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Spectral and photophysical characterization of donor π -acceptor arylthienyl- and bithienyl-benzothiazole derivatives in solution and solid state

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Abstract

A comprehensive study has been made in solution at room temperature (293 K), low temperature (77 K) and in thin films (Zeonex matrixes) of the spectral and photophysical properties of six arylthienyl and bithienyl-benzothiazole derivatives functionalized with different donor groups. Similar experiments have been carried out with two related precursors (containing the arylthienyl and aryl-bithienyl conjugated systems), and results are compared. Singlet-singlet and triplet-triplet absorption spectra, emission spectra together with lifetimes and quantum yields have been obtained, and from these data for all the radiative and non-radiative processes determined, providing information on the dominant radiative and radiationless decay processes. The arylthienyl-benzothiazole derivatives show high fluorescence quantum yields (ϕ_F) with negligible internal conversion (ϕ_{IC}), whereas the bithienyl-benzothiazoles display lower but still significant ϕ_F values, but now radiationless processes (ϕ_{IC} and ϕ_{ISC}) are competitive. The experimental results obtained for the bithienyl-benzothiazole derivatives strongly suggest that, these fluorophores could be used on the design of more efficient OLEDs since it minimises internal conversion, and significantly reduces triplet state formation. A comparison with the analogous oligothiophenes is made. Singlet oxygen yields were also determined and the triplet energy transfer to $^3O_2$ to produce $^1O_2$ was found to be highly efficient with values of $S_\Delta (=\phi_\Delta/\phi_T)$ varying from 0.4-1.