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RECENT ADVANCED IN TWO-PHOTON ABSORPTION MATERIALS AND APPLICATIONS

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Nonlinear optical features of organic materials have been extensively studied for various applications in optical and opto-electronic devices. One of the important nonlinear optical features is two-photon absorption in which some molecules can absorb simultaneously two photons, when irradiated by intense laser pulses. This makes an electronic transition from the ground state to an excited state. The rate of TPA scales quadratically whereas the rate of one-photon absorption linearly increase with the intensity of the incident radiation. The rate also depends upon the TPA cross-section (2) of the molecule. Therefore, the development of lasers as well as organic materials with large TPA cross-sections (2) are a requirement for various applications including two-photon fluorescence microscopy, three-dimensional optical storage, three-dimensional fabrication, photodynamic therapy, and optical power limiting.

Several research groups have tried to understand structure-to-property relationship for the design in organic materials possessing of large TPA cross-sections. They have obtained someunderstanding concerning the enhancement of TPA cross-sections of organic chromophores. They pointed out that substitution with symmetrical or asymmetrical donors and acceptors (D--D, A--A, D--A), increasing the conjugation length, changing donating abilities of electron-donors, and enhancing the co-planarity of -center played an important role in the enhancement of TPA cross-sections of organic chromophores. Based on these molecular design concepts we prepared various new organic TPA molecules having phenylenevinylnene, difuranonaphthalene, fluorene, phenyleneethynylene, thiophene, dithienothiophene (DTT) moieties as -center. Among them, DTT-based molecules showed highest TPA activities. This result indicates that the planarity of -center might be more crucial molecular factors than structural symmetry and donor strength.

In addition, most two-photon absorption (TPA) compounds based on -conjugated double bond presented a problem of reduction in TPA activities due to the quenching of fluorescences resulting from the formation of -complex by the chromophore aggregation. This occurs both in solid state and in solutions of