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Surface reconstructions during MBE growth of GaAs with Bi

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Abstract: The surface reconstruction phase map of $\text{GaAs}_{1-x}\text{Bi}_x$ is explored in this study as a function of growth temperature and As:Ga ratio. For comparison, the phase map of GaAs, at low temperatures is also obtained. It is observed that the (1×3) , (2×3) , (2×4) surface phases are common between GaAs and $\text{GaAs}_{1-x}\text{Bi}_x$ but due to the presence of Bi, a new (2×1) reconstruction appears in the case of $\text{GaAs}_{1-x}\text{Bi}_x$. This new reconstruction is observed for various Bi fluxes, showing the evolution of this phase with substrate temperature and As:Ga flux ratio. In addition, the emissivity of the (2×1) surface was found to be lower than for the other As-rich reconstructed surfaces (e.g. (1×3) and (2×3) surfaces) which suggests that the (2×1) surface phase is metallic. Several $\text{GaAs}_{1-x}\text{Bi}_x$ films were grown with (1×3) and (2×1) reconstructions at different substrate temperatures. Each film is characterized using high-resolution x-ray diffraction (XRD), photoluminescence spectra (PL). Superior crystal quality, higher Bi incorporation and higher intensity PL was observed for $\text{GaAs}_{1-x}\text{Bi}_x$ samples grown on (2×1) surfaces, relative to samples grown on (1×3) surfaces.