Conductivity of Doped Polypyrrole Films Synthesized by Electropolymerization

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Rare earth metals are useful in a wide range of electronic devices, but mining and purification are becoming more expensive and lead to wide-scale contamination. The synthesis of alternative materials for organic electronics rely on heavy metal catalysts, which can be highly toxic to the environment. Electropolymerization provides a green pathway for metal-free organic conductive polymer films. This investigation aims to maximize the conductivity of polypyrrole (Ppy). Electropolymerization of pyrrole into Ppy was done with various anionic, cationic, and inorganic dopants. The conductivities of these films were measured using a modified four-point conductivity circuit from Seng et al., J. Chem. Educ, 2014, 91, 1971-5. The experiments revealed several design criteria for dopants that maximize Ppy conductivity. Anionic dopants with sulfonate/sulfate vs. carboxylate groups, and longer alkyl chains, created more conductive films. Moreover, presence of reducing agents (e.g.: iodide ions, ascorbate ions, etc.) have been observed to interfere with electropolymerization. Films with darker colors were generally more conductive than those with lighter colors. “World demand for rare earth elements was estimated at 136,000 tons per year, with global production around 133,600 tons” (Humphries, 2013), and the disparity between demand and supply grows annually. With the rocketing expansion of electronic technology, an environmentally-friendly alternative that can be readily produced from safer, cheaper resources is more necessary than ever. These results may lead to designing new dopant molecules that exhibit added functionalities, and clarify how organic conductive polymers work for optimization in practical applications.

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