小さなΔE_{ST}を有する有機レーザー色素ーホスト材料選択の拡大ー

Novel lasing dye having small ΔE_{ST} easing the selection of host materials

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Quenching of singlets by long lifetime triplets is a serious issue for lasing from organic dyes, especially under long excitation duration[1]. To remove unnecessary triplets, organic laser dyes are often dispersed into a film of a host material having a rather large singlet-triplet energy gap (ΔE_{ST}) such as anthracene derivatives. However, finding such host materials are limited and another materials combination has been anticipated. In this study, we developed a novel laser dye of 2,6-dicyano-1,1-diphenyl-λ⁵σ⁴-phosphinine (DCNP)[2] having a small ΔE_{ST} on the basis of the concept of thermally activated delayed fluorescence-based materials. Since the ΔE_{ST} of DCNP is as small as 0.44 eV, we can employ 4-4′-bis[(*N*-carbazole)styryl]biphenyl (BSBCz) as a triplet quenching host, i.e., the triplets formed on DCNP are easily transferred to BSBCz as shown in Fig. 1a.

A 1 wt.%-DCNP-doped BSBCz film [photoluminescence quantum yield (PLQY) = 83 %], which was formed on a mixed-order distributed feedback grating, showed lasing with a low threshold value of 0.86 μJ cm^{-2} and a FWHM value of 0.5 nm (Fig. 1b). Because of suppressed singlet quenching in this system, we were able to operate it under true-continuous-wave operation (Fig. 1c), with a half-life of 2–3 min at a 3.6 kW cm^{-2} excitation power. This result would provide an alternative host-guest strategy of fabricating higher-performing laser devices.

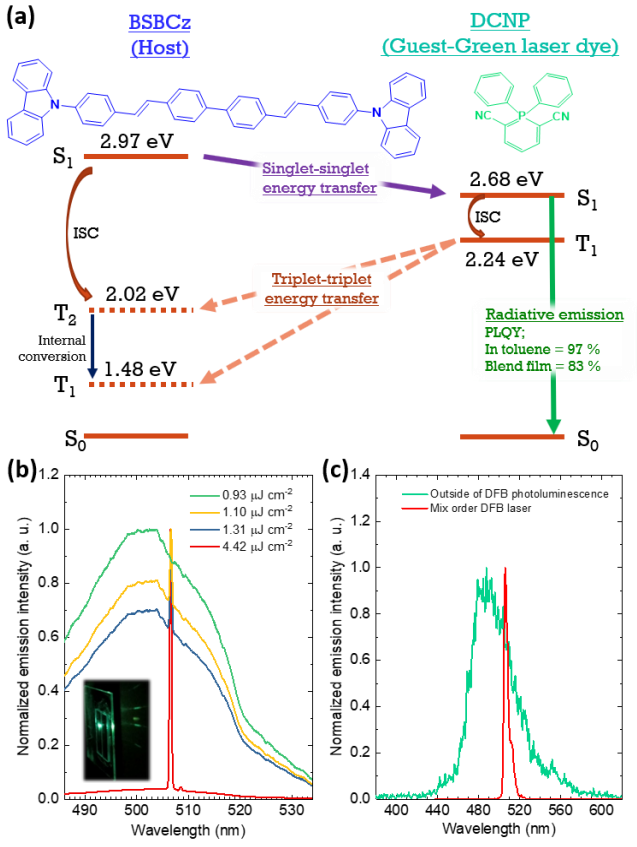

Figure 1: (a) Excited state energies of DCNP and BSBCz. Laser properties of a DCNP-doped BSBCz DFB laser device under optical (b) pulse or (c) continuous-wave excitation.

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