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Synthesis and Physico-Chemical Studies of Ambipolar Heterotruxenes as Potential Materials for Organic Electronics

This thesis presents the development and synthesis of new materials based on the truxene core, a star-shaped polycyclic aromatic hydrocarbon, to be used in organic electronics, in particular organic light-emitting diodes (OLEDs). Initial testing was performed on a simpler fluorene structure by obtaining a new diphenylphosphine oxide spirofluorenexanthene as a coligand for europium (III) complexes. The resulting complexes were characterized by spectroscopic methods (absorption, emission and phosphorescence spectra were recorded, luminescence lifetimes were measured and luminescence quantum yields were determined in solution and thin-film) and perspective compounds were tested in OLED devices processed from solution. Manufactured devices demonstrated high performance and were emitting pure red light (according to the standard NTSC).

The studied truxene compounds are divided into two categories: symmetric (C_3) truxenes and triazatruxenes and unsymmetrical truxenes and monothiatruxenes. Modification of the symmetrical truxene core gave a new trispiroxanthenetruxene which was characterized by spectroscopic methods but due to the low solubility and luminescence quantum yield it was not possible to use this material in the devices. Triazatruxenes were substituted with three pyridine rings and tested for the possibility of obtaining platinum and iridium complexes. Unsymmetrical carbon truxenes have been synthesized by a new method of cross-condensation dimer of indanone with 1,3-indandione. The resulting material and its derivatives were characterized by spectroscopic methods. Asymmetrical monoheterotruxene was synthesized by stepwise substitution of 1,3,5-tris(2-bromophenyl)benzene and then subjected to modification in order to obtain the donor-acceptor structure which was used in OLED devices as thermally activated delayed fluorescence (TADF) emissive material. Obtained devices showed high performance, with light-blue and blue-green light emission. Even though, the fabrication method was simple and inexpensive spin-coating methodology.

Key words: Organic electronics, truxenes, heterotruxenes, OLEDs, TADF.