Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplementary Information

Device Parameter to Evaluate Exciton Energy Transfer in Organic Whispering-Gallery-Mode Microresonators and its Dependence on the Amplified Spontaneous Emission Threshold

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Photoluminescence spectra of the 1 wt%-C545T:BSB-Cz doped film

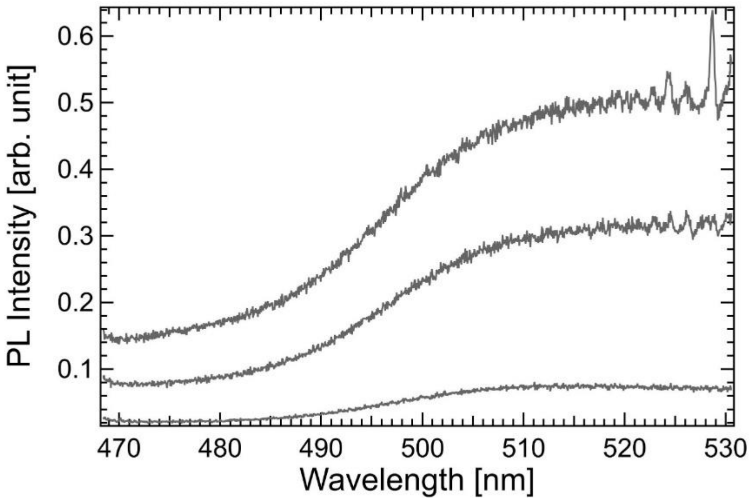

Figure S1. Dependence of photoluminescence spectra on the excitation intensity I_{ex} [(upper) $I_{ex} = 8.0\ \mu J\ mm^{-2}$, (middle) $I_{ex} = 1.6\ \mu J\ mm^{-2}$, (lower) $I_{ex} = 0.1\ \mu J\ mm^{-2}$].

The dependence of simulated electric fields on *d*t

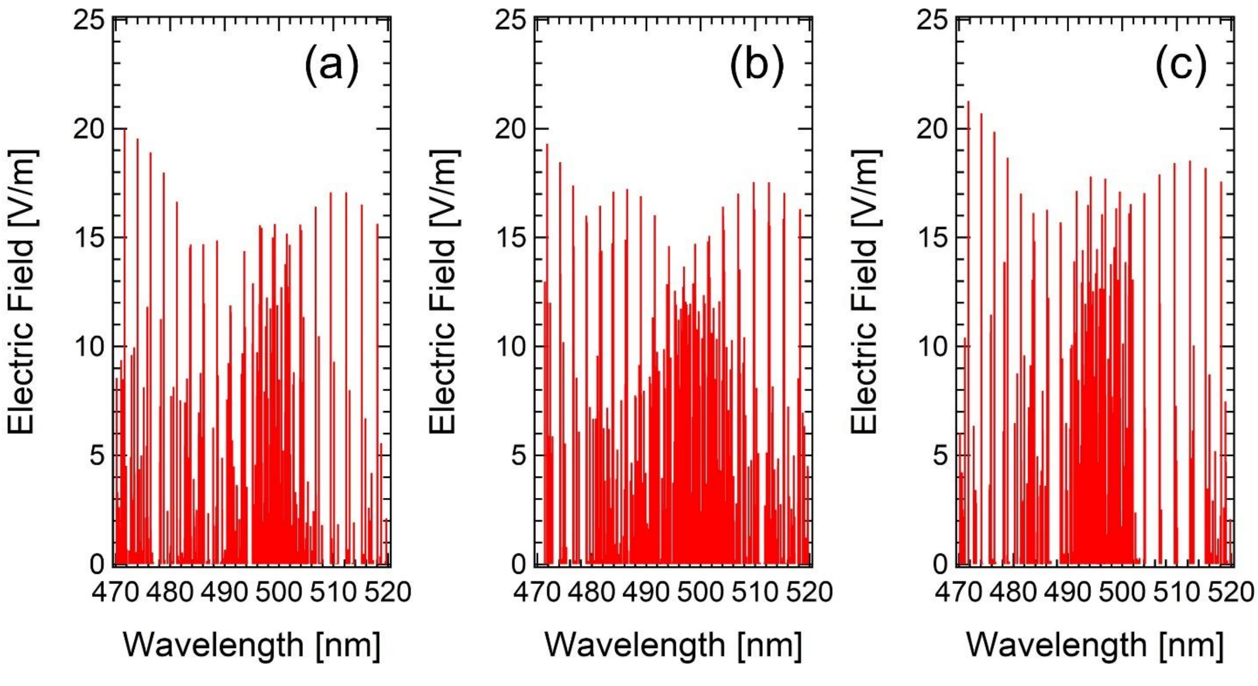

Figure S2. Simulated spectra of the electric fields horizontal to the substrates for (a) d_t = 124.5 nm, (b) d_t = 70 nm, and (c) d_t = 35 nm.

Photoluminescence spectra for d_u = 2 and 6 nm

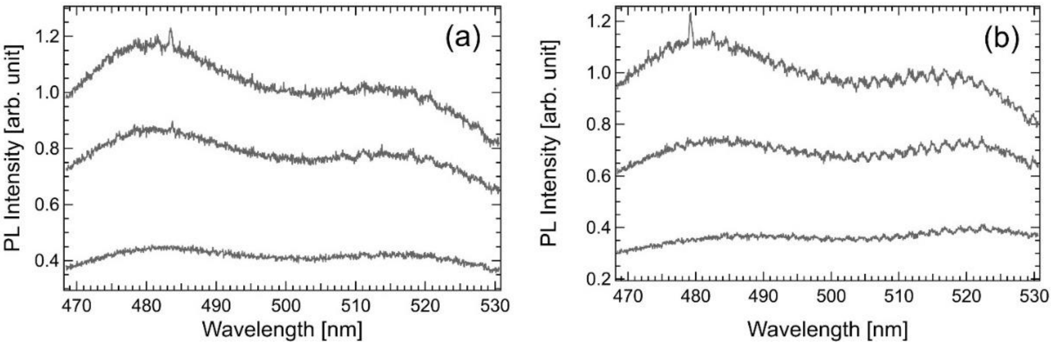

Figure S3. Dependence of the photoluminescence spectrum on the excitation intensity (I_{ex}) for (a) d_{C545T} = 6 nm [(top) $I_{ex} = 10\ \mu J\ mm^{-2}$, (middle) $I_{ex} = 4.1\ \mu J\ mm^{-2}$, (bottom) $I_{ex} = 0.8\ \mu J\ mm^{-2}$] and (b) d_{C545T} = 2 nm [(top) $I_{ex} = 24\ \mu J\ mm^{-2}$, (middle) $I_{ex} = 7.6\ \mu J\ mm^{-2}$, (top) $I_{ex} = 0.8\ \mu J\ mm^{-2}$].

Photoluminescence intensity versus excitation intensity characteristics

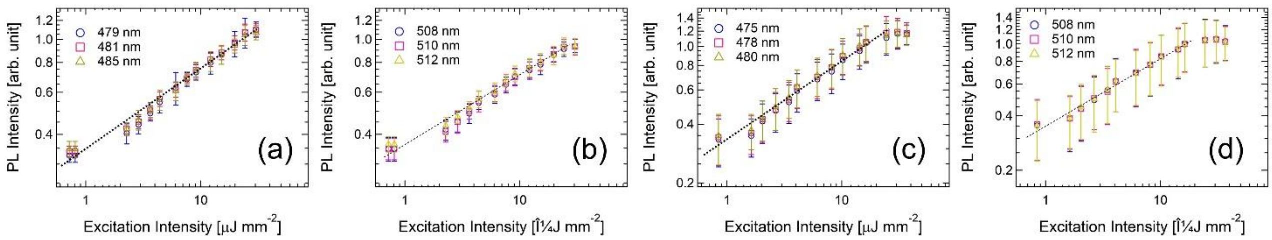

Figure S4. Photoluminescence intensity versus excitation intensity characteristics for (a) $d_{BSB\text{-}Cz}$ = 2 nm ($\lambda \sim$ 480 nm), (b) d_{C545T} = 2 nm ($\lambda \sim$ 510 nm), (c) $d_{BSB\text{-}Cz}$ = 6 nm ($\lambda \sim$ 480 nm), and (d) d_{C545T} = 6 nm ($\lambda \sim$ 510 nm).

Calculation of the rate constant of the Förster energy transfer. The rate constant of the Förster energy transfer or fluorescent resonance energy transfer (k_{FRET}) is given by $k_{FRET} = \frac{9000c^4 ln10}{128\pi^5 n^4 N_A \tau}\frac{k^2}{r^6}\int f\varepsilon\frac{dv}{v^4}$, where c is the velocity of light in vacuum, n is the refractive index, N_A is Avogadro's number, τ is the radiation lifetime of BSB-Cz, k^2 is the orientation factor (2/3), r is the distance between the C545T ground-state and BSB-Cz excited-state molecules, f is the shape function of the PL spectrum for BSB-Cz, ε is the molar extinction coefficient of C545T, and v is the frequency of light. Calculation of k_{FRET} in the layer-stacked structures is complex because the light absorption intensity depends on the position in the BSB-Cz layers (by extinction of the excitation light intensity in the medium). Thus, we defined the intensity of the Förster energy transfer I_{FRET} by

$I_{FRET}(t) = \sum I_T(d) \cdot R \exp(-k_{FRET}(d) \cdot t)$, where t is time, d is the distance between the surface of the BSB-Cz top layer and the arbitrary position inside the BSB-Cz top and bottom layers, I_T is the transmitted intensity of the excitation light, which was obtained by considering the extinction coefficient of the BSB-Cz thin film, and R is the probability that BSB-Cz absorbs the excitation light at the arbitrary position. In the actual calculation, we used the simplified equation $I'_{FRET}(t) = \frac{I_{FRET}(t)}{I_0 \cdot R} = \sum \frac{I_T(d)}{I_0} \exp(-k_{FRET}(d) \cdot t)$ to obtain the dimensionless value $I'_{FRET}(t)$, where I_0 is the excitation intensity (the value was arbitrarily defined). The step of d for the calculation was set to 1 nm. In the calculation of $I'_{FRET}(t)$, r is considered to be the distance between the arbitrary position and the nearest BSB-Cz/C545T interface. The thicknesses of the C545T layers are ignored because they are sufficiently thin with respect to the total thickness. The $I'_{FRET}(t) - t$ characteristics showed multiexponential decay. We consider that the lifetime of the Förster energy transfer is the time that the $I'_{FRET}(t)$ value becomes $1/e$ of the initial value [$I'_{FRET}(0)$], and that k_{FRET} is the inverse of the lifetime.