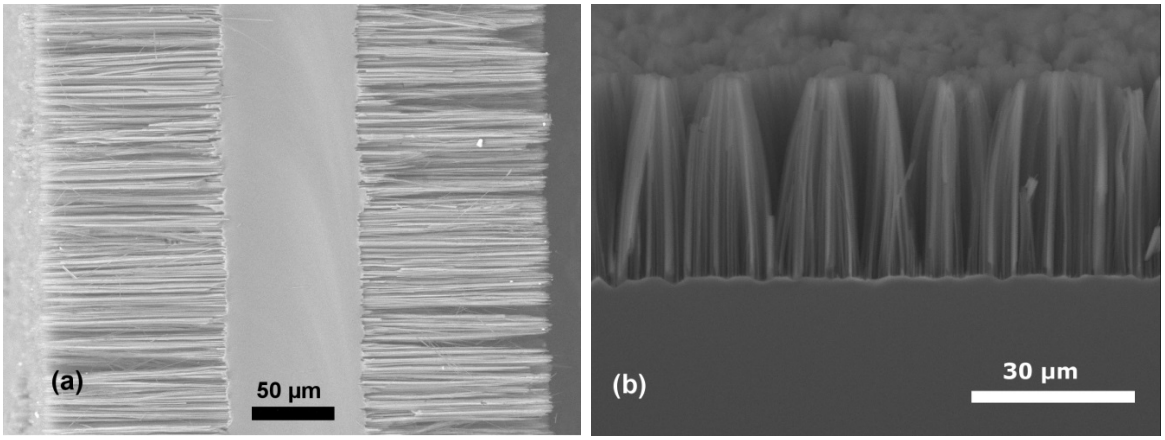
Short Abstract

Silicon nanowires are prepared by two-step metal-assisted wet chemical etching. We analysed the structure of solid, rough and porous nanowire surfaces of boron-doped silicon substrates by scanning electron microscopy and nitrogen gas adsorption. Silicon nanowires prepared from highly-doped silicon reveal mesopores on their surface. However, we found a limit for pore formation, with pores only forming by etching below a critical H_2O_2 concentration ($c_{H_2O_2} < 0.3\ \mathrm{M}$). Heavily boron-doped silicon nanowires are highly porous and the remaining single crystalline silicon nanoscale mesh leads to a redshift, which hints at a phonon confinement in mesoporous single crystalline silicon nanowire.



Above. Scanning electron micrograph of silicon nanowire ensembles from (a) undoped silicon (100). There are long solid wires (about 110 μm) on both sides of the thin (< 90 μm) remaining silicon substrate. (b) Highly boron-doped silicon (100). The wires form bundles and lie near against each other. The nanowire tips are bent to the tips of the neighbouring nanowires, indicating smaller diameters and pore formation.