High-Resolution Core-Level Photoemission Study of the Mg:Ag/Tris(8-hydroxyquinolato) Aluminum Interface

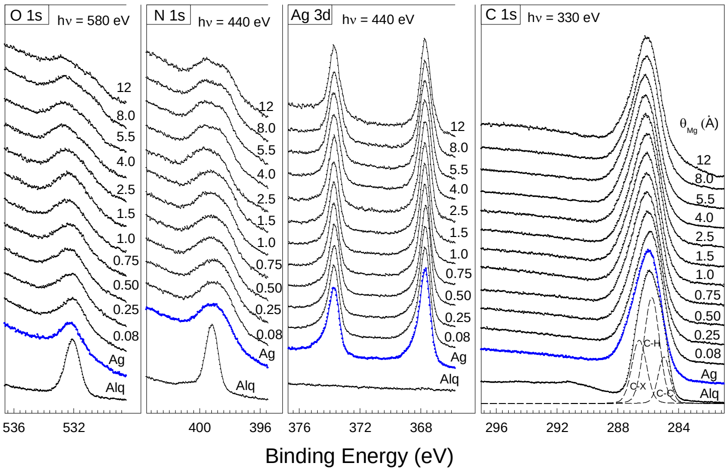
Tun-Wen Pi (皮敦文)[1], Hsin-Han Lee (李欣翰)[2],
Shiao-Shuan Lin (林孝軒)[2], and Jenn-Chang Hwang (黃振昌)[2]

[1]National Synchrotron Radiation Research Center, Hsinchu, Taiwan
[2]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan

The figure below displays O 1s, N 1s, Ag 3d and C 1s core-level spectra, taken with photon energies of 580, 440, 440 and 330 eV, respectively, in normal emission for the clean Alq$_3$ surface covered first with 2 Å Ag, followed by a sequential deposition of various Mg thicknesses. Kinetic energies of electrons ejected by these photons fall between 20 to 50 eV, thereby giving rise to a 3 - 5 Å inelastic mean-free-path. High surface sensitivity of the presented spectra is thus emphasized. Nevertheless, the photon energy for taking the Ag 3d core level spectra is a bit high so as to reduce the high rising background at small kinetic energies. The bottommost curve in each panel of Fig. 2 reveals the pristine Alq$_3$ film prior to incorporation of foreign atoms. Analysis of these line shapes can be found in detail elsewhere,[11] and we briefly mention the results here. For the O 1s and N 1s core levels, each shows a single peak at binding energies of 532.10 (O) and 399.40 (N) eV, reflecting only one bonding configuration for these atoms. For the C 1s core level three components are extracted, which originate from three different bonding environments for carbon in the structure of the 8-quinolinol ligand; that is, a bridged carbon connected to only other carbons (the C-C bond), an outer carbon that bonds to both carbon and hydrogen (the C-H bond), and an inner carbon attached to nitrogen or oxygen (the C-X bond). The binding energies of the three components are 285.05, 285.90 and 286.77 eV for the C-C, C-H and C-X components, respectively. All these core level spectra are manifests of loss structures marked as *, the absence of which (on atoms' adsorption) suggests their strong surface origin.

Right above the bottommost curves are the spectra with deposition of about 2 Å Ag. As is discernable in these curves, the silver deposit has caused changes in the line shapes of all the 1s cores so that new components develop on the low binding energy side of the original components. This is rather peculiar, since it is commonly understood in the study of core-level spectra of Alq$_3$ that an induced component that lies above the original component is cased by a charge donation from the deposited atoms. Applying this model to the present Ag/Alq$_3$ interface, we could then say that the deposited Ag has donated charge to the Alq$_3$ molecules.

Upon Mg deposition, development of the 1s cores reveal a few differences from those shown in the case of the Mg/Alq$_3$ interface where silver is absent at the surface. For O 1s, the induced component continues to gain strength in the low-energy position, while for the Mg/Alq$_3$ interface the induced component develops at a high-energy position. With regard to the N 1s core, the line shape remains virtually unchanged, in contrast to that in Mg/Alq$_3$ where the induced component increases in intensity with increasing Mg coverage. With regard to the C 1s core-level spectra, a line narrowing is clearly seen, which is mainly due to an intensity reduction of the C-X component. On the contrary, the C 1s counterpart in the Mg/Alq$_3$ interface exhibited little change with various Mg depositions.



The O 1s, N 1s, Ag 3d, and C 1s core-level spectra of Mg deposited on 2 Å Ag on an Alq$_3$ film. The mark * in (C) stands for the π→π* transitions.