Nanostructured surfaces

Formation and STM study of indium induced nanostructures on In_4Se_3 (100) surface

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Cleavages of the In_4Se_3 layered semiconductor crystal, owing to the furrowed and chainlike anisotropic surface relief, are considered as natural templates for self-assembled indium nanostructures formation.

The In_4Se_3 crystals grown by the Czochralski method from the In_4Se_3 + up to 10 at.% In alloy were n-doped by In with a carrier concentration of 10^{15}-10^{17} cm^{-3} and then cleaved *in situ*. The STM data were obtained with an Omicron NanoTechnology STM/AFM System. Indium was evaporated from an Omicron EFM3. To visualize the measured STM data we employed the WSxM software.

The STM surface morphology study resolved natural, depending on growing conditions, and deposited In nanostructures. The STM data were analyzed by averaging the roughness of the 1000x1000 nm^2 area for different random positions on the surface to minimize the influence of local topography variations. The roughness analysis allowed to estimate the averaging height of In deposited layers and the In deposition rate to be $3x10^{-4}$ nm/s. The dimensionality of surface nanostructures during the In deposition is dependent on the value of the In_4Se_3 bulk conductivity. The driving force for such behavior is the overstoichiometric In available on the cleavage surfaces due to the self-intercalation phenomenon.

Obviously, the (100) In_4Se_3 root-mean-square (RMS) roughness increases with the amount of indium deposition. However, the RMS and skewness for the low resistivity samples has sufficiently lesser values than those for the high resistivity ones, which indicates a relatively different formation of surface nanostructures. Kurtosis analysis indicates also a more mean unevenness for high resistivity crystals' In deposited surfaces, especially, after consequent thermal treatments. Thus, the STM data confirm the preferable formation of one-dimensional In-induced surface structures for the low-resistivity In_4Se_3 (100) surfaces against zero-dimensional for the high resistivity ones upon In deposition.