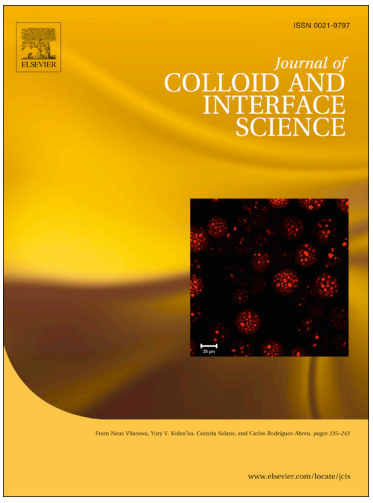

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ABSTRACT

Hypothesis/objective

We examine the time dependent viscometric behavior of a well-defined system of gelling colloidal silica and how this behavior may be understood from a simple theoretical model which incorporates the microstructure of the gel. The ultra-small angle neutron scattering (USANS) technique is used to interrogate structure during the gelation process.

Experiments

The investigations focused on a system where both particles and interactions are well-defined: 7 nm silica particle acid-treated aqueous solution subjected to a constant applied shear in Couette geometry. Ultra-small angle neutron scattering (USANS) time-dependent scattering intensities measured at wave vectors, q, in the range, $1.0 \times 10^{-3} \leq q/\mathrm{nm} \leq 7.3 \times 10^{-2}$ coupled with viscosity data recorded simultaneously. The interpretation of the USANS scattering data is reliant on an isotropic sample. This assumption has been investigated, over a limited range of scattering vectors, using more suitable small angle neutron scattering (SANS) instrumentation with a restricted q-range.

Findings

The first recorded direct kinetic measurements of the micron-scale structure in a gelling system are presented. A critical micro-structural feature of the intensity-viscosity time behavior of a gelling colloid subjected to a shear is the cluster size. A viscosity/intensity coupling observed at the time of a viscosity maximum that corresponds to a time-dependent critical stress and speculated to be independent of the wave vector over a wide q-range.

Keywords:

USANS, gelation, colloidal silica, shear, viscosity, kinetics, micron length scale, anisotropy