Structural Characterization of the (Ga,Mn)(Bi,As) Dilute Magnetic Semiconductor Epitaxial Layers

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Leaning towards structure perfection is an important part of the material's manufacture and application. Even while using high-quality growth technique, like low-temperature molecular-beam epitaxy (LT-MBE), a further comprehensive analysis of the structure homogeneity and composition is viable.

The topic of our recent studies has been a versatile depiction of the structure specifics of (Ga,Mn)(Bi,As) dilute magnetic semiconductor 50-nm-thick layers with 6% Mn and optional 1% Bi contents. All the samples were grown by LT-MBE within the same layers scheme on GaAs semi-insulating substrate with elective InGaAs buffer for strain-control purposes. Additional post-growth annealing treatment (T_A = 180°C, 50 h), typical for this class of materials [1], was applied.

High-resolution X-ray diffraction provided detailed insight into the crystal lattice – unit cell parameters along with strain in the top investigated layer. Secondary ion mass spectroscopy (SIMS) determined elements distribution throughout the epitaxial layers, while high-resolution transmission electron microscopy (HR-TEM) visualized fine structure of the lattice (Fig. 1). Discussion about defects and strain will be held around the Raman scattering spectroscopy analysis.

In general, all four methods came to an agreement about high-quality crystalline structure, sharp interfaces, homogeneity of the components and low concentration of defects within the investigated samples, leaving several open questions for the discussion.

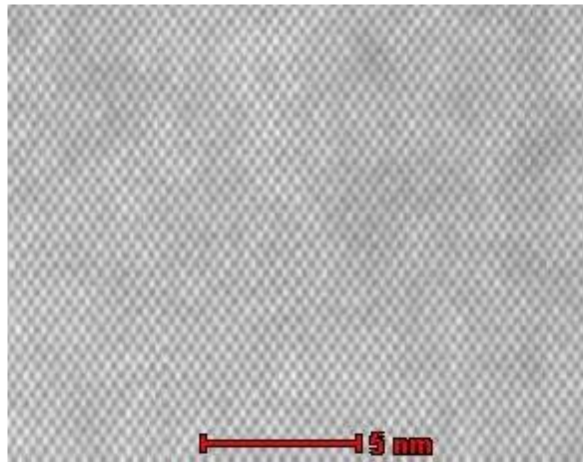

Fig. 1. Cross-sectional HR-TEM image of the (Ga,Mn)(Bi,As)/GaAs top layer.

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[1] K.W. Edmonds, P. Bogusławski, K.Y. Wang, et al., *Phys. Rev. Lett*. **92**, 037201 (2004).