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Project Number
38063

Project Title
Understanding the Difference between Working and Dead Pixels on an OLED Display: Investigation Using TOF-SIMS

Abstract

Objectives/Goals
The goal was to analyze working and dead pixels on an OLED (Organic light emitting diode) phone display to understand why the display region stopped working and if the damage done to the pixels was reversible. This was achieved using the Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) technique.

Methods/Materials
The phone screen display areas with working and dead pixels (blue and red for each) were analyzed. The cathode was removed and the OLED stack was analyzed with the TOF-SIMS instrument. The data from a 200 microns x 200 microns region was collected, showing which ions to track. An argon cluster gun sputtered a crater of 500 microns x 500 microns. The spectrum from the newly exposed surface was collected and the process was repeated until the anode was detected. OLED peaks were plotted as a depth profile. The procedure was repeated 3 times for each region.

Results
For both regions, the blue and red pixels showed similar layers, however, the intensities and depths of ions differed between the two pixels, indicating differing compositions. In contrast to that of the working region, the depth profiles from the pixels in the dead region (both blue and red) were either missing layers or the layers were present only at low levels. For example, the ion at mass 679 was present at a high intensity for the working pixel region but was barely above the detection limit for the dead pixel region

Conclusions/Discussion
A significant difference in the depth profiles of the pixels in the working region versus dead region was observed. I had not expected such a significant difference between the working and dead regions. This suggests that in the dead region, either the molecular species degraded or they migrated, resulting in the pixels going dead. This shows that the damage done to the pixels is irreversible. The insight gained from this experiment can be used to help design better performing OLED displays.

Summary Statement
Using the TOF-SIMS technique, I found significant differences between working and dead pixels in the organic layers of an OLED smartphone display, and this insight can be used in developing better working OLED displays.

Help Received
I used the TOF-SIMS instrument at EAG Laboratories under the supervision of Dr. Ginwalla, who taught me how to use the instrument and the accompanying software, and with this knowledge I carried out my experiment.