Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Small-Scale Respiratory Flows in a Space-Filling Model of the Pulmonary Acinus JOSUE SZNITMAN, SEBASTIAN SCHMUKI, RETO SUTTER, Institute of Fluid Dynamics, ETH Zurich, AKIRA TSUDA, Physiology Program, Harvard School of Public Health, THOMAS ROESGEN, Institute of Fluid Dynamics, ETH Zurich — Respiratory flows in the lung periphery are governed by low Reynolds number quasi-Stokes flow induced by the wall motion of sub-millimeter airways marked by the presence of alveoli. Following Fung's model of lung structure (J. Appl. Physiol, 1988), CFD simulations of respiratory flows are investigated in a dichotomous asymmetric three-dimensional space-filling model of a pulmonary acinus. Resulting alveolar flow patterns, induced by kinematic wall motion, are complex and intrinsically three-dimensional. The alveolar flow topology is quasi-steady, due to low Womersley numbers, and largely governed by the ratio of alveolar to ductal flow rates. This ratio describes the interplay between alveolar recirculation, induced by ductal shear flow over the alveolus opening, and alveolar radial flow, induced by the expansion/contraction wall motion. Lagrangian particle tracking of massless particles is conducted over cumulative breathing cycles to investigate the influence of alveolar flows on aerosol kinematics and the existence of irreversible chaotic mixing. Furthermore, our space-filling model is well suited to consider the influence on acinar flows of openings in the alveolar wall between adjacent alveoli (pores of Kohn).

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Date submitted: 11 Jul 2006 Electronic form version 1.4