

Whispering Gallery Mode Lasing from π -Conjugated Polymer Microspheres Coordinated with Europium Complex

Zakarias, S. Ngara^{1,2}, Daichi Okada, Oki Osamu, Yohei Yamamoto¹

¹ Division of Materials Sciences, Faculty of Pure and Applied Science, Tsukuba University, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8573

² Department of Physics, Faculty of Science and Engineering, Nusa Cendana University, Indonesia

Email : s-zakarias@ims.tsukuba.ac.jp

Introduction

By coupling with whispering gallery mode (WGM), photoluminescence (PL) exhibits sharp and periodic emission lines in their PL spectrum. We recently reported that several conjugated polymer microspheres show WGM PL upon irradiation to focused laser beam onto a single sphere. In order to amplify the WGM PL to obtain laser oscillation, here we utilize europium (Eu) complex, which originally show sharp photoluminescence spectrum. Self-assembly of π -conjugated polymer with metal-coordination properties, we obtain microsphere, which efficiently contains Eu complex. Upon laser irradiation, intrasphere energy transfer takes place from polymer to Eu, and the emission at the red color region is strongly enhanced to show lasing properties.

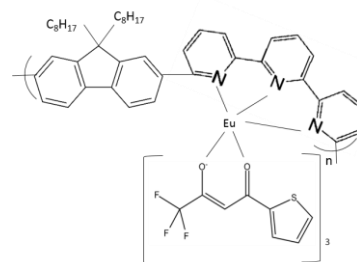


Figure 1 F8tpy coordinated to Eu^{3+} ion

Results and discussion

We use poly[(9,9'-dioctyl-9H-fluorene-2,7-yl)-5,5'-(2,2':6',2''-terpyridine) (F8tpy) and Europium (III) thenoyltrifluoroacetate ($\text{Eu}(\text{tta})_3$) as coordination conjugated polymer and metal complex (Fig. 1a). By self-assembly of F8tpy and its complex with Eu metal ion, we obtain well-defined microspheres with the diameters ranging from 2 to 9 μm , which are suitable for light confinement and coupling with WGM (Fig. 2a and b). The microsphere of F8tpy shows blue color PL (Fig. 2c), while those with F8tpy coordinated with Eu^{3+} ion, F8tpy- $\text{Eu}(\text{tta})_3$, display red-colored PL (Fig. 2d).

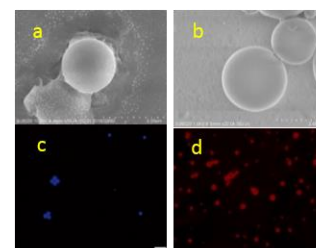


Figure 2 Microsphere of (a) F8tpy, (b) F8tpy- $\text{Eu}(\text{tta})_3$, (c,d) FL Mic. image

The difference of the PL color indicates that energy transfer takes place from F8tpy to Eu^{3+} ion. Figure 3 shows PL spectrum of the microsphere of F8tpy with excitation wavelength at 355 nm, where WGM PL appears at the wide spectral range from 420 to 680 nm. The microsphere from F8tpy- $\text{Eu}(\text{tta})_3$ shows sharp PL only at 620–630 nm range (Fig. 4), which is characteristic of PL from Eu^{3+} ion, indicating that energy transfer taken place from F8tpy to Eu^{3+} ion. As shown in Fig. 4, the peak width of the WGM peak is from 1.95 to 3 nm, with the highest quality factor (Q) of 320. As displayed in Fig. 5, PL peaks from F8tpy- $\text{Eu}(\text{tta})_3$ microsphere has clear threshold, indicating that this PL is laser emission. The lasing threshold is about 0.065 nJ. These results will pave the way to the developing microlaser and photonic devices with high performances.

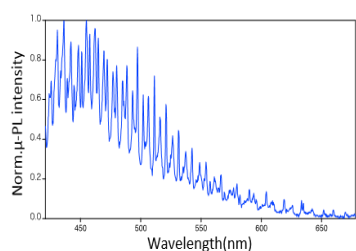


Figure 3 WGM spectrum of F8tpy

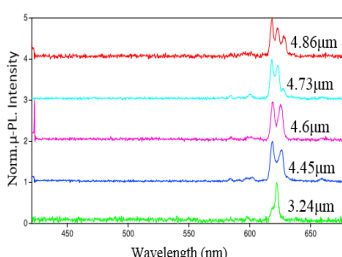


Figure 4 WGM spectra of F8tpy- $\text{Eu}(\text{tta})_3$

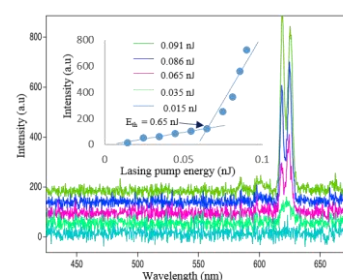


Figure 5 WGM spectra of F8tpy- $\text{Eu}(\text{tta})_3$ under different laser pump energy

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