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Chemical Sensing Properties of Self-Assembled Film Based on an Amphiphilic Ambipolar Triple-Decker (Phthalocyaninato) (Porphyrinato) Europium Semiconductor

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Abstract : An amphiphilic mixed (phthalocyaninato) (porphyrinato) europium triple-decker complex $Eu_2(Pc)_2(TPyP)$ has been synthesized and characterized. Introducing electron-withdrawing pyridyl substituents onto the meso-position of porphyrin ring in the triple-decker to ensure the sufficient hydrophilicity and suitable HOMO and LUMO energy levels and thus successfully realize amphiphilic ambipolar organic semiconductor. Importantly, high sensitive, reproducible p-type and n-type responses towards NH_3 andNO_2 respectively, based on the self-assembled film of the $Eu_2(Pc)_2(TPyP)$ fabricated by a simple solution-based Quasi–Langmuir–Shäfer (QLS) method, have been first revealed. The good conductivity and crystallinity for the QLS film of $Eu_2(Pc)_2(TPyP)$ render it excellent sensing property. This complex is sensitive to both electron-donating NH_3 gas in 5–30 ppm range and electron-accepting NO_2 gas 400–900 ppb range. Due to uniform nano particles there exist effective intermolecular interaction between triple decker molecules. This is the best result of Phthalocyanine–based chemical sensors at room temperature. Furthermore, the responses of the QLS film are all linearly correlated to both NH_3 and NO_2 with excellent sensitivity of 0.04% ppm^{-1} and 31.9 % ppm^{-1}, respectively, indicating the great potential of semiconducting tetrapyrrole rare earth triple-decker compounds in the field of chemical sensors.

Keywords : ambipolar semiconductor, gas sensing, mixed (phthalocyaninato) (porphyrinato) rare earth complex, Self-assemblies
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