Referência do Projecto: POCTI/CTM/47363/2002

Título: Produção e caracterização de um cristal líquido disperso numa matriz polimérica. Novas estratégias de polimerização e impregnação em scCO2.

Concurso * Programa * Área: Concurso 2002 * POCTI * Ciências e Engenharia dos Materiais - Física da Matéria Condensada, Química do Estado Sólido e Polímeros

Data de Início: 01-11-2003

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Funding: 102.000,00

Abstract

Supercritical carbon dioxide (scCO2) shows great potential as a medium for polymerisation and simultaneous incorporation of low molar mass compounds in polymer matrices. It has excellent plasticising properties and can easily penetrate into solid polymer films and extract or precipitate substances in those matrices, simply by manipulating pressure. Polymer dispersed liquid crystals (PDLC) are of great interest for electro-optical applications such as flexible displays or light shutter devices, consisting in low molecular mass liquid crystal microdroplets dispersed in a polymer matrix. These films scatter light in the Off state and can be electrically switched to a transparent On state.
The main objective of this project is the production of acrylate based PDLC's using supercritical fluid technology to incorporate a liquid crystal(E7). The scCO2 mixing technology (polymerisation and incorporation) will be applied to fine control the morphology of the PDLC's materials allowing an optimisation of the electro-optical response.
The project will start with the polymerisation of acrylate monomers induced by heat (AIBN initiator) and by light (DMPA initiator) by both conventional (task 1) and supercritical (task 2) media.
The scCO2 will be used to incorporate the liquid crystal (E7) by different experimental processes: in the final polymer and during the polymerisation process (task 3). In tasks 4 and 5, PDLC devices will be characterised in terms of physicochemical properties (phase-behaviour, solid state NMR, differential scanning calorimetry, dielectric relaxation spectroscopy) and electro-optical properties (measurement of the transmittance in function of the applied potential).
Dielectric relaxation spectroscopy, a technique that is sensitive to reorientational motions of permanent dipoles, will be used as a tool to monitor the dynamical changes that occur upon polymerisation and to characterise dielectrically the final product.
The present proposal joins together three research teams: CQFB1- with expertise in photochemistry and dielectric relaxation spectroscopy; CQFB2 - with expertise in high pressure phase behaviour and supercritical fluid technology and CFMC - with expertise in electro-optical behaviour.
These studies represent a new strategy to produce PDLC devices using supercritical fluid technology. We intend to bring an in-depth understanding of the evolution of the molecular motions underlying the processing of a PDLC which is an important contribution to establish a correlation between processing and electro-optical performance.

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Título: Estudo por espectroscopia dieléctrica das alterações de dinâmica molecular durante a formação de um cristal líquido disperso numa matriz polimérica

Concurso * Programa * Área: Concurso 2001 * POCTI * Ciências e Engenharia dos Materiais - Física da Matéria Condensada, Química do Estado Sólido e Polímeros

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Abstract

Polymer dispersed liquid crystal (PDLC) consist commonly of low molecular mass liquid crystals dispersed as micron sized droplets in a polymer binder. These materials have received considerable attention, because of their great importance for electrooptical applications such as flexible information displays and light shutter devices. The in-depth understanding of the processing conditions and formation steps is critical to improve the design of PDLC films due to the close dependence between processing and electrooptics. Among the most used monomers to prepare PDLCs, the acrylates are considered as the most reactive. Their polar groups allow pursuing the polymerization reaction by dielectric relaxation spectroscopy, DRS. This technique probes the interaction of a material with an oscillating electric field (1V), being sensitive to orientational motions of permanent dipoles. The deconvolution of a dielectric spectrum into its individual contributions informs on the relative intensitie and characteristic times of the underlying molecular motions.This project intends to monitor by DRS, the different stages of the PDLC formation by photoinduce the polymerization of a bifunctional acrylate mixed with a nematic mixture. By obtaining dielectric spectra at different stages of the polymerization process, collected after different exposure times, it will be possible to follow the changes in the dynamics of both polymer and LC. Upon polymerization of the bifunctional monomer, cross-links will form originating a gel. The LC can be oriented under the influence of an electric field in this gel state since their molecules are not chemically attached to the network, while the orientation of the network remains unchanged. At this stage the dielectric spectra should change dramatically and the optical properties as transmittance must denounce this behavior. Therefore the light intensity transmission coefficient will be measured for different applied voltages to get an insight in the changes occurring in electrooptical properties. With the ongoing of the polymerization process, the polymer mobility slows down and the dielectric spectra relative to the polymer deviates to low frequencies and the dielectric loss will decrease; in order to see this relaxation process an extra accuracy in the impedance analyzer is necessary which could be reach through the acquisition of a dielectric converter (equipment to purchase) to be combined with the existing analyzer. The kinetics of the polymerization process has characteristic features such as autoacceleration, autodeceleration and the early onset of what has been called reaction-diffusion behavior. The monitoring of the reaction rate will be achieved by differential scanning calorimeter adapted with a photocalorimeter accessory (equipment to purchase). This kind of study is sparse in the literature and represents an important contribution to the understanding at molecular level of the formation process of a PDLC

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