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DYFUZJA, SEDYMENTACJA I REOLOGIA GĘSTYCH ZAWIESIN CZĄSTEK Z TWARDYM RDZENIEM

DIFFUSION, SEDIMENTATION, AND RHEOLOGY OF CONCENTRATED SUSPENSIONS OF CORE-SHELL PARTICLES

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Key words: Stokes equations, Brinkman-Debye-Bueche equations, permeable particles, translational and rotational self-diffusion, sedimentation, effective viscosity

Short-time dynamic properties of concentrated suspensions of colloidal core-shell particles have been recently studied [1] using a precise force multipole method which accounts for many-particle hydrodynamic interactions (HIs). A core-shell particle is composed of a rigid, spherical dry core of radius a surrounded by an uniformly permeable shell of outer radius b and hydrodynamic penetration depth κ^{-1}. The solvent flow inside the permeable shell is described by the Brinkman-Debye-Bueche equation, and outside the particles by the Stokes equation. The particles are assumed to interact non-hydrodynamically by a hard-sphere no-overlap potential of radius b. Numerical results are presented for the high-frequency shear viscosity, sedimentation coefficient and the short-time translational and rotational self-diffusion coefficients. The simulation results cover the full three-parametric fluid-phase space of the composite particle model, with the volume fraction extending up to 0.45, and the whole range of values for κb, and a/b. Many-particle hydrodynamic interaction effects on the transport properties are explored, and the hydrodynamic influence of the core in concentrated systems is discussed.

An essential result of our study is that for concentrated core-shell systems, the influence of the internal particle structure is significant. Even for hardly permeable or very thin shells, the core-shell systems are not accurately approximated by the hard-sphere model.

However, one of our findings is that for $\kappa(b-a) > 5$, the core is practically not sensed any more by the weakly penetrating fluid. In this case, the core-shell systems can be well-approximated using the uniformly permeable particles, as schematically illustrated in Fig. 1. In most cases, the influence of the core grows only weakly with increasing concentration.

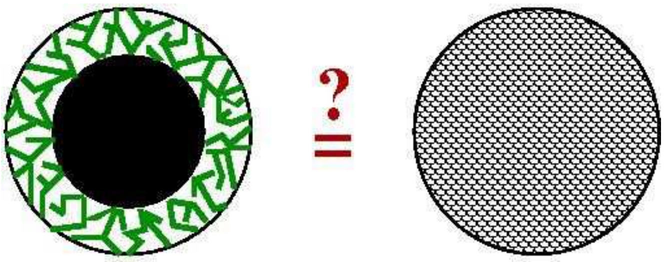

Fig. 1 Graphical abstract of the paper: Can core-shell particles in concentrated suspensions be well-approximated by uniformly permeable spheres with the same hydrodynamic penetration depth?

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[1] Abade G. C., Cichocki B., Ekiel-Jeżewska M. L., Nägele G., Wajnryb E., *Diffusion, sedimentation, and rheology of concentrated suspensions of core-shell particles***,** J. Chem. Phys., 2012, vol. 136, 104902.