Synthesis and Structural Properties of Magneto-Elastomeric Nanocomposites

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Recently there is an increasing interest in functional polymer nanocomposites due to emerging novel applications ranging from sensors and plasmonics through stretchable electronics and smart coatings for energy conversion and human health (see e.g. [1-2]). Further exploitation of the huge potential of functional nanocomposites requires full control of the underlying nanostructure and the interaction between the nanoparticles and the host matrix, e.g. by external fields. The present work is focused on synthesis and consecutive structural investigation of magneto-rheological nanocomposites.

It is known that properties of magneto-rheological nanocomposite materials depend strongly on the distribution of nanoparticles in the nanocomposite and cluster formation. A method to protect those nanoparticles from clustering during the preparation is encapsulation. In this work superparamagnetic iron oxide nanoparticles (SPIONs) [3] encapsulated with a co-polymer embedded in a polymeric matrix were used as nanofiller. For this purpose, a polymer with carbon double bonds (polybutadiene (PB) or polyisoprene (PI)) was used which was cross-linked to stabilize the internal polymer shell surrounding the nanoparticles (see figure 1). For the external polymer shell poly(ethylene oxide) (PEO) was used.

Using scattering methods (SAXS and SANS) and transmission electron microscopy (TEM) we show that the encapsulation of the nanoparticles can be tuned to reach well dispersed SPIONs in polymeric matrix. In addition, the effect of spontaneous chain-like ordering of the nanoparticles without magnetic field was observed (fig.2). In particular, SAXS data analysis using cylinder-sphere model results in about 30% SPIONs participating in chain formation. In average the chains are composed of 3-4 SPIONs.

These magneto-rheological nanocomposites will be used as a model system for functional nanocomposites based on the magnetic properties of SPIONs and supramolecular polymers [4].

[1] J. Jestin et al., Adv. Mater., **20** (2008) 2533
[2] A.-S. Robbes et al., Macromolecules **44** (2011) 8858
[3] C. Chevigny et al., Macromolecules **44** (2011) 122
[4] http://gepris.dfg.de/gepris/projekt/283337657?language=en

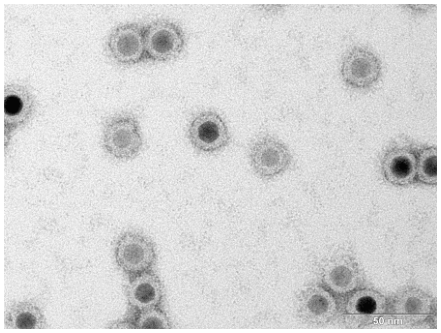

Fig. 1 TEM image of encapsulated SPIONs.

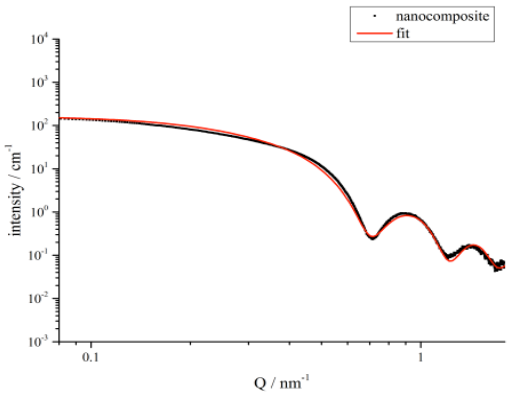

Fig. 2 SAXS intensity of the nanocomposite based on SPIONs encapsulated in PB-PEO shell. The red line shows a fitting curve with cylinder-sphere model.