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► **To cite this version:**

Claire Guyot, Jean-Paul Barnes, Olivier Renault, Denis Mariolle, Tony Maindron. Correlative TOF-SIMS & XPS for the analysis of dopants for organic light-emitting diodes layers. SIMS-24 - 24th International Conference on Secondary Ion Mass Spectrometry, Sep 2024, La Rochelle, France. cea-04653870

HAL Id: cea-04653870

<https://cea.hal.science/cea-04653870v1>

Submitted on 19 Jul 2024

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Correlative TOF-SIMS & XPS for the Analysis of Dopants for Organic Light-Emitting Diodes Layers

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Organic light-emitting diodes (OLEDs) are widely used for display and lighting applications yet improvements need to be made in device lifetime, efficiency and luminance to address new applications. To facilitate these developments, there is a need to study the impact of new molecules and dopants [1]. The use of Ag to replace Cs as a dopant was recently demonstrated [2, 3] in 2019 and should be more air-stable. Here we study Ag doped BPhen (4,7-Diphenyl-1,10-phenanthroline) and Ca doped BPhen in a set of test samples where the BPhen layer is sandwiched between two electrodes. We used a correlative protocol to combine TOF-SIMS and XPS measurements on exactly the same sample area [4]. TOF-SIMS tandem mass spectrometry was performed on the Ag doped BPhen layer to confirm the formation of a Ag-BPhen complex. XPS C 1s and N 1s spectra acquired from the same layers show a 0.6 eV peak shift to higher binding energy that is consistent with an n-type doping for both Ag and Ca doped films in comparison to the undoped BPhen film.

To assess the stability in air, both films were depth profiled after different air exposure times. For Ca doped films the silicon interface width increases rapidly. After 30 minutes the film has an RMS roughness of 1.25 nm which is over four times that of the Ag doped film after the same air exposure time. This roughening is attributed to crystallization of the Ca-doped BPhen film. Backscattered Argon clusters was also used to analyze layers as a function of air exposure [5, 6]. These results confirm improved stability of Ag-doped vs Ca doped films. This work, carried out on the Platform for Nanocharacterisation (PFNC), was supported by the “Recherche Technologique de Base” and “France 2030 - ANR-22-PEEL-0014” programs of the French National Research Agency (ANR)

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