ADVANCED DEPTH PROFILING CHARACTERIZATION OF MIXED ORGANIC/INORGANIC MULTILAYER DEVICES USING X-RAY PHOTOELECTRON SPECTROSCOPY (XPS) AND A COMBINED MONATOMIC AND GAS CLUSTER ARGON ION SOURCE

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Abstract

Organic electronic devices are becoming increasingly important in a wide variety of applications. These nano-structured devices are typically composed of complex thin/ultrathin multilayers of novel organic or organometallic compounds, along with inorganic materials. The overall electronic behavior of these devices is strongly influenced by the electronic properties and chemical compositions of the individual layers, as well as interactions at layer interfaces. Nanometer scale sampling depth and the ability to provide chemical state information make X-ray photoelectron spectroscopy (XPS) an ideal analytical technique for investigating the surface composition of these advanced materials. There is also an increasing requirement for in-depth compositional depth profiling of such devices. Traditional XPS depth profiling using monatomic argon ion sources usually results in a high degree of chemical modification and decomposition for organic materials. Over the last few years, there have been numerous investigations into the use of argon cluster ion sources for depth profiling materials that are prone to ion beam damage from conventional monatomic ion sources. While cluster beams have proven useful for depth profiling organic and polymeric materials, it still remains necessary to use monatomic argon ion beams for depth profiling inorganic layers because inorganic materials, unlike organic materials, are not effectively sputtered by cluster ions. This presentation will discuss applications of a unique combined monatomic and gas cluster argon ion source that allows full depth profiling of complex electronic devices based on mixed organic/inorganic thin film stacks. Results will be presented for the analysis of an organic solar cell and an organic field effect transistor (FET). XPS depth profiling results with the combined monatomic and gas cluster ion source were consistent with minimal ion beam sample damage and preservation of important chemical state information throughout the profiles.