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Neutron Scattering by Copolymers

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Neutron scattering is a very efficient tool for studying polymers in bulk as well as in solution. This is mainly due to the difference of scattering length between hydrogen and deuterium which allows the possibility of changing the contrast without too serious alteration in the conformation and thermodynamics of the systems.

In order to take full advantage of this possibility, one has to remember the general rules which allow the evaluation of the total scattering function $S(q)$ as a function of the partial scattering functions $S_{pq}(q)$ which describes the contributions of the interferences between scattering center of species p and q.[1,2] In a first part we shall briefly establish these rules for incompressible systems introducing what has been called by J. Koberstein[3] the molecular contrast and the phase contrast.

In the second part of this talk we shall discuss the problem of copolymers. $S(o)$ the intensity scattered at zero angle depends on the heterogeneity in composition of the sample,[4] for homogeneous composition $S(o) = o$. This gives the possibility of studying trans-esterification in polyester, for example.

At finite q for a monodisperse system, $S(q)$ is not zero and it will be shown how it depends on the length of the sequences and the architecture of the copolymers. If the number of blocks is large $S_{pq}(q)$ is practically not affected by the total length of the polymer.[5]

The condition $I^{-1}(q) = o$ allows one to write the equation of a q dependent generalized spinodal and therefore to determine the parameters which govern the stability of a multiphase system.

In the last part we shall discuss the problem of the application of this formalism to networks and gels made of different types of units. It will be shown that the scattering is mainly sensitive to the local conformation and that the introduction of translational order between the units does not affect significantly the scattering curves but can explain the occurrence of secondary maxima which have been observed in polyurethane and ionomers.[6]

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