

Exciton Quenching of Thermally Activated Delayed Fluorescence Molecules

OPERA Kyushu Univ., JST ERATO, °Atula S. D. Sandanayaka, T. Matsushima, and C. Adachi

E-mail: adachi@cstf.kyushu-u.ac.jp

Thermally activated delayed fluorescence (TADF) materials have emerged as next–generation electroluminescence materials.[1] Because chemical structures of the TADF materials are designed to show a very small energy gap between singlet and triplet excited states, efficient reverse intersystem crossing from the singlet to triplet excited states is possible, resulting in that not only singlet excitons but also triplet excitons are converted into photons.[1] However, one of the crucial drawback is the presence of strong efficiency roll–off commonly observed in the TADF based OLEDs,[2] probably because a TADF component having a long exciton lifetime is easily affected by the other excitons and carriers.

In this works, we studied exciton quenching behavior of TADF molecules of (4s,6s)–2,4,5,6–tetra(9H–carbazol–9–yl)isophthalonitrile (4CzIPN) under a hole or electron current using a time–resolved transient photoluminescence (PL) technique. Since both holes and electrons are injected in OLEDs, it is difficult to investigate which holes or electrons more strongly induce exciton quenching. Therefore, we fabricate the hole–only and electron–only devices (HOD and EOD, Fig. 1a, b) to simplify the discussion on the exciton quenching characteristics.

Results of the analysis of the prompt PL components under a hole or electron current flow reveals that electrons do not quench the excitons at all (Fig. 1d) but holes significantly quench the excitons (Fig. 1c). The rate constant of the hole-induced exciton quenching is calculated to be on the order of 10^{-11}–10^{-12} cm^3 s^{-1} from the rate equation analysis. We also find interesting photophysical properties that the TADF components are enhanced in the presence of holes, probably because of a reduction of a singlet–exciton energy level.

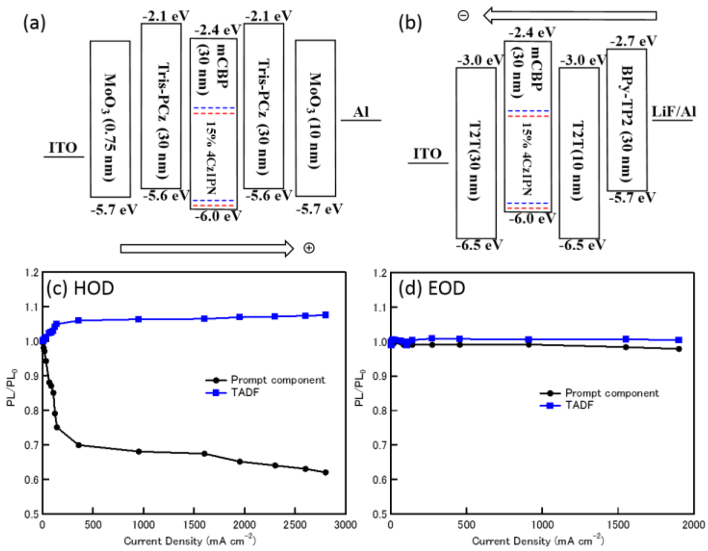

Fig 1. Energy–level diagrams of (a) HOD and (b) EOD. and plots of PL/PL$_0$ of prompt and TADF components vs current density of (c) HOD and (d) EOD.

1. Uoyama, H.; Goushi, K.; Shizu, K.; Nomura, H.; Adachi, C. *Nature*, 2012, *492*, 234–238.
2. Zhang, Q.; Li, J.; Shizu, K.; Huang, S.; Hirata, S.; Miyazaki, H.; Adachi, C. *J. Am. Chem. Soc.* 2012, *134*, 14706–14709.

