365b Molecular Dynamics of Pamam Dendrimers

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PAMAM (poly(amidoamine)) dendrimers, or "dense star" polymers, represent an exciting new class of macromolecular architecture. Unlike conventional polymers, dendrimers have well defined, highly branched, compartmentalized structure in the nanometer size range. Dendrimers have a high degree of molecular uniformity, narrow molecular weight distribution, specific size and shape characteristics and a highly functionalized outer surface, making them promising candidates for applications in drug delivery, gene therapy, imaging, sensing, optoelectronics and catalysis.

The principal objectives of this study are to conduct a systematic investigation of the fundamental dynamic features of a series of PAMAM dendrimers, explore the unique characteristics of these materials and quantify the effect of molecular (generation, terminal group) and external (temperature) factors on their properties. By studying dynamics on the nanoscopic and microscopic level, we learn important information about the physics that underlies processing, structure and properties on the macroscopic level. In this study, the dynamics of PAMAM dendrimers was investigated by dielectric relaxation spectroscopy (DRS) and dynamic mechanical spectroscopy (DMS). A set of different PAMAM generations are investigated in the frequency range from 10^{-1} to 10^{9}Hz, between -100 and 150°C by DRS and from 0.01 to 100rad/s between 10 and 100°C by DMS.

Preliminary results are interesting. Broadband DRS (10^{-1} - 10^{9}Hz) was employed to study the molecular dynamics of poly(amidoamine) dendrimer generation 0 over a wide range of temperature. At temperature below the glass transition two processes are observed and a possible signature of the third process was noted. Isothermal data of the dielectric loss are fitted to a superposition of two relaxation functions using Havriliak-Negami functional form and conductivity contribution. The lower frequency process is very broad and shifts to higher frequency with increasing temperature. The peak intensity increases with increasing temperature. At temperature near the glass transition, the frequency of maximum loss is 10^{2}Hz which is a characteristic of the □-process. The higher frequency process also shifts to higher frequency with increasing temperature and the peak intensity increases. We assigned that process as □. At temperature above the glass transition we observe three processes. Dielectric loss spectra are dominated by a huge increase in permittivity at low frequencies. This behavior can be ascribed to conductivity contribution from ionic transport. A complete quantitative picture of PAMAM dynamics and comparative analysis of DRS versus DMS results will be presented.