

From Polymer Nanoparticles to Structured Materials

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Emulsion polymerization is widely used at the industrial scale to produce aqueous dispersions of polymer colloids, with highly controlled size and polydispersity, in a variety of different chemical compositions and morphologies. Such nanoparticles are typically coagulated in appropriate devices to produce the desired polymeric materials in the form of dry powders.

Recent results in the theory of colloidal systems indicated the possibility to exploit the aggregation and breakage events occurring in these devices to produce supranano-structures, which cannot be achieved otherwise. Appropriate chemical reactions are then conducted to provide suitable functionalities as well as mechanical properties.

For example, one can mix dispersions of colloids of different composition and realize composites where the different phases retain the same size and morphology of the original colloidal particles. By controlling the gelation process, one can create percolating phases inside such composites, which allow transferring physicochemical properties from the nano to the macro scale. The case of bigels, where two independently percolating phases are created is also discussed.

Examples of different structured materials of interest for various applications are discussed. These include the production of controlled porous materials in the form of powders or monoliths, which can be used as adsorbents for large (bio) molecules or as thermal insulators. Other areas of interest include drug delivery and enhanced oil recovery.