A Growth Model for Selective Area Epitaxy of Horizontal GaAs Nanoridges by MOVPE

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Selective area epitaxy (SAE) opened the path for reliable and reproducible growth of nanowires over large areas. The application of SAE to III-V horizontal 1D nanostructures, i.e. nanoridges, has the potential to narrow the gap between lab-scale research and industrial implementation [1], while widening the range of nanoscale architectures available (i.e. closed loops, networks, intersections) [2]. Despite the fast progress of the field, the growth mechanism and the interplay of different growth parameters still need to be fully explained.

In this work, we investigate the growth of GaAs nanoridges on (100) GaAs substrates by MOVPE, drawing comparisons to the equivalent growth by MBE previously performed by our group [3]. Using SEM and AFM, we observe layer-by-layer, and step-flow growth, and we identify the primary driving force for these growth regimes. Initially, these nanostructures have {101} side facets and a flat (100) top facet, which later diminishes as the growth proceeds until {101} facets dominate. Islands and terraces are present on this top facet throughout the whole growth, which we relate to the atomic coordination at the step edge. Later, we study the effects of a high-temperature in-situ deoxidation step on the depth and topography of the exposed GaAs trenches prior to growth. We find that Ga and As adatoms rearrange at the bottom of the trenches. Depending on the geometrical parameters, namely width and pitch, some trenches experience a net loss of material such that their depth increases after annealing. We develop a simple model to describe growth in three distinct phases. Finally, we highlight several important differences between MOVPE and MBE growth and comment on the potential advantages of MOVPE as a growth technique for such GaAs nanostructures.

References

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