Atomic structure and optical properties study of GaAsBi for PV applications

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The dilute $GaAs_{1-x}Bi_x$ alloy has experienced an extensive amount of research and represents the emerging class of bismuth-containing group III-V semiconductors. Incorporation of Bi atoms into the GaAs lattice leads to large bandgap narrowing ~90 meV/Bi% and allows to achieve 1.0 eV energy gap with the least lattice mismatch with GaAs substrate than any other ternary alloy. Such subcell material is highly sought after in order to realize the optimal bandgap combination in 3- and 4-junction solar cells.

Due to very high efficiencies and radiation resistance III-V multi-junction solar cells (MJ) are dominating the space photovoltaic (PV) energy and concentrated sun applications. Recent advancements aimed at their cost-reduction strategies encourage further development of this technology. As a motivation to the 1.0 eV GaAsBi material investigations, a brief overview of the thin film III-V MJ development activities at FTMC will be also presented in this talk.

Previous studies of the spontaneous CuPt-type atomic ordering of GaAsBi focused exclusively on the microstructure analysis. In this atomic structure–property relationships study we show that at typical GaAsBi molecular beam epitaxy growth conditions the ordering leads to pronounced birefringence and linear dichroism as well as polarized photoluminescence. All optical anisotropy observations agree with the theoretical predictions of point symmetry reduction in the ordered GaAsBi phase. Non-trivial associated electronic-structure changes are also predicted. These findings elucidate the ordering effects in dilute GaAsBi absorber allowing for better understanding of the complex bismide alloys and the prospects of their incorportation into III-V MJ solar cells.

References:
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