Synthesis and Characterization of Environmentally Benign Nanoparticles

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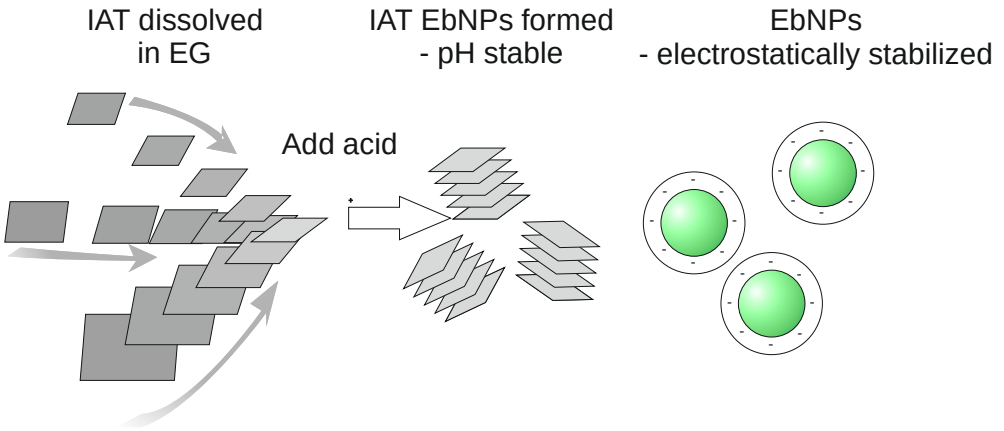
There has been a growing interest in replacing current non-biodegradable and toxic nanosystems with environmentally benign biopolymer based ones to minimize post-utilization hazards due to uncontrolled accumulation of nanoparticles in the environment. Lignin based nanoparticles (NPs) are biodegradable, environmentally benign, and may be potentially employed as foam and emulsion stabilizers, and as matrices for environmental remediation systems. We will report means of synthesizing such Environmentally benign Nanoparticles (EbNPs) in a simple, inexpensive, and non-toxic way, by applying green synthesis methods such as environmentally friendly acid precipitation technology, or by employing solvent exchange precipitation method on modified lignin, e.g. Indulin AT (IAT) and High Purity Lignin (HP-L). For IAT EbNP formation, the water-water based pH drop method resulted in nanoparticles with diameters ranging from 40 to 200 nm. These particles show only limited pH stability ranging from pH 1.80 to pH 3.0. IAT EbNPs with pH stability ranging from pH 4.0 to 9.0 were synthesized with the ethylene glycol (EG)-water based pH drop method. Here, IAT is dissolved in EG, in which IAT EbNPs formation is triggered upon acid addition. Our hypothesis for the pH stability of these EbNPs might be a favorable IAT molecular stacking facilitated by EG prior to precipitation. For HP-L EbNP formation, HP-L is first dissolved in acetone and then rapidly diluted with DI water leading to supersaturation, nucleation, and EbNP growth. HPL EbNPs with diameters ranging from 40 to 200 nm with pH stability ranging from pH 4.0 to 9.0 were obtained. All IAT and HP-L EbNPs synthesized bear negative surface charges and are electrostatically stabilized. Post treatment options for surface charge modification to positive via adsorption of positively charged polyelectrolytes have been explored and are available. Dynamic Light Scattering is employed to measure EbNP size distributions as a function of the operating parameters such as pH drop magnitude, initial modified lignin loading in stock solution, and choice of solvent. Particle morphologies and shapes are determined by Transmission Electron Microscopy. Comprehensive bioactivity studies on various eukaryotic cells, prokaryotic mammal cells, and fish eggs are planned in collaboration with the U.S. Environmental Protection Agency (EPA) to evaluate the biotoxicity and the environmental impact of these 2nd generation EbNPs.



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Note: 362 words + 100 for graph