Growth of GaSb nanowires revealed by environmental TEM

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Group III-Sb semiconductor nanowires are an important material system with potential uses in applications such as quantum electronics, optoelectronics and sensing. This is due to their excellent electrical properties, including high carrier mobility and narrow band gap. However, current device development is slowed down by the difficulty to control the growth of Sb-based nanowires, as compared to the more common III-As materials. To a large extent this is caused by the complex growth conditions of antimonides, as elemental antimony exhibits low vapour pressure and surfactant effect.1 In order to understand the limits and possibilities of the III-Sb nanowire system, a thorough investigation of the growth behaviour is therefore needed. Since atomic scale growth dynamics and liquid catalyst composition while growth proceeds are parameters that are not readily accessible during conventional nanowire growth, in-situ investigations are crucial in order to develop a comprehensive understanding of the growth dynamics.

Herein we utilize environmental transmission electron microscopy to analyze Au-seeded GaAs-GaSb nanowires in-situ as shown in Figure 1 (a). By acquiring compositional data during growth, we demonstrate how the precursor flows affect the seed particle composition that affects the seed particle volume subsequently leading to dramatic changes in nanowire diameter (shown in Figure 1 (b-c)). Furthermore, we examine in close detail the layer-by-layer growth dynamics revealing how precursor flows affect the step-flow and incubation processes which describe the time in which a bilayer progresses across a liquid-solid interface and the time until a new layer is nucleated, respectively.