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Positron-annihilation Induced Auger Electron Spectroscopy study of metal and semiconductor surfaces

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Since the presence of chemical impurities and defects at surfaces and interfaces greatly influence the properties of various semiconductor devices, an unambiguous chemical characterization of the metal and semiconductor surfaces becomes more important in the view of the miniaturization of the devices towards nanometer scale. Among the various conventional surface characterization tools, Electron-induced Auger Electron Spectroscopy (EAES), X-ray Photoelectron Spectroscopy(XPS) and Secondary Ion Mass Spectroscopy (SIMS) are being used for the identification of the surface chemical impurities. In this talk, a novel surface characterization technique will be introduced. Positron-annihilation induced Auger Electron Spectroscopy (PAES) provides a unique method for the analysis of the elemental composition of the top-most layer.

In PAES, monoenergetic positrons of a few eV are implanted to the surface under study and these positrons become thermalized near the surface. A fraction of the thermalized positrons trapped at the surface state annihilate with the neighboring core-level electrons, creating core-hole excitations, which initiate the Auger process with the emission of Auger electrons almost simultaneously with the emission of annihilation gamma-rays. Thus, PAES experiments can be used to selectively obtain chemical information from the topmost atomic layer with eliminating large secondary electron background. Further, the energy of positrons used for the initiation of Auger process is much smaller (about a few eV) compared to that of EAES (about a few keV) and thereby, it causes no lattice damage to the surface under study. The enhanced surface selectivity over conventional electron induced Auger electron spectroscopy was applied to many metal and semiconductor surface and overlayer systems such as, Au/Cu, Pd/Cu, Rh/Ag and Si/Ge.