Fluorescence Microspectroscopic Analysis of Aggregation-Induced Emission Enhancement by Optical Trapping

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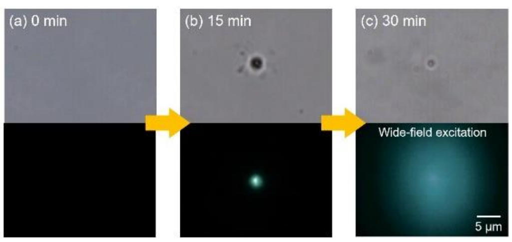
Optical trapping has been utilized as a powerful method for the manipulation of nano/micrometer-sized objects. Our group has extended this optical trapping method to generate assembling and crystallization of various molecules. Most recently, we succeeded in demonstrating aggregation-induced emission enhancement (AIEE) of a tetraphenylethene (TPE) derivative using this method and controlling its AIEE phenomenon arbitrarily by tuning laser power. In this work, we extend the method to a polymer appended by TPE and investigate the temporal change in fluorescence upon its aggregation.

Polydimethylaminoethylacrytlate (PDMAEA) containing a TPE derivative unit was dissolved in phosphate D_2O buffer solution to prepare our sample (36 μM, pD = 2.60). A continuous-wave 1064nm laser beam was focused at the surface layer of the sample solution through an oil immersion objective lens (100x, NA = 1.40). The trapping and aggregation behaviors were observed in real time by a CCD camera, and the fluorescence imaging and spectral analysis were carried out using a 405-nm laser.

Fig. 1 shows transmission and fluorescence images during laser irradiation. Before irradiation of the trapping laser, no aggregate was observed (Fig. 1a). At 2-min, a single sub-micrometer-sized aggregate was formed at the focal spot and continuously grew up to be 2-3 μm at 15 min, when its green fluorescence was observed (Fig. 1b). By further irradiation, the fluorescent color was changed from green to blue, and the fluorescent area was extended to the outside with no visible aggregate (Fig. 1c). Fig. 2 shows the temporal change in the fluorescence spectrum during these behaviors, as well as that of the monomer solution. The intensity of the fluorescence emission was enhanced, and the fluorescence peak shift from 530 to 465 nm indicates the conformational change of a TPE unit during trapping. These results imply that optical trapping produces a highly-concentrated liquid phase, in which solute molecules are densely distributed, showing different fluorescence from the monomer solution.

(1)



(2)

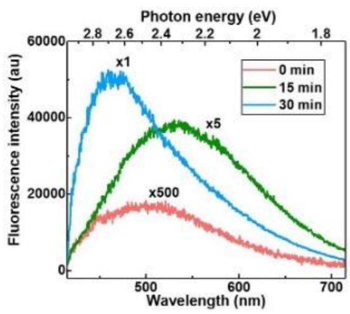


Figure 1 and Figure 2 show the transmission and fluorescence images during optical trapping and the fluorescence spectra at each trapping stage, respectively.