Synthesis, characterization and electrical properties of indigoids for organic semiconductor applications

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Date of Award:
2016

ABSTRACT

Two new series of organic soluble indigoids 7-7’-dialkoxyindigoids (**4a, 4b**) and 4,4’-dibromo-7,7’-dialkoxyindigoids (**5a, 5b**) (alkoxy = *n*-butoxy and *n*-octyloxy) have been synthesized starting from the inexpensive 3-hydroxybenzaldehyde for OFET applications. The indigoids were soluble in common organic solvents such as chloroform, dichloromethane, toluene, ethyl acetate and ethers. The enhanced solubility was suggested to be a lack of intermolecular hydrogen-bonds as confirmed by single crystal X-ray diffraction analyses. It was found that intramolecular hydrogen-bonds in indigoids were crucial to the exhibition of field-effect in OFETs, while intermolecular hydrogen-bonds only caused insolubility of the indigoids. Compared to the pristine insoluble indigo (LUMO = -3.55 eV and E_g = 1.91 eV), the soluble indigoids containing electron donating alkoxy side chains at the indigoid 7 and 7’ positions were shown to have LUMO decreased by -0.13 to -0.26 eV as well as a lower bandgap energy from E_g = 1.66 to 1.94 eV. A bottom-gate-top-contact OFET employing polystyrene as the dielectric layer was used to demonstrate the field-effect properties. The indigoid 4,4’-dibromo-7,7’-dioctyloxyindigoid (**5b**) was found to exhibit the highest electron mobility at 2.20 × 10^{-5} $cm^2V^{-1}s^{-1}$. In addition, 4,4’-dibromo-7,7’-dioctyloxyindigoids (**5**) can be further derivatized by organometallic catalyzed aryl-aryl coupling reactions to create functional organic electronic materials.

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