Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Modeling drag reduction by slippery surfaces comprised of microridges with two fluids[1] MOHAMED A. SAMAHA, MARCUS HULTMARK, Princeton University — Theoretical analysis, numerical simulations, and experimental study are developed to predict drag reduction possessed by slippery surfaces, which entrap a second immiscible fluid within their micropores. The aim is to improve our understanding of the slip-flow and drag-reduction effects in terms of surface morphology and properties of both fluids. Stokes flow is simulated over surfaces with microstructure of both streamwise and spanwise ridges configurations. The entrapped fluid circulation between the microridges is also simulated for different geometries of the cavity. For validation, the results of the theoretical model are compared to those of the numerical simulations, and also compared to the available results of previous studies reported in the literature. Scaling laws are obtained for the reduction in shear stress at the surface in terms of the generic surface characteristics (surface roughness and both fluids' properties). These predictions are compared to the experimental data of rheological tests performed on fabricated samples. The models allow using different kinds of fluids with a wide range of viscosities. This work could be utilized to design slippery surfaces such as superhydrophobic and omniphobic coatings to maximize drag reduction.

[1]Office of Naval Research (Grant #: N00014-12-1-0875), program manager Dr. Ki-Han Kim.

Mohamed A. Samaha
Princeton University

Date submitted: 17 Jul 2013 Electronic form version 1.4