Investigation of Trap Sites and Their Roles in Organic Triphenylamine-Based Photorefractive Materials

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ABSTRACT

Organic photorefractive (PR) materials have been studied during the last quarter-century, and they have recently received much attention due to their updatable features that allow them to be used in dynamic holographic devices. However, understanding bulk trap sites that drive the PR effect (by inducing a space-charge field) remains a critical issue. In general, the trap site behavior can be controlled from the energetic point of view; however, bulk devices contain not only the energy trap sites but also structural neutral ones, which decrease the carrier mobility. Organic PR devices are bulk optoelectronics devices, and the investigation of their trap tuning mechanism is still ongoing.

In this thesis, carrier transport and trapping properties of the PR materials (represented by triphenylamine-based polymers) with induced space-charge fields are investigated. The effects of plasticizers and wavelengths of interference beams on the PR performance of the resulting holographic devices are studied via photoconductivity measurements. In order to solve a critical challenge of trap tuning, a modified fabrication technique is proposed, which enhances the photoconductivity of the PR materials by suppressing shallow traps. The trap site properties are controlled by studying bulk dipolar molecules with a photoemission yield spectroscopy in air technique, which provides the distribution of both the transport and trap sites. Finally, dynamic holographic images were produced by using organic PR composite films.