Experimental report

08/02/2016

Proposal: 9-12-374 **Council:** 10/2014

Title: Study of the internal dynamics of soft gel - carbon nanoparticle composite systems

Research area: Soft condensed matter

This proposal is a new proposal

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Samples: water H2O
heavy water D2O
carbon nanotube C
poly(N-isopropylacrylamide) (C6H11NO)n

Instrument	Requested days	Allocated days	From	To
IN11	12	10	07/07/2015	13/07/2015
			22/10/2015	26/10/2015

Abstract:

Environmentally sensitive hydrogels are good candidates for future targeted drug delivery or adsorption systems. Despite extensive studies in recent years their application is still highly restricted, mainly owing to their slow response rate and poor physical characteristics. One possibility to overcome these problems is to incorporate nanoparticles, i.e. prepare composite materials that combine the responsive behaviour of the gels with the mechanical stability and heat conductivity of carbon nanoparticles. Here we propose a detailed neutron-spin echo study of composite poly(N-isopropyl-acrylamide) /pNIPA/ + carbon nanotube /CNT/ systems. By this technique the internal dynamics of the composite systems will be explored as a function of the surface chemistry of the CNT incorporated. The results are expected to improve our knowledge about these delicate systems, and contribute to the development of smart responsive materials suitable for controlled (drug) delivery applications. The study is part of the ILL PhD project "Carbon nanoparticle - responsive gel composites for controlled delivery".

"Study of the internal dynamics of soft gel – carbon nanoparticle composite systems"

Experimental report on 9-12-374 performed on IN11 7-13 July 2015 and 22-26 October 2015

The aim of the experiment was to perform a detailed neutron spin-echo (NSE) study on poly(N-isopropyl-acrylamide) (pNIPA) nanocomposites containing carbon nanoparticles (CNP). Owing to problem of external magnetic field disturbances during the scheduled period the experiment was cut into two parts. To compensate the inconvenience and the lost time owing to the necessity of double alignment and resolution measurements, the second half of the experiment was extended by 4 additional days. This allowed us to measure not only the carbon nanotune (CNT) containing samples, but to test few graphene oxide (GO) containing nanocomposites as well. At all case samples swollen in D_2O were measured at 25°C. As the scattering length density of the CNPs and D_2O are practically identical, the experiment allowed us to obtain information exclusively on the diffusive motion of the polymer chain matrix. Figure 1 presents representative intermediate scattering functions obtained for the pure PNIPA gel and a CNT containing nanocomposite.

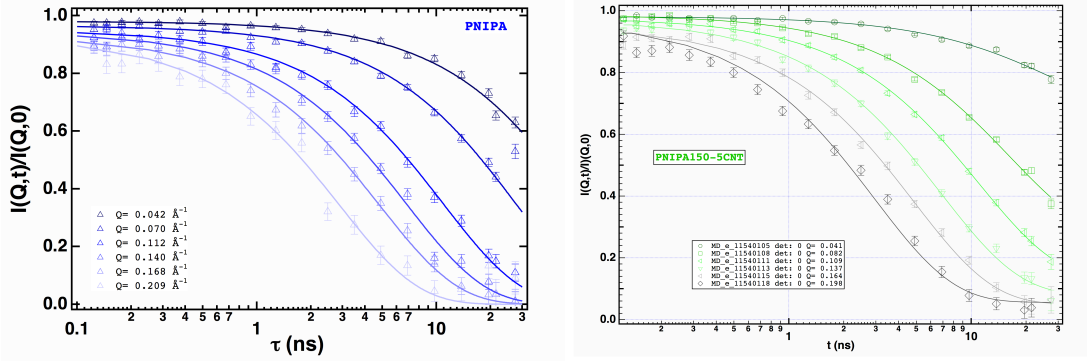

Figure 1. Experimental intermediate scattering functions from NSE with the corresponding single exponential fits measured at 25°C. left: pure PNIPA gel right: 5mg CNT/gNIPA nanocomposite

For all samples the curves obtained could have been fitted to a single exponential curve. In all cases the relaxation rates (Γ) were proportional to q^2. From a linear fit to Γ vs q^2 the diffusion constant was calculated (D_{diff}), yielding the hydrodynamic correlation length (ζ_H) of the systems. Data analysis of the second part of the experiment is still under progress, but results from the summer measurements revealed that the hydrodynamic parameters of the polymer matrix are little affected by the incorporation of the CNPs. This observation is surprising, since in case of nanocomposite samples the temperature induced volume phase transition is dramatically affected on the macroscopic scale.
Some of these results are included in the publication "Static and dynamic behaviour of responsive graphene oxide - poly (N-isopropyl acrylamide) composite gels" that has been submitted and is currently under review.