Picosecond time-resolved fluorescence microscopy for organic nanoparticles

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Time-resolved fluorescence spectroscopy combined with a micro- or nano-scale spatial resolution has become of interest because lifetimes of excited states in microscopic local regions are essential information to reveal the reaction mechanism of nanostructured photofunctional materials and devices, such as photoresists, organic and inorganic nanocrystals, and organic light-emitting diode (OLED) devices. In this report, we demonstrate a time-resolved fluorescence microscope system with picosecond temporal (20 ps) and micrometer spatial (1 μm) resolutions. This system has been applied to lifetime measurements for organic nanocrystals.

In our system, the light source for excitation was a pulsed laser diode (405 nm, 10 μW, 1 MHz). Incident laser beam was collimated and lead into an inverted microscope and focused onto a sample with a 1 μm diameter spot by an objective lens (NA = 0.95, x40). Fluorescence from the sample was collected by the same objective lens, lead into a polychromator and detected by a high speed streakscope. Samples are perylene nanocrystals of diameter 50~100 nm which were prepared by the reprecipitation method [1]. The nanocrystals were sparsely adsorbed on a glass substrate with density of a few particles per excitation laser spot area (diameter 1 μm). The perylene nanocrystals show a fluorescent peak of self-trapped excitons around 580~590 nm. From peak wavelengths (= λ_{max}), we can estimate relative sizes of nanocrystals.

Figure 1 shows time-resolved fluorescence decay curves measured at different positions of the sample where λ_{max} showed different values. We can see dependence of lifetimes (= τ) on the λ_{max}, i.e. the crystal sizes of nanoscale. Relations between the lifetime and the detailed structure of a single perylene nanocrystals are now under study.


![Fig. 1 Time-resolved fluorescence decay curves for a few perylene nanocrystals.](image-url)