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High-resolution MCs_n^+ - SIMS: An innovative mass spectrometric technique for compositional analysis of quantum structures without 'standards'

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Excellent detection sensitivity, high dynamic range and superior depth resolution make the SIMS technique extremely powerful for the analysis of low-dimensional structures. However, a serious problem in SIMS analysis lies in its "matrix effect" that hinders the material quantification. Appropriate corrective measures are therefore, needed to calibrate the secondary ion currents into respective concentrations for accurate compositional analysis. Working in the MCs^+ -SIMS mode (M – element to be analyzed, Cs^+ – bombarding ions) can circumvent the matrix effect. The emission process for the neutral species $M0$ is decoupled from the MCs^+ ion formation process, in analogy with the ion formation in secondary neutral mass spectrometry (SNMS), resulting in a drastic decrease in matrix effect in the MCs^+ -SIMS mode. Although this technique has found its applicability in direct quantification, it generally suffers from a low useful yield. In such cases, detection of MCs_n^+ ($n=2,3, \dots$) molecular ions offers a better sensitivity, even by several orders of magnitude. A complete understanding on the formation mechanisms of these MCs_n^+ ($n=2,3, \dots$) molecular ion complexes formed in the SIMS process has been explored. We have demonstrated the prospective use of this innovative MCs_n^+ -SIMS technique in the direct interfacial analysis of ultra-thin films, metallic multilayers, semiconductor superlattices, quantum well structures and compositional analysis of MBE grown $Si_{1-x}Ge_x$ alloys without 'standards'. The talk will address on the fundamentals, challenges and applications of the novel MCs_n^+ -SIMS technique in all its complexities.

Biography

Purushottam Chakraborty is a Senior Professor at Saha Institute of Nuclear Physics, Kolkata, India and an Honorary Professor at the University of Pretoria, South Africa. His research interests range from 'ion beam analysis of materials' to 'XUV optics and photonics'. He worked at many renowned centres like FOM – Institute for Atomic and Molecular Physics, Padova University, ICTP, Laval University, Osaka Electro-communication University, etc. He has published more than 125 papers including reviews and book-chapters. He has been awarded the 'most eminent mass spectrometrists of India' and is one of the world leaders in Secondary Ion Mass Spectrometry (SIMS).

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