Iuliacumite: a novel two-dimensional chemical short range order in a wurtzite single monolayer $InAs_{1-x}Sb_x$ shell on InAs nanowires

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The reduced dimensionality of semiconductor nanowires (NWs) offers the unique opportunity to grow materials with crystal structures, which are otherwise unstable. One of the most prominent example is the growth of wurtzite (WZ) structure InAs NWs, although stable InAs bulk material prefers the zincblende (ZB) structure. In contrast, other III-V materials, notably $InAs_{1-x}Sb_x$, prefer to keep their ZB bulk structure even in NWs or nanostructures with reduced dimensionality. However, lateral overgrowth of these ternary III-V semiconductor alloys on sidewall facets of WZ structure III-V nanowires offers the prospect to nevertheless obtain reliably a WZ structure shell, despite being unstable. Thereby new polytype structures of ternary III-V semiconductor alloys can be achieved, offering additional degrees of freedom for adjusting the band structure in, e.g., core-shell nanowires. Therefore, we designed a two-dimensional single monolayer $InAs_{1-x}Sb_x$ WZ structure shell on sidewall facets of InAs nanowires and investigated the chemical ordering using atomically resolved scanning tunneling microscopy. We identify the existence of a short-range chemical ordering in this WZ structure single monolayer shell. The new type of two-dimensional ordering, called Iuliacumite, is characterized by an ordering vector in [0001] and an anti-ordering vector in <11-20> direction. The ordering is driven by a strong repulsive interaction of neighboring Sb atoms along the <11-20>-oriented atomic chains on the *m* plane sidewall facets.

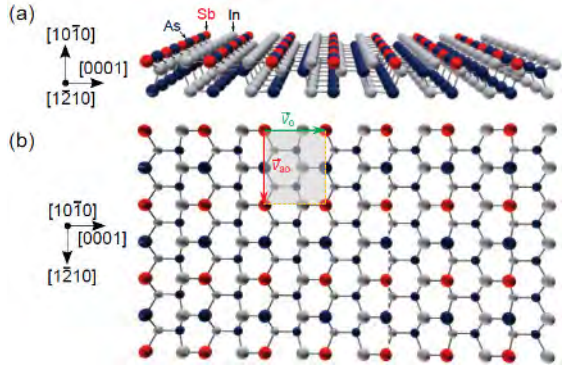

Figure 1 Perspective view of a ball model of the two-dimensional idealized (long range) chemical ordering of the monolayer shell on the InAs sidewall facet, based on the ordering and antiordering vectors extracted from pair correlation function. (a) Side and (b) top view with surface unit cell.

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