

Metal Nanoparticles in Dendrimer-Containing Polymer Networks: New Organic-Inorganic Hybrid Materials Studied by SAXS

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Beamline(s): X27C

Introduction: Due to quantum-size effects, inorganic nanoparticles have unique and size-dependent optical, electrical and magnetic properties that can lead to a wide variety of practical applications. Higher generation polyamidoamine (PAMAM) dendrimers have the ability to act as templates for the formation of inorganic nanoclusters in solution, controlling the number of atoms forming one nanocrystal.¹

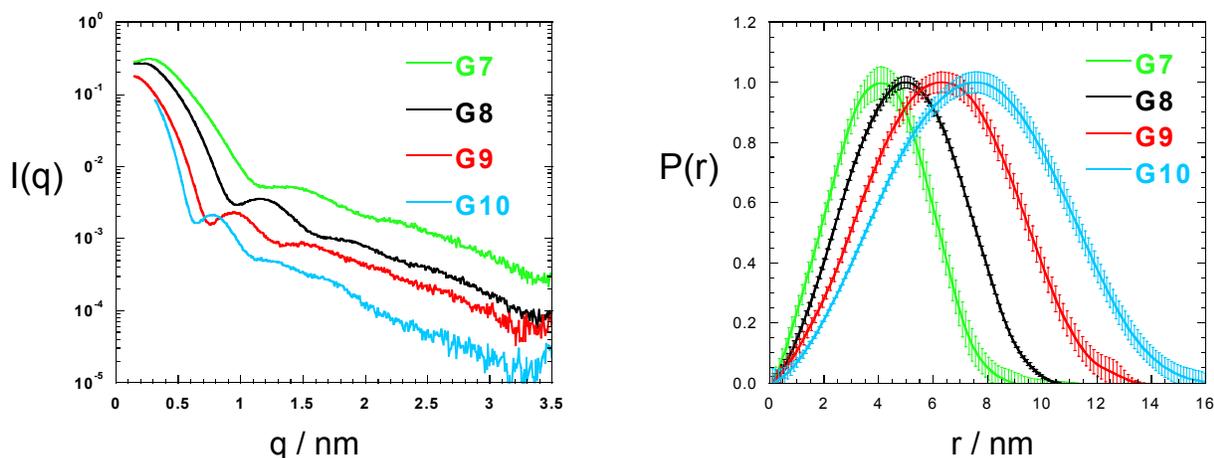


Figure 1. SAXS data for polymer networks containing dendrimers of different generations loaded with Pt salt: $I(q)$ and $P(r)$ obtained by Fourier Transformation (program ITP, Otto Glatter)

Results: Here, we use dendrimers dispersed in a polymer matrix to create a new type of *solid* polymer-inorganic composite material. Hydrophilic polymer networks (poly(2-hydroxyethyl methacrylate)) that contain polyamidoamine dendrimers were swollen in aqueous solution and metal ions were attached to the dendrimers. In the small angle x-ray scattering (SAXS) experiment, the metal ions provide the contrast for the measurement. The scattering curves and pair distance distribution functions $P(r)$ in Fig.1 exhibit the features typical of the form factors of these higher generation dendrimers in solution (sphere form factors), demonstrating that the metal ions are accumulated inside the dendrimers and the dendrimers are well-dispersed in the matrix.

Chemical reduction on these precursor ions results in metal nanoparticles that are located inside the dendrimers, which are dispersed in the polymer matrix. SAXS $P(r)$ data for these hybrid materials are displayed in Fig.2. SAXS and TEM measurements show that the metal particles are formed inside the dendrimers. While for lower generations, one particle per dendrimer is observed, multiple particles are formed in higher generation dendrimers, analogous to the results for dendrimer templating in solution.

These new organic-inorganic hybrid materials may be important for a combination of optical or catalytic properties of the colloids with the mechanical properties provided by the polymer network.

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References:(1.) F. Gröhn, B.J. Bauer, Y.A. Akpalu, C.L. Jackson, E.J. Amis; *Macromolecules*, **2000**, *33*, 6042.

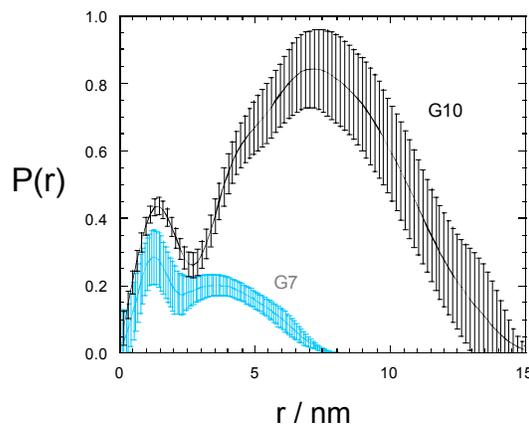


Figure 2. SAXS $P(r)$ data for polymer networks containing Pt nanoparticles inside dendrimers