Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Operation of Nanoelectromechanical Sensors in Damping Fluid Environment O. SVITELSKIY, V. SAUER, N. LIU, K.-M. CHENG, M.R. FREEMAN, W.K. HIEBERT, University of Alberta Physics Department and National Institute for Nanotechnology, Edmonton AB Canada — The quality factor of these devices is strongly influenced by environment that directly impacts their sensitivity and performance, which is particularly important for biosensing and medical applications. To shed a light on this problem, we present a comprehensive study of nanomechanical sensor resonators submerged in the damping environment of three gases (He, N2, CO2), and one liquid (CO2). Resonant dynamics, in multiple devices of varying size (0.15-3 μm) and frequency (10-350 MHz) over 10 decades of pressure (from 1 mPa to 20 MPa), is measured using a specially built gas pressurization optical chamber and real time-domain stroboscopic optical interferometry. The wide pressure range allows full exploration of the regions of validity of Newtonian and non- Newtonian flow damping models. Observing free molecular flow behavior extending above atmospheric pressure, we find a fluid relaxation time model to be valid throughout, but not beyond, the non-Newtonian regime, and a Newtonian flow vibrating spheres model to be valid in the viscous limit.

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Date submitted: 16 Nov 2009 Electronic form version 1.4