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Mcs_n^+ molecular ion - SIMS for direct chemical analysis of nanostructures without calibration standards

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If alkali metals such as Cs, Li, Rb, K, Na, etc. (referred as A in general) are present in the neighborhood of the probing element (M) on a sample surface, quasi-molecular ions can be formed by the attachment of these alkali ions [$(MA)^+$ formation] in the secondary ion mass spectrometry (SIMS) process. Formation of these MA^+ molecular ions has a strong correlation to the atomic polarizability of the element M. The emission process for the re-sputtered species M^0 is decoupled from the MA^+ ion formation process, in analogy with the ion formation in secondary neutral mass spectrometry (SNMS), resulting in a drastic decrease in the conventional 'matrix effect' in SIMS. Although the detection of MA^+ molecular ions in SIMS has found its applicability in direct materials quantification, it generally suffers from a low useful yield. In such cases, detection of $(MA)_n^+$ (n=2, 3,….) molecular ions offers a much better sensitivity (even by several orders of magnitude), as the yields of such molecular ion complexes have often been found to be higher than that of MA^+ ions. The recombination coefficient of MA^+ or MA_2^+ molecular species depends on the electro-positivity or electro-negativity of the element M, respectively. Apart from the surface binding energy of the respective uppermost monolayer, the changes in local surface work-function have often been found to play a significant role in the emission of these molecular ions. Although these MA_n^+ molecular-ion based SIMS has great relevance in the analysis of materials, a complete understanding on the formation mechanisms of these ion-complexes is still lacking. A procedure, based on *MA_n^+-SIMS* approach, has been proposed for the accurate germanium quantification in Molecular Beam Epitaxy (MBE)-grown $Si_{1-x}Ge_x$ alloys. The 'matrix effect' has been shown to be completely suppressed for all Ge concentrations irrespective of impact Cs^+ ion energies. Cesium, the fifth alkali element, is the most reactive of all the metals. The methodology has successfully been applied for direct quantitative composition analysis of various thin film and multilayer structures. Recent study on various ZnO-based nanostructures has successfully been correlated to their photo-catalysis and photoemission responses. The talk will address the various possible formation mechanisms of MCs_n^+ molecular ion complexes in sputtering process and the fascinating applications of the *MCs_n^+-SIMS* approach for the interfacial analysis of ultra-thin films, superlattices, quantum wells, etc. and for compositional analysis of MBE - grown $Si_{1-x}Ge_x$ alloy structures.

Biography

Purushottam Chakraborty is considered India's one of the most prominent figures in the field of Spectrometry, he is one of the world's leading experts in SIMS. He has published more than 150 scientific papers impacting the discipline through vast knowledge. He has given lectures over 130 countries including Invited talks and Chaired Sessions across the globe. Honored with numerous awards, including the "Most eminent Mass Spectrometrist of India" in 2003 is most significant one among many.

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