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Short-time dynamics and high-frequency rheology of suspensions of spherical core–shell particles with thin-shells

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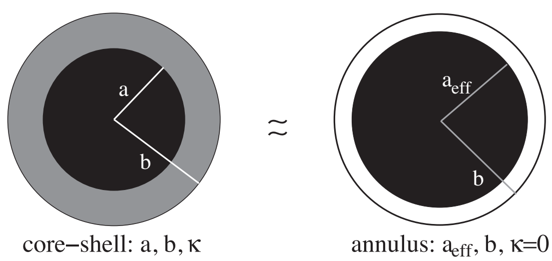
HIGHLIGHTS

- ▶ Dynamics of core–shell particles suspensions was analyzed in the thin-shell limit.
- ▶ Virial coefficients for self-diffusion, sedimentation and viscosity were evaluated.
- ▶ The standard model of hard spheres with hydrodynamic radii was shown to be imprecise.
- ▶ The hydrodynamic and no-overlap radii were used to define an effective annulus model.
- ▶ For thin-shells, accuracy of the effective annulus model was shown and justified.

GRAPHICAL ABSTRACT



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ABSTRACT

Short-time dynamics and high-frequency rheology for suspensions of non-overlapping core–shell particles with thin shells were analyzed. In the thin-shell limit, the single-particle scattering coefficients were derived and shown to define a unique effective radius. This result was used to justify theoretically (in the thin-shell limit) the accuracy of the annulus approximation with the inner radius equal to the effective hydrodynamic radius of the core–shell particle. The two-particle virial expansion of the translational and rotational self-diffusion, sedimentation and viscosity was performed. The virial coefficients were evaluated and shown to be accurately approximated by the effective annulus model, in contrast to the imprecise effective hard sphere model.

1. Introduction

Recently, there has been a growing interest in micro and nanogels, and other permeable particles, which can be used to carry drugs or proteins [1–6]. For such systems, density of polymer segments inside the core region is frequently much higher than in the outer part, and therefore they are often approximated as core–shell particles.

A core–shell particle consists of a solid core of radius a, and a surrounding permeable shell, with the inner and outer radii, a and b, respectively (see Fig. 1). The porous medium inside the shell is characterized by the uniform hydrodynamic penetration depth κ^{-1}.

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