Experimental report

13/02/2017

Proposal: 9-11-1767 **Council:** 4/2015

Title: Using aligned nanocomposites to measure the anisotropy of confined polymer coils

Research area: Materials

This proposal is a new proposal

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Samples: PMMA/rGO nanocomposite

Instrument	Requested days	Allocated days	From	To
D11	2	1	23/11/2015	24/11/2015

Abstract:

Graphene materials have extraordinary physical properties, e.g conductivity, mechanical strength and surface area that may be married with polymer properties within nanocomposites. Alignment of the nanofiller in the direction of stress transfer is desirable toimprove nanocomposite properties, and small-angle scattering techniques allow an average measurement of the nanoparticle orientation. Previous SANS shows that, for randomly-oriented composites, there is a reduction in the polymer radius of gyration (Rg) that is most pronounced at a sweet spot in the nanofiller concentration. Here, we test the prediction that Rg is reduced normal to the nanofiller interface, while the coil dimensions parallel to the filler interface are unaffected. Composites made from reduced graphene oxide (rGO) will be prepared with a blend of hydrogenous and deuterated polymer. Aligned nanocomposites will be characterised by SAXS to measure the degree of alignment in the rGO. 2D SANS patterns from D11 will then measure the anisotropy in the scattering from the polymer chains. SANS offers a unique opportunity to study the average of the individual chain conformations in all directions.

Using aligned nanocomposites to measure the anisotropy of confined polymer coils

9-11-1767

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From 23/11/2015 to 24/11/2015

Experimental report

We report a successful SANS experiment on D11 lasting for 24 hours. The experiment was simple transmission mode SANS, aiming to measure the shape and size of polymer chains in polymer-graphene oxide nanocomposites, paying special attention to the relationship between alignment of the nanoscale filler material and the polymer coils. This experiment exploited the use of isotopic substitution in order to study blends of hydrogenated and deuterated poly(methyl methacrylate) (PMMA). Polymer nanocomposites of the h/d PMMA blend were formed with various concentrations of graphene oxide (GO) via a solvent processing method. The GO concentrations varied from 0-10 per cent by weight. A single molecular weight of PMMA of around 229 kDa was used with the hydrogenous and deuterated components matching closely.

The alignment method was not successful from a sample preparation point of view, so it was decided to measure the samples in simple transmission mode (i.e. 'face on') and use the samples as an additional dataset to complement results from the same research project, studied in experiment 9-12-372.

As with our previous D11 experiment, due to the stable nature of the samples at room temperature a simple sample changer and program was used to scan through samples and camera lengths with data collection progressing without any major issues to report. There was no loss of time due to beam outage, sample environment or mechanical issues.

After reduction the data are excellent in terms of statistics, and will form the backbone of a planned publication. A dataset from the experiments is included for illustration in Figure 1. As with our previous data on these systems, the full conclusion of the data requires further analysis of data from complementary techniques, but the data appear to show significant new effects and should advance our understanding of interfacial effects in polymer nanocomposites.

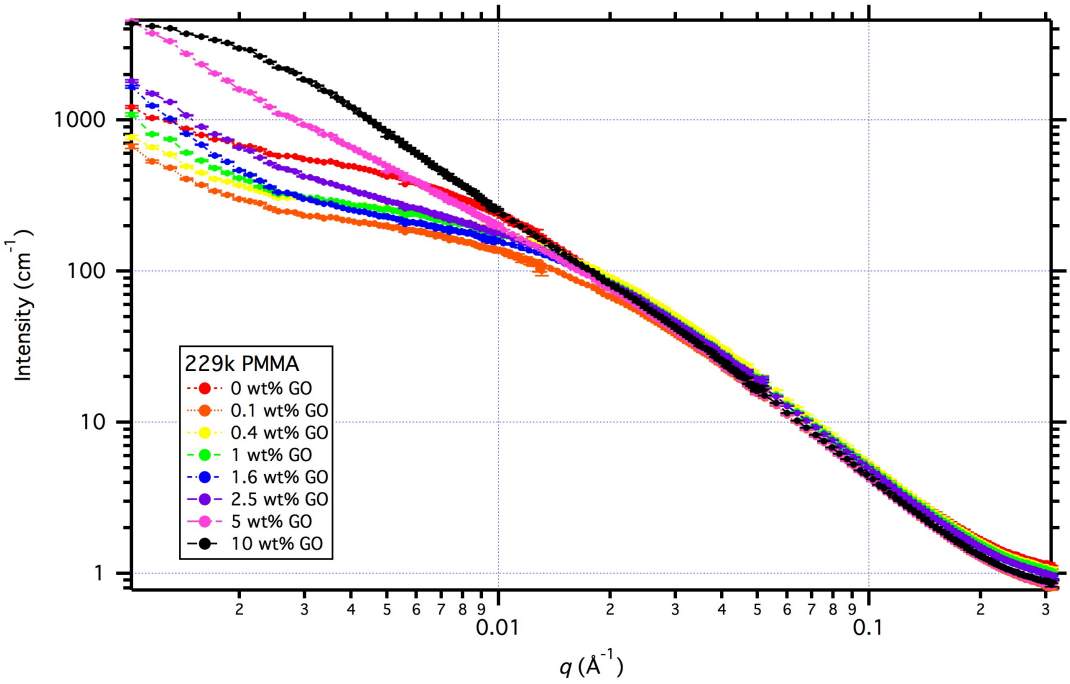

Figure 1. SANS data collected from the D11 instrument during the reported experiment, on PMMA-GO nanocomposites.

We would like to take this opportunity to thank the ILL for a very good experimental experience and great support from the beamline and technical teams.