PHYSICAL ELECTRONICS
A DIVISION OF ULVAC-PHI

TOF-SIMS Analysis of Organic LED Thin Films

Overview: Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS) offers great potential for the analysis of components in organic light emitting diodes due to its ability to obtain unique secondary ion molecular fragmentation patterns for each component. To characterize molecular changes as a function of use, it would be informative to obtain compositional depth profiles of the layers in these devices. It is widely accepted that sputter depth profiles of organic materials using low energy (500 eV) argon ion beams destroy the very chemical structures that are being investigated. Recent experiments using argon gas cluster ion beams have demonstrated the ability to sputter through organic materials while retaining chemical and molecular information that can be observed with XPS and TOF-SIMS.

Experimental: All spectra were taken on a PHI Model TRIFT V *nanoTOF* equipped with an Ar_{2500}^{+} gas cluster ion beam (GCIB) source for sputtering and a liquid metal ion gun (LMIG) with a Bi source for analysis. The Ar_{2500}^{+} gas cluster ion gun was operated at 10 kV and the GCIB was rastered over a 2 mm by 2 mm area to sputter through the thin film stack. A Bi_3^{++} ion beam was used to image a 300 µm by 300 µm area at the edge of the sputter crater for TOF-SIMS analysis. Line scans across the edge of the crater were created retrospectively from the image data file for several molecular fragments. The sample was a 100 nm thick layer of tris(8-hydroxyquinolinato)aluminium (ALQ3) doped with approximately 1% of quinacridone (Qd).

Results: Shown in figure 1 are TOF-SIMS images of the sputter crater wall with the position of the line scan marked by a solid white line. The retrospective line scan created from the indicated area is shown in figure 2. The interface resolution measured with the line scan is less than 5% of the entire film thickness with a relatively constant intensity of AlQ_2^{+} and $Qd+H^{+}$ through the entire 100 nm thick film. This data demonstrates the ability of the GCIB to generate a sputter crater through the entire AlQ_3 film with minimal damage to the molecular composition of the film. TOF-SIMS images and line scans can then be used to detect the distribution of important dopant ions in the thin film structure.

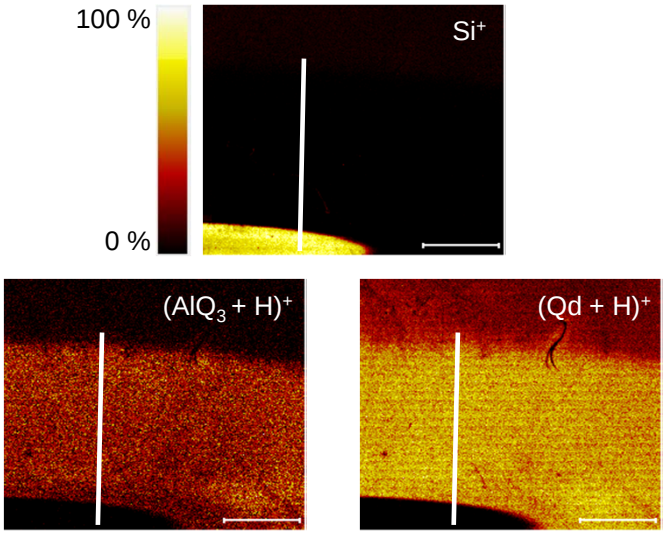

Figure 1. TOF-SIMS images (300 µm FOV) collected at the edge of the sputter crater showing the location of the line scan across the organic LED film.

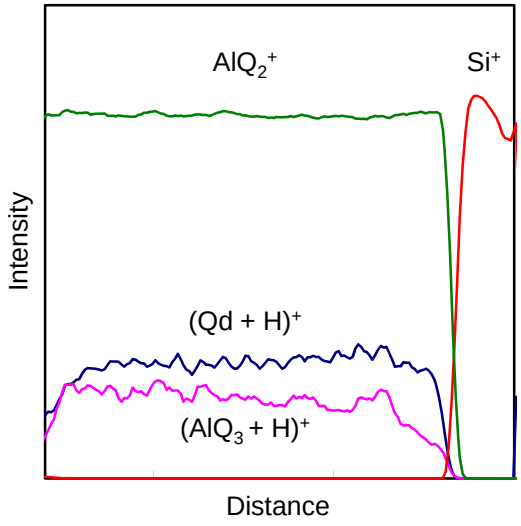

Figure 2. Retrospective line scan showing the distribution of materials across the 100 nm thick organic LED film on a Si wafer.

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