Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Macroscopic nanoporous graphene membranes for molecular-sieving-based gas separation MICHAEL BOUTILIER, ROHIT KARNIK, NICOLAS HADJICONSTANTINOU, MIT — Nanoporous graphene membranes have the potential to exceed permeance and selectivity limits of existing gas separation membranes. This is made possible by the atomic thickness of the material, which can support sub-nanometer pores that enable molecular sieving while presenting low resistance to permeate flow. The feasibility of gas separation by graphene nanopores has been demonstrated experimentally on micron-scale areas of graphene. However, scaling up to macroscopic membrane areas presents significant challenges, including graphene imperfections and control of the selective nanopore size distribution across large areas. Towards this goal, gas permeance experiments are conducted on single and few layer graphene membranes to understand leakage pathways and a model is developed to predict conditions under which molecular sieving can occur in macroscopic membranes. Approaches to seal or mitigate the effects of micron and nanometer scale defects in graphene are investigated and methods of creating a high density of selectively permeable nanopores are explored. Experimental results demonstrating separation ratios exceeding the Knudsen effusion limit, indicating molecular sieving in agreement with the model predictions, are presented and discussed.

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Date submitted: 01 Aug 2016 Electronic form version 1.4