Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Extension of Kirkwood-Riseman Theory across the Entire Range of Knudsen Numbers JAMES CORSON, MICHAEL ZACHARIAH, GEORGE MULHOLLAND, HOWARD BAUM, University of Maryland — Aggregates of small, spherical particles form in many high temperature processes (e.g. soot formation). We consider the drag force on a fractal aggregate using Kirkwood-Riseman (KR) theory, in which the force exerted on each particle in the aggregate can be obtained from the hydrodynamic interaction tensor $\mathbf{T}$ and the friction coefficient f for flow around an isolated sphere. The force on the aggregate is the vector sum of the force on each particle. Meakin and Deutch (1987) demonstrated that this approach yields a reasonable estimate of the drag force for an aggregate in continuum flow, where $\mathbf{T}$ is the modified Oseen tensor of Rotne and Prager. We have extended this approach across the entire Knudsen range by calculating $\mathbf{T}$ and f using the BGK model in the linearized Boltzmann equation. Our results for f agree with Millikan's data for the entire Knudsen range, and the free molecular drag force on the aggregate calculated with our extended KR theory is within a few percent of the drag computed using Monte Carlo methods. These results suggest that we can obtain a reasonable estimate of the drag in the transition regime in seconds once we have obtained $\mathbf{T}$ and f for a given Knudsen number.

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Date submitted: 01 Aug 2016 Electronic form version 1.4