Influence of cross-linking density on the swelling behaviour of liquid crystalline elastomers in a nematogenic solvent

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In the present study, we have explored the effect of cross-linking density \( (C_D) \) on volume phase transition of liquid crystalline networks comprising a mesogenic crosslinking agent in low molar weight LC solvent.

The swelling behaviour of LC network in LC solvents has been the subject of several theoretical studies since decades but surprisingly attracted experimental investigations only very recently \([1,2,3]\).

The side-chain LC networks were prepared by radical polymerization of the mesogenic acrylate monomer 6-(4’-cyanophenyl-4’’-phenoxy)hexyl acrylate (6OCBA) and (acrylic acid 6[4’-(6-acryloyloxy-hexyloxy)biphenyl-4yloxy] hexyl) ester (cross-linker) (AHBH) which contains a mesogenic group showing a nematic isotropic transition at 82.7°C, respectively. The concentration of the initiator (2-hydroxy-2- methyl-1-phenyl-propane-1-one) was 0.5 mol % in the total reactants. The mixture was dissolved in 2 mL of a dimethylsulfoxide-toluene mixture (40-60 vol %) \([4]\). The introduced amounts of cross-linker in the total reactants during synthesis were varied from 0.12 to 5 mol %. We call this parameter the cross-linking density.

The obtained dry networks were characterized by differential scanning calorimetry (DSC) and immersed in an excess of LC solvent 4-cyano-4’-pentylbiphenyl (5CB) forming polymer gels. Detailed study by polarized optical microscopy (POM) allowed us to determine the swelling degree of the gels and the phase behavior of the solvent inside the polymer matrix in a wide range of temperature \([5]\).

We note that the swelling characteristics strongly correlate with the phases of the LC molecules inside and outside the gel. The two independent nematic-isotropic transition temperatures for the gel \( (T_{NI}^G) \) and the surrounding pure solvent \( (T_{NI}^S) \) yield three characteristic temperature regions. In the totally isotropic and nematic phases \( T>T_{NI}^G \) and \( T<T_{NI}^S \), respectively, and in the region \( T_{NI}^S < T < T_{NI}^G \) where the LC phases inside and outside the gel are different.

It has been found also that as \((C_D)\) increases, the nematic-isotropic transition temperature of the pure dry LC network \( (T_{NI}^N) \) decreases, in that case the ability of swelling of network decreases and since the \( T_{NI}^N \) is much higher than the nematic-isotropic transition temperature of the \( T_{NI}^S \), the nematic-isotropic transition temperature of gel \( T_{NI}^G \) shifts to higher temperatures.

References:


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