

## Spray fabrication approach for the uniform solid film for triplet-triplet annihilation upconversion

IFMRI, AIST<sup>1</sup>, ESPRIT, AIST<sup>2</sup>, °(PC)Aizitiaili Abulikemu<sup>1</sup>, Toshiko Mizokuro<sup>2</sup>, Kenji Kamada<sup>1</sup>



E-mail: k.kamada@aist.go.jp

### 1. Introduction

Triplet-triplet annihilation upconversion (TTA-UC) is a photophysical process of that converts two low-energy photons into one higher energy photon at the excitation intensity as low as sunlight. The solution casting method with quick evaporation of solvent allows to fabricate binary crystalline solid showing TTA-UC with the quantum yield (QY) of 10% or more [1]. However, it is difficult to obtain a uniform film by using the casting method. To overcome this problem and realize a cm scale film suitable for device applications, we apply solution spraying technique to fabricate the solid film for TTA-UC because this technique can offer quick evaporation of solvent leading better dispersion of the sensitizer.

### 2. Results and discussion

The mixed solution of the triplet sensitizer (Pt-octaethylporphyrin, PtOEP, Fig. 1a) and the emitter (9, 10-diphenylanthracene, DPA) in tetrahydrofuran with molar ratio around PtOEP : DPA=1 : 1000 was employed for spraying. We have tested different spray conditions (Fig. 1b) and found that the combination of 30-s spraying and 10-min drying in several cycles are suitable for a uniform film. By using this procedure, a uniform film (thickness of  $3.8 \pm 0.3 \mu\text{m}$ ) of the PtOEP:DPA binary solid over nearly whole area of a slide glass (64 mm×26 mm) was successfully fabricated (Fig. 1c).

The fabricated film showed the blue upconverted emission peaked at 442 nm (Fig. 1d) by 532-nm CW laser excitation ( $\sim 3 \text{ W/cm}^2$ ). The emission spectrum showed that the considerable intensities of the phosphorescence of PtOEP (at 648 nm) and the unknown yellow band (at 565 nm) also appeared. The UC-QY of the film was investigated more than 100 positions on the film under a microscope and

found to be  $\sim 0.2\%$  in air. This value is one order of magnitude smaller than those by the casting method [1] and may be affected by the deactivation processes through the phosphorescence and yellow emission. The further control of these processes is the key for the improvement. The detailed discussion of fabrication method and UC-QY measurement will be made on presentation.

### Reference

[1] K. Kamada, Y. Sakagami, T. Mizokuro, Y. Fujiwara, K. Kobayashi, K. Narushima, S. Hirata, M. Vacha, *Mater. Horiz.* **2017**, 4, 83.

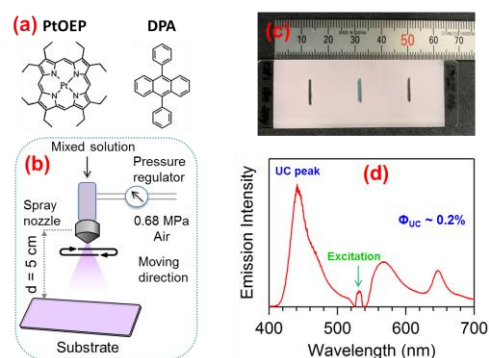


Fig. 1. (a) Chemical structures. (b) Spraying apparatus. (c) Appearance of the solid film fabricated by 4 cycles. (d) Emission spectra of the solid film.