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# Polymerization kinetics of cyanate ester confined to hydrophilic nanopores of silica colloidal crystals with different surface-grafted groups

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## Abstract

© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This study investigates the kinetics of confined polymerization of bisphenol E cyanate ester in the nanopores of the three types of silica colloidal crystals that differ in the concentration and acidity of the surface-grafted proton-donor groups. In all three types of pores, the polymerization has released less heat and demonstrated a very similar significant acceleration as compared to the bulk process. Isoconversional kinetic analysis of the differential scanning calorimetry measurements has revealed that the confinement causes not only a dramatic change in the Arrhenius parameters, but also in the reaction model of the polymerization process. The obtained results have been explained by the active role of the silica surface that can adsorb the residual phenols and immobilize intermediate iminocarbonate products by reaction of the monomer molecules with the surface silanols. The observed acceleration has been quantified by introducing a new isoconversional-isothermal acceleration factor Zα,T that affords comparing the process rates at respectively identical conversions and temperatures. In accord with this factor, the confined polymerization is 15–30 times faster than that in bulk.

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## Keywords

Colloidal crystals, Confinement, Cyanate esters, Isoconversional kinetic analysis, Polymerization kinetics, Thermal analysis

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