Surface Mediated Formation of Horizontal ErSb Nanowires

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ErSb, and related Rare Earth-Group V materials, are semi-metallic in nature and compatible with III-V semiconductors structures, forming sharp stable epitaxial interfaces. Unfortunately overgrowth of III-V material is hampered due to the difference in symmetry between ErSb [001] (4-fold) and GaSb [001] (2-fold) resulting in symmetry defects preventing the use of ErSb as a buried contact. One proposed method of circumventing this problem is to use ErSb horizontal nanowires as a buried contact while allowing percolative GaSb growth to occur between the nanowires to maintain crystal orientation. ErSb is known to form a variety of nanostructures in GaSb depending on the ratio of Ga to Er flux during deposition. [1] Understanding the growth mechanisms behind the formation of these different nanoparticles is an important step towards their use as buried contacts, and to achieve nanowire formation in other material systems.

We investigate the growth of horizontal nanowires in the ErSb/GaSb material system, and observe a growth process involving large GaSb macrosteps as the mechanism behind the transition from vertical nanowires to horizontal nanowires.

We also observe a previously unseen low temperature growth mode resulting in horizontal nanowire formation under a much wider range of flux conditions. This new growth mode does not use the embedded growth observed at higher temperatures and may allow for horizontal nanowire formation without the presence of macrosteps, as well as the formation of significantly smaller nanoparticles which may be useful for accessing nanoparticle dimensions that result in electron confinement.

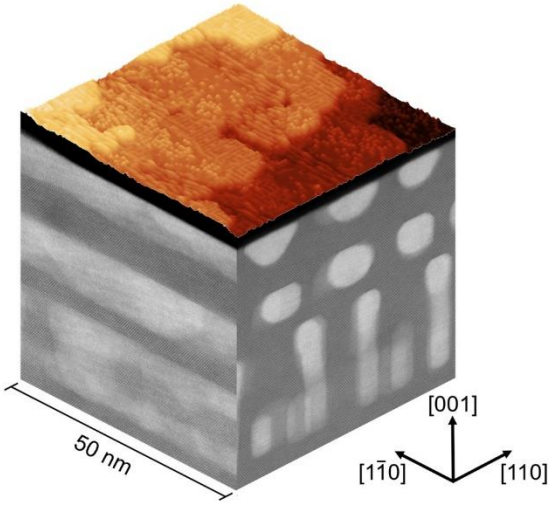

Figure 1Figure 1- Composite image of an $Er_{0.3}Ga_{0.7}Sb$ sample showing an STM topography image of the (001) growth surface as well as HAADF-STEM images along the [110] and [1-10] directions. STM has exaggerated vertical scale.

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[1] J. Kawasaki, B. Schultz, H. Lu, A. Gossard, C Palmstrøm, Nanoletters **13** 2895(2013).