Local Positional Alignment of InSb Nanostructures by Self-Assembled Epitaxial Growth on Ge Substrate

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InSb/GaAs and InSb/InAs have type II and type III band alignment, which possess unique electronic properties.[1] Realization of InSb nanostructures by using self-assembled growth in Stranski-Krastanov mode has been investigated. Here, we report on the molecular beam epitaxial growth of InSb nanostructures by self-assembled growth on (001) Ge substrate. Local alignment of InSb nanostructures on anti-phase domain (APD) boundary of GaAs buffer layer is observed.

Figures 1 and 2 show atomic force microscopy (AFM) images of InSb nanosturctures grown on (001) GaAs and (001) InAs substrate. The nanodots have typically rectangular-based with flat top structure. Magnified three-dimensional AFM image of single InSb nanostructure is shown in the inset of Fig. 2. When Ge substrate is used and GaAs is grown as a buffer layer, the APDs of GaAs are formed due to the growth of polar (GaAs) on non-polar (Ge) material. Every nearby APD has perpendicular crystal orientation. Therefore, APD boundaries are observed. By depositing InSb on this surface, InSb nanostructures form and align along the boundaries. Figure 3 shows an AFM image of InSb/GaAs on (001) Ge substrate. Due to the large lattice mismatch (~14%) between InSb and GaAs, we attribute this observation to the preferential formation of InSb on the lower strain energy position.

In this work, attempt to combine with our previous experience on the preparation of a cross-hatch virtual substrate is also being made. Figure 4 shows an alignment of InAs quantum dots on cross-hatched InGaAs surface.[2] The aim of this work is to find suitable growth conditions for self-assembling of ordered nanostructure array without any top-down patterning techniques.

1 H. Kroemer, *Physica E* **20**, 196-203 (2004).
2 C. C. Thet, S. Panyakeow, and S. Kanjanachuchai, *Microelectronic Engineering* **84**, 1562-1565 (2007).

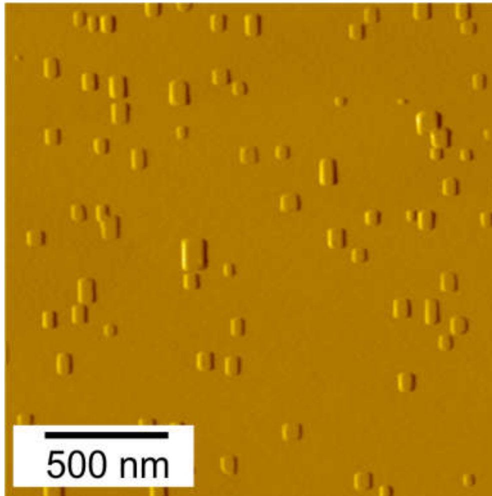

Fig. 1 InSb/GaAs nanostructure on (001) GaAs substrate

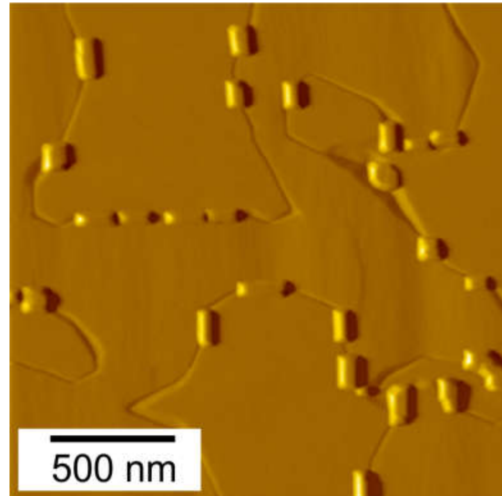

Fig. 3 InSb/GaAs nanostructure on (001) Ge substrate

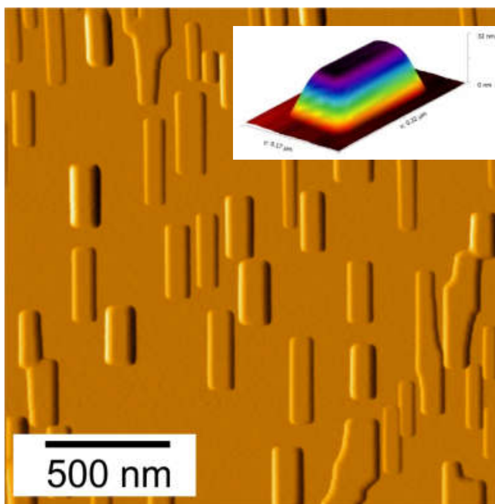

Fig. 2 InSb/InAs nanostructure on (001) InAs substrate

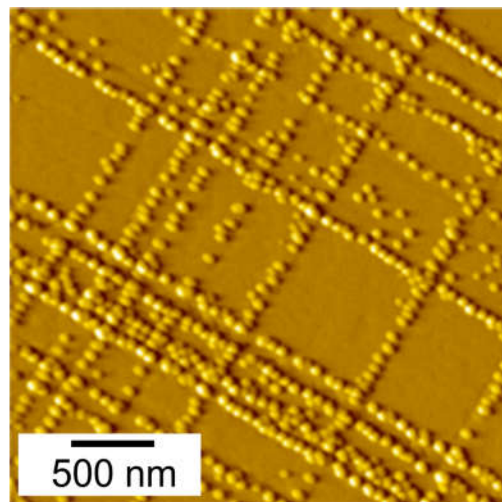

Fig. 4 InAs QDs on cross hatched $In_{0.15}Ga_{0.85}As$ surface[2]