Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Transient motion of mucus plugs in respiratory airways[1] PARSA ZAMANKHAN, YINGYING HU, Biomedical Engineering Department, University of Michigan, BRIAN HELENBROOK, Department of Mechanical and Aeronautical Engineering, Clarkson University, SHUICHI TAKAYAMA, JAMES B. GROTBERG, Biomedical Engineering Department, University of Michigan — Airway closure occurs in lung diseases such as asthma, cystic fibrosis, or emphysema which have an excess of mucus that forms plugs. The reopening process involves displacement of mucus plugs in the airways by the airflow of respiration. Mucus is a non-Newtonian fluid with a yield stress; therefore its behavior can be approximated by a Bingham fluid constitutive equation. In this work the reopening process is approximated by simulation of a transient Bingham fluid plug in a 2D channel. The governing equations are solved by an Arbitrary Lagrangian Eulerian (ALE) finite element method through an in-house code. The constitutive equation for the Bingham fluid is implemented through a regularization method. The effects of the yield stress on the flow features and wall stresses are discussed with applications to potential injuries to the airway epithelial cells which form the wall. The minimum driving pressure for the initiation of the motion is computed and its value is related to the mucus properties and the plug shape.

[1]Supported by HL84370 and HL85156.

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Date submitted: 12 Aug 2011 Electronic form version 1.4