Archetype Cationic Iridium Complexes and Their Use in Solid-State Light-Emitting Electrochemical Cells

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The archetype ionic transition-metal complexes (iTMCs) [Ir(ppy)2(bpy)][PF6] and [Ir(ppy)2(phen)][PF6], where Hppy = 2-phenylpyridine, bpy = 2,2'-bipyridine, and phen = 1,10-phenanthroline, are used as the primary active components in light-emitting electrochemical cells (LECs). Solution and solid-state photophysical properties are reported for both complexes and are interpreted with the help of density functional theory calculations. LEC devices based on these archetype complexes exhibit long turn-on times (70 and 160 h, respectively) and low external quantum efficiencies (2%) when the complex is used as a pure film. The long turn-on times are attributed to the low mobility of the counterions. The performance of the devices dramatically improves when small amounts of ionic liquids (ILs) are added to the Ir-iTMC: the turn-on time improves drastically (from hours to minutes) and the device current and power efficiency increase by almost one order of magnitude. However, the improvement of the turn-on time is unfortunately accompanied by a decrease in the stability of the device from 700 h to a few hours. After a careful study of the Ir-iTMC:IL molar ratios, an optimum between turn-on time and stability is found at a ratio of 4:1. The performance of the optimized devices using these rather simple complexes is among the best reported to date. This holds great promise for devices that use specially-designed iTMCs and demonstrates the prospect for LECs as low-cost light sources.
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