Dendritic Nanoscale Chelating Agents: Synthesis, Characterization, Molecular Modeling, and Environmental Applications

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Abstract

Dendrimers are highly branched nanostructures with controlled composition and architecture. Poly(amidoamine) (PAMAM) dendrimers that possess functional nitrogen and amide groups arranged in regular “branched upon branched” patterns. Their high density of nitrogen ligands along with the possibility of attaching functional groups such as primary amine, carboxylate, hydroxyl, etc., to PAMAM dendrimers can result in a substantial increase in binding capacity for transition metal ions [e.g., Cu(II), Ag(I), Fe(III), etc.]. The well-defined molecular compositions, sizes, and shapes of PAMAM dendrimers have also made them particularly attractive as: (1) scaffolds for paramagnetic metal ions in magnetic resonance imaging, and (2) templates for the synthesis of metal-bearing nanoparticles with tunable electronic, optical, catalytic, and biologic activity.

This project explores the fundamental science of metal ion uptake by PAMAM dendrimers in aqueous solutions and assesses the extent to which this fundamental knowledge can be used to develop: (1) high capacity and reusable chelating agents for industrial and environmental separations; and (2) FeS laden nanoparticles with enhanced reactivity, selectivity and longevity for reductive detoxification of tetrachloroethylene (PCE) in aqueous solutions and subsurface formations.

The overall results of this research suggest dendritic nanoscale chelating agents provide unprecedented opportunities for developing a new generation of efficient and cost-effective high capacity/recyclable chelating agents and FeS dendrimer nanocomposites for treatment of water contaminated by toxic metal ions and redox active solutes.