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Doping Induced Energy Level Shift in Organic Semiconductors
HUANJUN DING, University of Rochester, KATE GREEN, University of Michigan (REU student), YONGLI GAO, University of Rochester — Using photoemission and inverse photoemission spectroscopy (UPS, XPS and IPES), we investigated the electronic structure of alkali metal (Cs and Na) doped copper phthalocyanine (CuPc) and tris(8-hydroxyquinoline) aluminum (Alq) films. We found that doping induces energy level shift, which can be seen as in two different stages. The first stage is predominantly due to the Fermi level moving in the energy gap as a result of the doping of electrons from the alkaline metal to the organic, and the second stage is characterized by the significant modification of organic energy levels such as the introduction of a new gap state and new core level components. In addition, we observed that the energy level shift in the first stage depended in a semi-logarithmic fashion on the doping concentration, whose slope could not be explained by the conventional model used in inorganic semiconductors. Furthermore, we also observed a reversal shift by depositing Au on alkali metal doped Alq film. The initial Au deposition quenches the Alq gap state, as well as the new component in N 1s core level, caused by the alkali metal doping. Further Au depositions shift gradually the energy levels opposite to that induced by doping. The results indicate that the gap state and energy level positions can be decoupled in the organic semiconductors, and that it's possible to fine tune the electronic structure by selective doping in the interface region.

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