Chemically driven growth of Gold-rich nanostructures on AIIIBV semiconductor surfaces

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AIII-BV semiconductors due to their unique properties such as high electron mobility and direct bandgap are seriously considered for new generation of nanoscale electronic devices to overcome the limitations of silicone technology. One of the important aspect of AIII-BV semiconductor technology is gold-semiconductor interaction at the nanoscale, since Au is widely used to catalyse the growth of AIII-BV nanostructures.
Here, we present a comprehensive study of gold-semiconductor interactions at the nanoscale via investigation of the thermally induced Au self-assembly processes on different AIII-BV semiconductor (001) surfaces i.e. InSb, InAs, InP, GaSb, GaAs, GaP in ultrahigh vacuum (UHV) conditions. The resulted surface morphology for each substrate was investigated by the high resolution Scanning Electron Microscopy (SEM), Fig. 1a, together with Energy Dispersive X-ray Spectroscopy (EDX) chemical quantitative analysis supported by Machine Learning at the nanoscale [1]. Furthermore, the developed nanostructure cross-sections were investigated by Scanning Transmission Electron Microscopy (STEM) High Angle Annular Dark Field (HAADF) imaging at the atomic scale with chemical sensitivity, since the contrast is proportional to the material average atomic number (Fig. 1b,c). This allows us to identify crystallography and chemistry of formed phases at nanostructures. From the reaction stoichiometry we were able to estimate the number of AIII-BV bounds broken due to the interaction with single Au atom on the surface. We have found also a difference in the Au interaction between In- and Ga-based AIII-BV semiconductors as confirmed by machine learning methods [2].

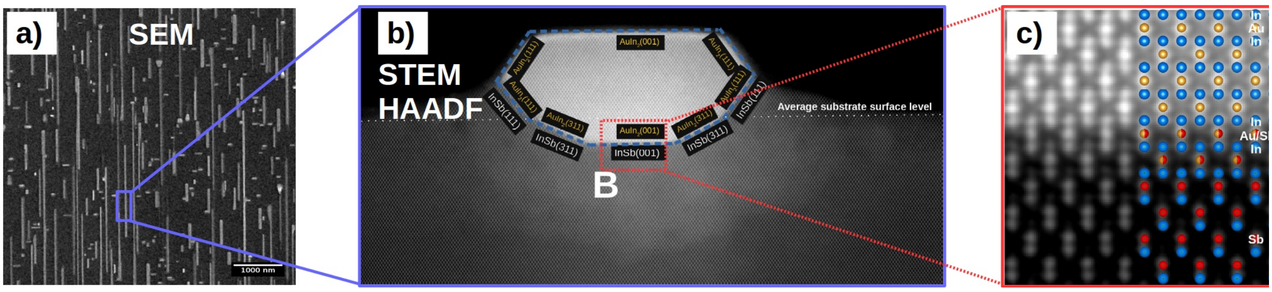

Figure 1 Au-rich nanowires resulted from the thermally-induced self-assembly of 2ML Au deposited on reconstructed InSb(001) surface in UHV. a) SEM image of the sample surface, b) HAADF STEM image of nanowire cross-section, c) atomically resolved HAADF STEM of nanowire-bulk interface together with atomic structural model.

References:
[1] B.R. Jany et al., *Nano Lett.*, 17 (11), pp 6520–6525 (2017)
[2] B.R. Jany et al., “Chemically driven growth of Au-rich nanostructures on AIII-BV semiconductor surfaces”, in preparation (2018)