

Bottom-up Fabrication of FeSb₂ Nanowires on Crystalline GaAs Substrates with Ion-induced Pre-patterning

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Ion irradiation offers great possibilities to modify the surface morphology of materials. Exposed to a broad ion beam, the surface of a solid is either smoothed or various nanoscale patterns emerge depending on the irradiation conditions and the material properties [1]. Surface patterns produced by ion irradiation can be used as templates for bottom-up fabrication of nanostructures. Here we present an approach for the bottom-up fabrication of FeSb₂ nanowires on crystalline GaAs(001) substrates with ion-induced surface nanopatterning.

GaAs(100) substrates were pre-patterned using ion irradiation at elevated temperatures of 400°C with a broad, unfocused ion beam of 1 keV Ar⁺ at normal incidence. The self-organized surface pattern is characterized by almost perfectly parallel-aligned ripples at the nanometer scale [2]. For the fabrication of FeSb₂ nanowires, iron and antimony were successively deposited on the pre-patterned GaAs substrates at grazing incidence and post-annealed at 250°C in vacuum.

Using high-resolution TEM imaging for structural analysis and spectrum imaging based on energy-dispersive X-ray spectroscopy for elemental characterization it was shown that FeSb₂ nanowires have been produced successfully on GaAs(100) substrates with an ion-induced nanopatterned surface [3] (Fig. 1). The nanowires have a polycrystalline structure and a cross-sectional area, which is scalable up to 22x22 nm². Due to the highly ordered nanostructure of the GaAs substrates, the nanowires have a length of several 100 μm. This bottom-up fabrication method for nanowires is suitable for several applications, e.g. thermoelectric, catalytic, magnetic, optical or biological devices.

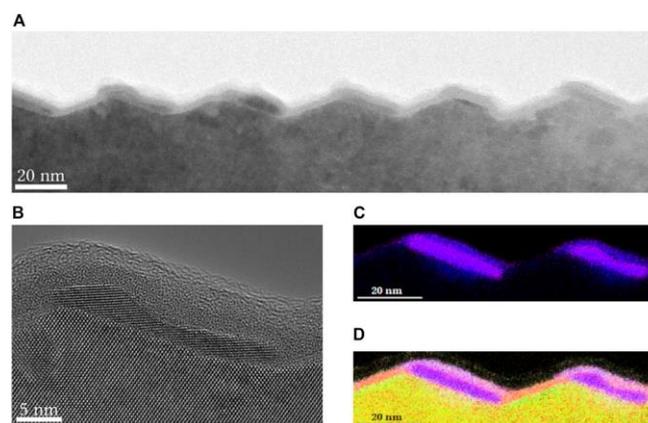


Fig. 1. Cross-sectional overview bright-field TEM image of an array of nanowires in (A) and HR-TEM image of an individual nanowire in (B) with corresponding EDXS based element distributions of Fe and Sb in (C), and of Fe, Sb, Ga, As, and O in (D). EDXS coloring: Fe - blue, Sb - magenta, Ga - red, As - green, oxygen – white.

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