Abstract No. Dang0318

The Use of SXPS to Evaluate the Interaction of Hg and Thin Oxide Films in Fluorescent Lamp Discharges: A Feasibility Study

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Beamline(s): U12A

Fluorescent lamps use mercury for efficient conversion of electrical power to light. During lamp operation some Hg is consumed through interaction and/or deposition on various lamp components, and it is no longer available for the discharge. One of the primary sites for interaction is the soda lime glass. The degree of Hg/glass interaction is significantly decreased when a thin oxide film is applied on the glass surface (between the glass and the phosphor layer). Characterization of Hg/glass interaction can become very challenging with this type of lamp configuration using a conventional X-ray source. Indeed, XPS analyses carried out on a Physical Electronics 5700 spectrometer for aged lamps, which used yttrium oxide coated glass tubing but contained no phosphor, yielded only a trace level of Hg (<0.1 atomic%). This Hg concentration is very close to the Hg detection limit of the instrument. Characterization of the Hg/glass and Hg/metal oxide interactions in a thin oxide film configuration would, therefore, require a new approach.

A feasibility study for similar lamp systems using SXPS at beamline U12A showed a dramatic enhancement in Hg sensitivity. Compared to the XPS results for the same sample using a Physical Electronics 5700 XPS, the SXPS results at U12A (300 eV; 300 /mm grating) offered about ~40X improvement in sensitivity for the Hg4f peak. The Hg4d, which was not observed with Phi XPS, was readily apparent with SXPS (500 eV, 800 /mm grating). The evaluation of the effectiveness of various oxide films as well as the nature of their interaction with Hg can now be studied in depth.