Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

**Physical principle of airway design in human lungs** KEUNHWAN PARK, TAEHO SON, Department of Mechanical & Aerospace Engineering, Seoul National University, Seoul, Korea, WONJUNG KIM, Department of Mechanical Engineering, Sogang University, Seoul, Korea, HO-YOUNG KIM, Department of Mechanical & Aerospace Engineering, Seoul National University, Seoul, Korea —
From an engineering perspective, lungs are natural microfluidic devices that extract oxygen from air. In the bronchial tree, airways branch by dichotomy with a systematic reduction of their diameters. It is generally accepted that in conducting airways, which air passes on the way to the acinar airways from the atmosphere, the reduction ratio of diameter is closely related to the minimization of viscous dissipation. Such a principle is formulated as the Hess-Murray law. However, in acinar airways, where oxygen transfer to alveolae occurs, the diameter reduction with progressive generations is more moderate than in conducting airways. Noting that the dominant transfer mechanism in acinar airways is diffusion rather than advection, unlike conducting airways, we construct a mathematical model for oxygen transfer through a series of acinar airways. Our model allows us to predict the optimal airway reduction ratio that maximizes the oxygen transfer in a finite airway volume, thereby rationalizing the observed airway reduction ratio in acinar airways.

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Date submitted: 01 Aug 2014 Electronic form version 1.4