Abstract Details:

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03.Narrow Gap and Compound Semiconductors	08/09	12:50	Exhibition Hall 1

Title:

Effect of temperature on the mutual diffusion of Ge/GaAs and GaAs/Ge

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Abstract:

GaAs/Ge heterostructures are commonly used in high efficiency solar cell: structures such as InGaP/GaAs/GaAs or GaAs/Ge and triple junction InGaP/GaAs/Ge, are continuously improving their efficiency. Sharp heterointerfaces and abrupt dopant profiles are essential in order to obtain a good control of the heteroepitaxy.

One common problem in the Ge/GaAs, GaAs/Ge, Ge/GaAs/Ge, Ge/GaAs/GaAs, GaAs/Ge/GaAs and GaAs/Ge/Ge heterostructures is the interdiffusion of the elements in the different layers, i.e. Ge in GaAs and Ga and As in Ge. Since Ge acts as dopant in GaAs, and vice-versa, the film/substrate interdiffusion of Ge and GaAs is able to change the carrier concentrations in the layers.

In order to assess this problem we grew Ge/GaAs and GaAs/Ge heterojunctions by metal-organic vapour phase epitaxy (MOVPE) using iso-butylgermane, arsine and trimethylgallium in hydrogen atmosphere at low pressure, varying the deposition temperature. The use of low temperature GaAs and Ge buffer layers was investigated in order to limit the interdiffusion. Different experimental techniques, including Secondary Neutral Mass Spectrometry (SNMS), High Resolution X-ray Diffraction (HR-XRD), Transmission Electron Microscopy (TEM), Rutherford Backscattering Spectrometry combined with Channeling technique (RBS/C) and Atomic Force Microscopy (AFM) have been used to investigate the samples. HR-XRD profiles show the good crystalline quality of the epitaxial layers, with a lattice mismatch between the layer and the substrate as calculated form the peak separation corresponding to perfectly adapted layers RBS/channeling spectra show no significant difference between the samples grown at different temperatures, indicating that the presence of extra defects, strain, or misorientation at the interface is below the detection limit. The depth profile analysis of samples measured by SNMS show remarkable interdiffusion of all components at the heterointerfaces between the layers and substrates, indicates a variation with temperature. The results confirmed that a low temperature GaAs buffer layer could efficiently reduce GaAs/Ge mutual diffusion. The same is not true for a low temperature Ge buffer layer in Ge/GaAs epitaxy. TEM was used to assess the crystal quality of the grown layers and composition distribution by X-ray microanalysis, that confirmed elements interdiffusion as measured by SNMS.