In-depth Characterization of Nanolayered Structures in III-V Semiconductors by Secondary Ion Mass Spectrometry (SIMS)

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The progressive structural and functional complexity in modern microelectronic devices represents the driving force to imporve or develop analytical techniques for the characterization of surfaces, interfaces and thin films [1]. On the other hand, most of those microelectronic devices are layered materials in which the chemical composition for major contituents, trace elements, dopands and impurities might vary within the sample thickness. Moreover, a wide variety of factors could affect the microstructure and interstitial chemistry of such devices due to the nanometric thicknesses involved and the different nature of the constituent beds, making the analysis especially challenging. Therefore, the information provided by the characterization techniques must be accurate and reliable in order to provide a depth understanding about the materials quality and the impact of the individual processing steps during device manufacturing. Nowadays, the most important developments in microelectronics are focused on physics and technology of semiconductors, depending mainly on two families of materials: the group IV elements and the III-V compounds [2].

Several surface analysis techniques are commonly used in this field - such as X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), Rutherford backscattering spectroscopy (RBS), atomic force microscopy (AFM), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), etc- providing complementary insights of the sample chemical composition and morphology. However, SIMS is considered the reference technique for both in-depth elemental/molecular distributions and chemical mapping of microelectronics/semiconductor devices due to its capability for detecting all elements with excellent sensitivity (up to sub-part per million) and sub-nanometric depth resolution [3-5].

Nowadays, some of the most important developments in microelectronics are focused on physics and technology of semiconductors, depending mainly on two families of materials: the group IV elements and the III-V compounds. In this communication, the application of SIMS depth profiling to the analysis of triple junction solar cells and the investigation of metallic diffusion in High Electron Mobility Transistors (HEMTs) is shown [6,7]. These samples represents a great challenge due to their multilayered structure, the reduced thickness of many of them, the different inter-diffusion and migration processes that may occur during the fabrication, and the large range of concentrations where the main constituents may be present.

References:

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Figures:

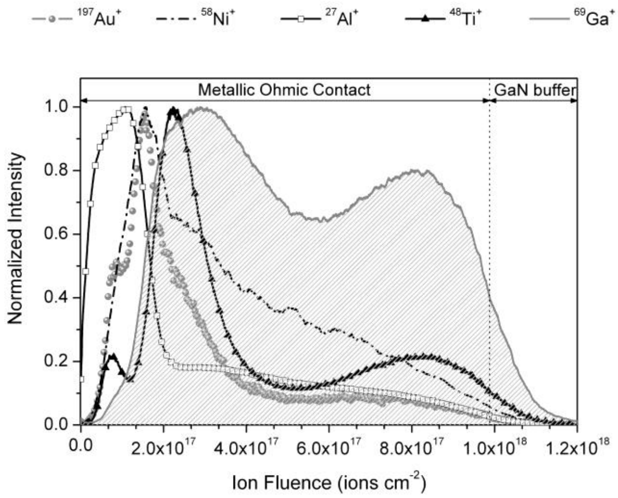

Figure 1. Positive SIMS depth profile of an annealed ohmic contact

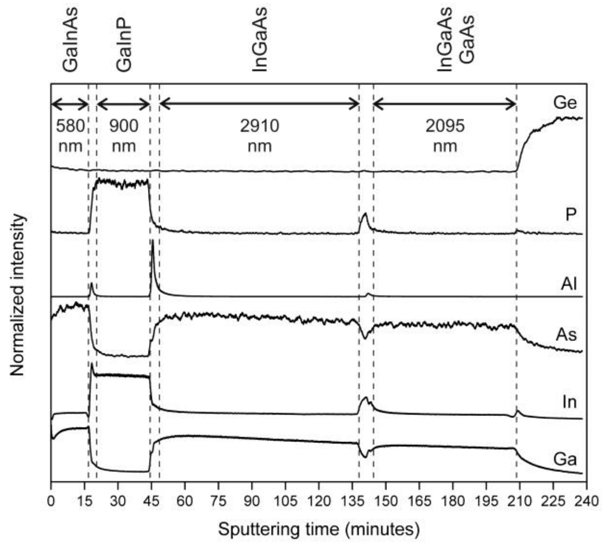

Figure 2. In-depth analysis of a triple junction solar cell. The top, middle and bottom subcells are clearly identified, as well as the outer AlGaAs contact layer.