

Charge-Transporting Polymers and Low-Molar-Mass Glasses for Organic Electronics

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Organic charge-transporting materials are currently widely used in optoelectronic devices such as electrophotographic receptors, light-emitting diodes, solar cells and electronic devices such as thin film transistors. Among charge transporting materials used in electrophotographic photoreceptors of laser printers and copying machines polymers and molecularly doped polymers prevail. Molecularly doped polymers are understood as solid solutions of low-molar-mass organic charge-transporting compounds (guests) in inert polymers (hosts) such as polycarbonates and polyvinylbutyral [1]

Organic low-molar-mass compounds with stable solid amorphous phase above room temperature are called molecular glasses or amorphous molecular materials [2]. A dramatic increase of the interest in organic charge-transporting low-molar-mass glass-forming materials occurred after the discovery of high performance multilayer electroluminescent devices prepared from vacuum-sublimed organic dye amorphous films [3].

In this presentation the recent results of the work on the synthesis and properties of electroactive polymers and molecular glasses performed in the author's laboratories are described. Many hole-transporting polymers and molecular glasses recently synthesized have been used in electrophotographic photoreceptors [4]. In the design and synthesis of these materials aromatic amino groups have been used as the main building blocks. Charge transporting polymers have been prepared by ionic (photo)polymerization of oxiranes, oxetanes, thiranes, vinyl ethers bearing different electroactive groups [5]. Such polymers were also prepared by polycondensation, polyaddition and polymer analogous reactions [6,7]. Hole-transporting molecular glasses belonging to the families of condensed aromatic amines [8], hydrazones [9], enamines [10], ethynylenes, stilbenes and electron-transporting materials belonging to the families of thioxanthenes and aromatic imides have been prepared by different methods. Cross-linkable charge transport materials containing different reactive functional groups are emphasized. The thermal, optical, photophysical and photoelectrical properties of the charge transporting compounds synthesized are reported. Ionization potentials established by the electron photoemission in air technique range from 5.00 to 5.80 eV. Time-of-flight hole drift mobilities in the amorphous films of the newly synthesized 2,7-substituted derivatives of carbazole and carbazole-based enamines exceed 10^{-2} cm²/V. Electron mobilities in the layers of polyethers containing naphthalene diimide moieties as substituents reach 10^{-5} cm² V⁻¹ s⁻¹ at high electric fields.

3-(9-Carbazolyl)carbazoles and 3,6-Di(9-carbazolyl)carbazoles have appeared to be effective host materials for blue organic electrophosphorescent devices. The triplet energies of these materials approach 3.0 eV. Using these host materials, blue phosphorescent OLEDs having efficiencies of up to 15 %, 31 cdA⁻¹, and 28 lmW⁻¹ were demonstrated [11]. Some of the recently synthesized high-triplet-energy glass-forming hosts have appeared to be fairly effective bipolar semiconductors, i.e. materials capable of transporting both holes and electrons [12]. They were successfully used for the development of single layer electrophosphorescent devices with quantum efficiencies of 8-9% for blue and 13-14% for green devices [13].

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