

New ambipolar 1,8-naphthalimide derivatives exhibiting aggregation enhanced emission phenomenon: photophysical and photoelectrical studies

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Organic materials with a tetraphenylethene (TPE) moiety are widely applied in an array of fields ranging from biosensing to optoelectronic systems as they are characterized by strong photoluminescence in solid state comparing to that observed for solutions [1]. Emitters with aggregation enhanced emission (AEE) phenomenon are used for the fabrications of organic light emitting diodes (OLEDs) since their emission is enhanced in the solid state [1]. In addition to high photoluminescence quantum yield (PLQY) in the solid state, emitters for OLEDs should have possibility to transport charges so effectively that holes and electrons recombine emitting light after reaching the emitting layer [2]. Donor and acceptor moieties can be combined in one molecule to get both high efficient photoluminescence and ambipolar transport of organic emitters in solid-state for OLEDs.

With the aim to develop efficient emitters for OLEDs, we have studied the photo- and electro-physical properties of three new TPE substituted 1,8-naphthalimide derivatives with the TPE as a donor and 1,8-naphthalimide as an acceptor. These compounds were found to be capable of transporting both holes and electrons. Ionization potentials of the solid samples of the compounds were estimated by electron photoemission spectroscopy, which gave values in the range from 5.76 eV to 5.9 eV.

For the estimation of AEE activity of the new compounds the fluorescent behavior of their dilute dispersions in the mixture of THF and water with the different water fractions were studied. The emission of the THF solutions of the studied derivatives was weak, however, an enhancement in luminescence intensity was observed with the increase of the concentration of water. Since the studied derivatives are insoluble in water, the increase of the water fraction in the mixture of solvents leads to the reduction of the number of the dissolved molecules of the compounds. The emission of the 50:50 (v/v) water/THF mixture of the derivatives was extremely low. The enhancement of luminescence intensity was observed with the further increase of water fractions. In addition, the intensity maxima of PL spectra (λ_{\max}) were shifted to the red region. For example, for one of the studied compounds λ_{\max} was observed at 522 nm for the 10:90 water/THF mixture while λ_{\max} at 630 nm was recorded for the 90:10 water/THF mixture. These observations allow to conclude that the studied donor-acceptor molecules are characterized by two AEE emissive centers which emit light in the different regions of the visible spectra and the shifts of PL of the molecules occurred due to strong intramolecular charge transfer (ICT) between the AEE emissive centers.

Y. Shtokaylo acknowledges the financial support from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7/2007-2013 under REA grant agreement no. 612670.

References

- (1) Mei, J.; Leung, N.L.C.; Kwok, R.T.K.; Lam, J.W.Y.; Tang, B.Z. *Chem. Rev.*, **2015**, *115*, 11718.
- (2) Bučinskis, A.; Volyniuk, D.; Danyliv, Y.; Grazulevicius, J.V.; Baryshnikov, G.; Minaev, B.; Ivaniuk, K.; Cherpak, V.; Stakhira, P. *RSC Advances*, **2015**, *5*, 78150.