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Communication

Amplified spontaneous emission, optical waveguide and polarized emission based on 2,5-diaminoterephthalates

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ABSTRACT

A series of 2,5-diaminoterephthalates with a simple structure were synthesized through one-st reaction, and their bar-shaped single crystals with a large size and a smooth surface have been obtained *via* the solvent-evaporation method. These crystals exhibit bright emission with fluorescence quantum yields higher than 0.2. They display the waveguide property, and low optical loss coefficients for waveguide have been determined for the crystal of one compound. addition, the crystal can cause linear polarization of the light emitted from it, with a high polarization contrast of 0.70. Most importantly, these crystals can realize amplified spontaneo emission (ASE), including the red ASE, with appreciable energy thresholds of 72–198 kW/cm and high gain coefficients, which suggests the potential of these crystals for the application in organic solid-state lasers.

In recent years, organic optoelectronic materials have attracted considerable attention due to their various applications, such as organic light-emitting diodes, field-effect transistors, photovoltaics, sensors and solid-state lasers [1–8]. As a kind of morphological forms studied for optoelectronic materials, single crystals are featured by the ordered molecular arrangement and well-defined surface, which endow the crystals with diverse and outstanding properties, such as good thermal stability, high charge-carrier mobilities, low light propagation loss and reflecting mirror structures [9–14]. As such, they have attracted increasing research interest in optoelectronics.

Amplified spontaneous emission (ASE) is a phenomenon that has long been studied, which is closely related to pumping laser [15–21]. In general, the ASE is accompanied by the waveguide and emission polarization properties of the active materials. Some organic crystals have been found to possess good waveguide and ASE performance because of their low light scattering, smooth surfaces and high fluorescence quantum yields (Φ_F) [22,23]. To date, the ASE of crystals with blue, green and red colors has all been reported. However, the crystals that can realize red ASE with low energy thresholds and high gain coefficients are still lacking [24–27].

In this work, we have employed a series of 2,5-diaminoterephthalates, **1**–**4**, for ASE study (Fig. 1). The existence of electron-donating amino and electron-withdrawing ester groups in the molecule is beneficial to the realization of desirable low-energy emission. The substituents on the peripheral phenyl rings are adopted to tune the material properties. The intramolecular hydrogen bonds between the amino and the carbonyl groups are expected, which could lead to a relatively planar and rigid conformation for the central part of the molecules. Such a conformation may enhance the luminescence efficiency in the dispersed state and thus provide a good opportunity for realizing high solid-state Φ_F that benefits the ASE [24]. Although compounds **1**, **3** and **4** are known [28,29], their optoelectronic properties have not been disclosed. In addition to the ASE, the waveguide and polarized emission properties have also been explored.