



Ultrafast excited state dynamics of six-branched styryl derivatives based on 1,3,5-triazine: Dissolved in chloroform solution or formed spin-coating film

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ABSTRACT

Nondegenerate pump-probe experiment was performed to study the effect of the environment on the excited state decay dynamics of six-branched styryl derivatives based on 1,3,5-triazine. The two compounds were dissolved in CHCl₃ solutions for research in solvent environment, and the spin-coating films were also prepared for research in agglomerate state. Obvious different excited state dynamics were observed under two conditions. A fast process about several ps and a long process ~100 ps were observed for compounds in CHCl₃ solutions. However, another ultrafast process ~0.8 ps was observed for compounds in spin-coating film condition, indicating some other decay channels and some processes of other mechanism.

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1. Introduction

Materials that exhibit large two-photon absorption (TPA) properties, have been extensively investigated for their practical applications in optical limiting, optical data storage, three-dimensional microfabrication, bioimaging, upconversion laser and photodynamic therapy [1–6]. New structural material with improved TPA property has been a focus of research in the field of materials, chemistry and physics. The excited state decay dynamics contain many photophysical and photochemical processes which providing great information about the excited states, and have been the focus of studies in related fields.

We have investigated TPA properties and ultrafast dynamics of several organic systems under solution condition [7–13]. All of the results provided better understanding of the excited states and guided the optimization of new TPA materials. However, for some practical applications, the TPA materials should be fabricated into thin film [14]. In this study, to further investigate the dynamics of compounds under spin-coating film condition, pump-probe techniques under perpendicular polarization configuration for two six-branched derivatives were performed and different dynamics properties were observed. The results revealed the effect of agglomerate state on the excited decay properties of molecular and some new decay channels of other mechanism were proposed.

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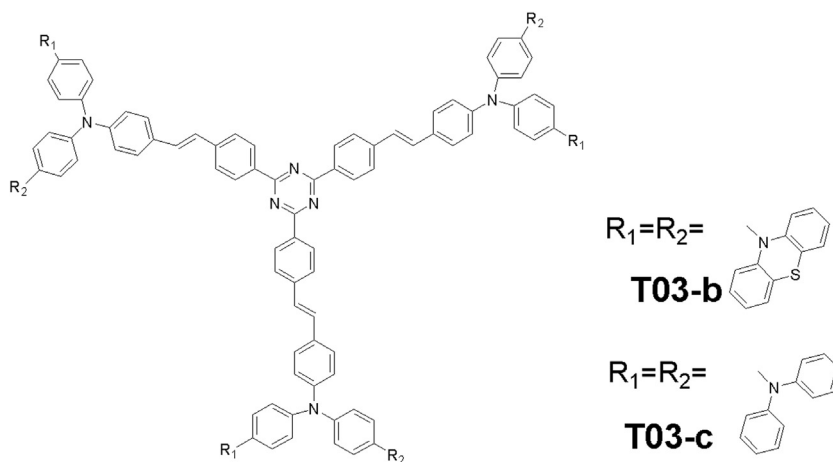


Fig. 1. Molecular structures of compounds T03-b and T03-c.

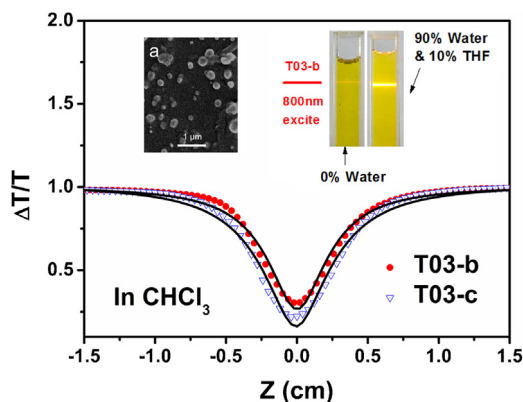


Fig. 2. The experimental data (open circle) and fitting results (solid line) of open aperture Z-scan results for T03-b and T03-c dissolved in CHCl_3 solutions. Insets are SEM image of T03-b nanoaggregates and fluorescence emission image under excitation of 800 fs pulses.

2. Materials and experimental

Molecular structures of six-branched compounds T03-b and T03-c are shown in Fig. 1. The synthesis and characterization were reported elsewhere in detail [11]. 1,3,5-triazine was employed to serve as electron acceptor group and central core, three triphenylamine groups were employed to serve as the electron donor group, forming an octupolar tribranched structure containing three $D-\pi-A$ subunits. The six-branched compound T03-b and T03-c can be considered as the extension by linking the phenothiazine group and diphenylamine groups to the terminal of triphenylamine groups. The two terminal electron-donor groups linked to a same triphenylamine group share a same conjugated-bridge, and all the six terminal electron donor groups share a same 1,3,5-triazine group as the electron-acceptor and central core. Chloroform (CHCl_3) was used without further distillation.

The ultrafast dynamics of these six-branched compounds in different environment were investigated by a nondegenerate femtosecond (fs) pump-probe experiments [15]. Fs pulses employed in ultrafast measurements and open aperture Z-scan experiment were generated by an amplification stage of fs laser system (Spitfire, Spectra-Physics). The output power from Spitfire of our fs system was about 300 mW. The pulse duration was 140 fs, the wavelength was 800 nm, and the repetition rate was 1 kHz. All of the ultrafast response measurements were carried out at room temperature.

3. Results and discussions

Optical properties of these six-branched compounds dissolved in CHCl_3 solutions have been introduced in our previous work [16]. As shown in Fig. 2, due to the cooperative interaction between different branches, and the increased delocalization of the electron cloud, all of the two six-branched compounds exhibited very large TPA cross section (4000 GM and 6100 GM for T03-b and T03-c, respectively, which are measured by open aperture Z-scan technology using fs pulses at wavelength of 800 nm). Insets are SEM image of T03-b nanoaggregates and fluorescence emission image under excitation of 800 fs pulses.

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