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Assignment of the Unoccupied States and Quantitative Electronic Charge Transfer in the Cs-on-Alq_3 Interfaces by NEXAFS Analyses

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Top-emitting organic light-emitting diode (TEOLED) has generated considerable interest in recent years, owing to their use in the active matrix displays. Significant research trend has been concentrated on the development of thin semitransparent cathodes (STCC). To understand a quantitative effect for electron injection from cathode to an electron-transporting layer (ETL), the NEXAFS spectra at the C, O, and N K-edges were analyzed. In the Cs-on-bis(8-quinolinolato)aluminum (III) (Alq_3) interfaces, an electronic charge transfer was largely increased with increasing Cs coverage on Alq_3. This is attributed to the reduction of the barrier height for an electron injection induced by an electron of Cs with low work function (2.1 eV). In the OLEDs, Alq_3 is generally used as an ETL and Cs is the adjoining cathode layer adjacent to Alq_3. Meanwhile, the energy levels of π^* unoccupied states in atom-reserved NEXAFS spectra of each interface were assigned to LUMO, LUMO+1, LUMO+2, and LUMO+3, respectively. As Cs coverage was increased, electronic charge transfer in the NEXAFS spectra at C K-edge was slightly excited to more high energy level of LUMO+2 and LUMO+3. However, the transition to LUMO and LUMO+1 levels was reduced somewhat. Electronic charge transfer at O K-edge was little by little increased to LUMO and LUMO+2 with increasing Cs coverage on Alq_3, when compared to charge transfer to σ^* unoccupied states. Electronic charge transfer at N K-edge to LUMO, LUMO+2 and LUMO+3 was a little increased, compared to σ^* unoccupied states. Electronic charge transfer to the different energy level at C, O, and N atoms composing Alq3 means both the different contribution by an electron providing Cs and various chemical reaction. In the angle-reserved NEXAFS spectra, when the incident angle was changed to 20, 45, and 90 degree, the intensity of the NEXAFS spectra is not sensitive about the incident angle.