Surface Analysis Seminar

Tuesday January 5th, 2pm in MAS 2.06

XPS, Auger and TOF-SIMS 3-D Characterization of Micro-Structures and Nano-Thin Films

Dr. John S. Hammond

Physical Electronics USA, Chanhassen, Minnesota, USA

Today X-ray Photoelectron Spectroscopy (XPS) is the most commonly used surface analysis technique due to its intrinsic capability for quantitative elemental characterization, chemical state identification, and the XPS sampling depth of 1 to 5 nm. These capabilities are widely used to differentiate between a modified surface layer that is homogeneous in surface coverage and the underlying bulk chemistry. With the selection of one of many types of sputter ion sources, the chemistry and thickness of these modified surface layers can often be characterized.

For many industrial applications of surface modified materials, it is now essential to engineer micro-structures, often with multi-layer nano-thin film structures. To elucidate the surface chemistry of these micro-structure samples, a unique micro-focused scanning x-ray monochromator can be used to rapidly acquire quantitative chemical state information from points, line scans and maps with a spatial dimension less than 10 µm. The scanning x-ray monochromator can produce x-ray excited secondary electron images to accurately locate non-homogeneous surface structures for additional analysis. These capabilities were used to characterize a MoS_2 wear track on a steel surface. The surface chemistries of Mo, S, Fe and O were found to vary across the wear track with a 10 µm spatial resolution. Multi-point depth profiling also measured the 10 nm thick MoS_2 transfer layer in the wear track.

Quantitative chemical state characterization of multi-layer thin film structures also requires the selection of the optimum sputter ion source. Today, Ar^+, C_{60} cluster sources and Gas Cluster Ion Beam (GCIB) sources offer different advantages for different types of nano-thin films. The sputter rates, interface resolution between different layers, and the accuracy of the chemical compositions as a function of sputter depth will vary with the different sputter sources and different compositions of the nano-thin films. Examples will be presented to explain the superiority of Ar^+ for profiling multi-layer metal films, C_{60}^+ for profiling metal oxide films, and GCIB for profiling multi-layer organic films and organic biomaterials.

TOF-SIMS offers molecular characterization with sub-micron spatial resolution. GCIB sample cross-sectioning provides the ideal tool for elucidating adhesive failures and the characterization of multi-layer engineered plastics. The characterization of hot dipped galvanized steel surfaces to image the heterogeneous coverage of Zn and Si with a 10 nm spatial resolution Scanning Auger nanoprobe will also be presented.