Aerosol Based Fabrication of Water Soluble Polymer Nanospheres

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It is well-known that water soluble polymers (WSPs) are gaining more and more importance in specific fields like pharmaceutic products and food additives (Finch, 2013), moreover, due to environmental hazardous issues; water-based formulations are replacing organic ones in important areas such as drilling fluids, cosmetics and paints.

Generally, WSPs particles are synthesized by conventional liquid phase methods such as emulsions polymerization where surfactants are used frequently and decrease product purity (Landfester *et al*, 1999). These methods suffer from additional drawbacks such as time and cost consumption. In fact, after wet polymerization, the particles should be separated and purified by downstream processes such as centrifugation or filtration followed by washing and drying steps. To overcome these limitations, we have used a facile synthesis method of continuous aerosol-photopolymerization to produce nanospherical water soluble polymers and copolymers. Furthermore, aerosol-photopolymerization can take place at ambient temperature without any surfactant required.

The continuous experimental setup for aerosol based photopolymerization is a combination of three main components, an atomizer, a flow-through photoreactor, and a collection filter (Figure 1). Monomer solution is sprayed with an atomizer in a nitrogen atmosphere to produce monodisperse droplets. Then sprayed droplets are passed through the photoreactor, where the free radicals are generated upon UV irradiation and subsequently photopolymerization process was initiated ‘‘in flight’’. Finally, the obtained polymer particles leaving the photoreactor were collected in powder form on a filter membrane.

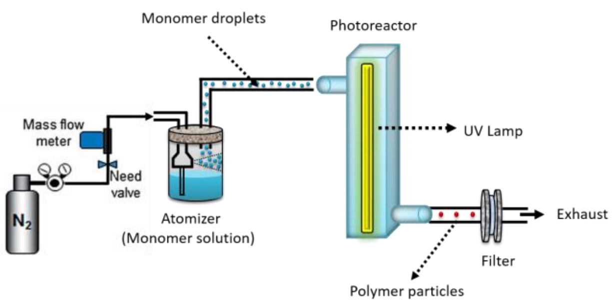

Figure 1. Scheme of experimental setup for aerosol-photopolymerization process.

The resulting polymers were characterized by SEM, TEM, ^{1}H NMR, FT-IR, TGA and elemental analysis.

TEM images of the resulting polyacrylamide (PAM), as an example of WSPs, indicate that PAM nanoparticles were successfully synthesized by aerosol-photopolymerization (Figure 2). Furthermore, the size and morphology of the resulting polymer particles could be controlled by the initial composition and concentration of monomer solution as well as through the reaction conditions.

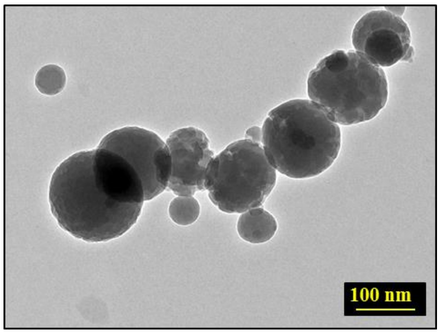

Figure 2. TEM image of PAM particles produced by aerosol-photopolymerization.

Furthermore, the produced PAM was analyzed by FT-IR, two important peaks at 3350 cm^{-1} and 1660 cm^{-1} attributed to the presence of NH_2 and C=O groups respectively (Figure 3A).

The thermal degradation of resulting PAM under air conditions show that the main decomposition of the PAM begins at 150 °C and is complete at 667 °C. The maximum weight loss occurs at a temperature of 237 °C.

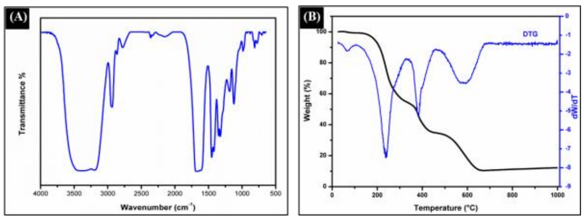

Figure 3. (A) FT-IR and (B) TGA spectra of PAM particles produced by aerosol-photopolymerization.

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