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"Smart materials with versatile chromic response to external stimuli developed by macromolecular engineering"

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Abstract

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RESUME

The aim of *SMARTCrom* project is to develop new polymeric architectures which will be able to be processed into smart materials being capable of a reversible chromic response to external stimuli, such as electric potential, metallic ions or UV light, for applications in advanced technologies. In the first stage of the project it is reported the synthesis of a new monomer with a diamine structure and three corresponding polyimides, representing the support polymers which will be functionalized in the following stages, with various receptors sensible to external stimuli. It is expected that each of the receptors which will be introduced in these polymeric substrates will drastically modify the physico-chemical properties of the corresponding material. Thus, in this stage we performed the physico-chemical characterization of the support polymers, in order to easily understand the modifications induced by the functionalities introduced as receptors (which will be performed in the next stages). The polymers were thoroughly characterized with respect to their thermal, mechanical, optical and electrochemical properties. The data showed that the obtained imide-type polymers possess a good solubility in organic solvents such as DMF, DMAc, NMP and less polar solvents such as THF, due to its non-coplanar structures, of the bulky pendant phenyl group as well as of the two methyl substituents from the main chain which lead to a reduction of interchain interactions. Each one of the above mentioned solvents can be used to prepare films, THF and chloroform being the most appropriate to obtain very thin films on various supports, while DMAc and NMP may be used in the fabrication of free-standing films. The imide structure is directly responsible for the high thermal stability (the thermal decomposition begins after 480°C) and it also influences the excellent mechanical properties, which confer to the synthesized polyimide films a desirable characteristic of a material suitable for advanced high-performance applications. The specific properties, such as redox or photo-optical properties, are induced by both imide and triphenyl-methan moieties. The triphenyl-methan unit is also responsible for the formation of charge-transfer-complex, both intra- and inter-molecular, which explains the blue color of these polymers. *This is a unique feature for the phthalmide-type polymers (with 5 members in the ring)* because they usually show a yellow-grey color of the solid which sometimes goes to brown. The imide unit has a strong electronegative behavior being capable of accepting one electron and transforming into an anionic radical, thus conferring the studied systems injections and transporting electron properties, fitting into n-type materials domain. Moreover, the imide unit together with all the structural modifications of the macromolecular chains, such as the incorporation of hexafluoroisopropylidene moiety, shape and influence the dielectric constant of the present materials. Thus, it has been shown that polyimides **AM-6FDA** and **AM-ODPA** are very good isolators with low losses in permittivity and dielectric loss, while **AM-BTDA** polymer can reach high values of dielectric constant being suitable as dielectric for various devices including field effect transistors. Some of the obtained results were disseminated by oral presentations on 3 conferences, by publishing one paper on an ISI journal and by sending one paper to publication to an ISI journal.