Investigation of reaction parameters in one-step surfactant-free emulsion polymerization reactions

Salvatore Chiera[1], Jakob Iser[1], Karina Bley[1] and Nicolas Vogel[1]

[1] *Institute of Particle Technology, Friedrich-Alexander University Erlangen-Nürnberg (FAU), Haberstrasse 9A, 91058 Erlangen,*

Monodisperse polymer colloidal particles are applied both in fundamental research and applied technology. These particles are for example used as defined building blocks for fundamental investigations on self-organization[1]. Furthermore they can be used as colloidal templates for the fabrication of surface patterns with nanoscale precision in a process termed colloidal lithography[2]. In more applied fields, these colloids find application in size exclusion and high-performance liquid chromatography, calibration standards and in molecular biology as scaffolds to isolate proteins and nucleic acids for analysis and purification [3].

In the present study, the influence of both chemical engineering aspects and physicochemical parameters on the surfactant-free emulsion polymerization of styrene and acrylic acid were investigated with the goal to provide a scalable and robust approach towards micron-sized monodispersed polymer colloids. Regarding the chemical engineering aspects, four stirrer types were tested for various specific power inputs and stirring speeds. The investigation of the physicochemical parameters lead to the recognition that the most significant influence on the particle size and polydispersity is the temperature of the reaction, the electrolyte and initiator concentration. Especially, the addition of electrolyte is crucial for the reaction as it influences colloidal stability during the nucleation phase, which lead to larger particles, and during the growth phase, which leads to the formation of coagulates. We attempt to exploit this instability to reduce the number of particle nuclei by inducing colloidal instability exclusively during the nucleation period. In order to avoid coagulation the electrolyte were sequestered by means of chelating agents after the nucleation time.

We found that the sequestration of the electrolyte ions after the nucleation is a promising approach for the formation of large monodisperse polymer particles. Furthermore, the careful combination of chemical and physicochemical parameters, like stirrer type and speed as well as initiation and monomer concentration, is necessary to produce polymer colloidal particles with narrow size distribution and controlled sizes.

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[3] J Ugelstad et al., *Prog Polym Sci* **17** (1992) 87.