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Flow and stress-relaxation properties of dense spongy-particle systems

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Introduction
Permeable particles (envisaged as sponges) are widely used in nature, e.g. casein micelles in dairy products, and in industrial applications, e.g. paints. Their permeable structure allows them to undergo rate-dependent volume changes as their elastic network takes up or expels the viscous suspending solvent. We study the effect of the single-particle elastic modulus and permeability on the flow properties and on the stress-relaxation behavior of dense permeable-particle suspensions, using the Brownian Dynamics simulations developed in [1].

Flow properties\textsuperscript{[2]}
\begin{itemize}
  \item shear-induced ordering
\end{itemize}

\begin{itemize}
  \item long-time shear stress
  \item transition time
\end{itemize}

\rightarrow long-time stress values of spongy-particle suspensions are governed by the particle modulus
\rightarrow the particle permeability affects the rate at which the final state is reached

Stress-relaxation\textsuperscript{[3]}
\begin{itemize}
  \item flow-cessation simulations
\end{itemize}

\rightarrow stress relaxation occurs on shorter time scales in the case of permeable particles compared to impermeable particles.

\rightarrow stress relaxation is promoted by the motion of the particles within the cages formed by the surrounding particles, rather than by cage escape.

Conclusions
a. Under imposed deformation: Long-time stress is governed by particle elasticity, while the rate at which the final state is reached depends strongly on particle permeability.
b. Upon flow cessation: Particle permeability accelerates stress relaxation, due to particle compression induced during pre-shear, which renders their cages less effective

References