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Photomodulated Reflectance Spectroscopy of GaAsBi/GaAs layers grown by MBE

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Abstract: The III-bismides are considered to be a very attractive set of III-V alloys due to their potential applications in photonic and spintronic devices. The incorporation of bismuth into GaAs, with its band anti-crossing effect in the valence band of GaAs, leads to a decrease in the temperature dependence of the bandgap. Such a material may be very useful in designing temperature-insensitive semiconductor lasers, optical amplifiers and optical modulators in the near-and mid-IR region [1].As bismuth is a comparatively large atom, its alloying to III-V semiconductors can possibly lead to a large spin orbit splitting needed for spintronic devices [2]. This property is also expected to significantly increase the operating efficiency of near-IR lasers by suppressing Auger recombination and inter-valence band absorption [3].

In order to investigate the basic physical properties of this new alloy, spectroscopic measurements were performed on epilayer samples based on GaAsBi. Room temperature photoreflectance (PR) studies on 30-40nm epitaxial layers of GaBixAs1-x (2.3 %< x<10.4%) grown on GaAs (100) have shown a band-gap reduction, together with an increase in the spin-orbit splitting energy, with increasing Bi percentage. In addition, we observed a valence band heavy-hole/light-hole (HH-LH) splitting in the compressively-strained GaAsBi thin layers grown on the GaAs substrate. This strain-induced valence band splitting was used to calculate the deformation potential for this novel bismide material. PR spectroscopy of GaAsBi quantum wells grown with the same Bi flux, but different As flux, also reveal further interesting results, as will be discussed.

References:
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