Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

Nanoscopic friction as a probe of local phase transitions ELISA RIEDO, ROBERT SZOSZKIEWICZ, GeorgiaTech — Water gas-liquid phase transitions have been investigated by measuring nanoscale friction forces between an atomic force microscope tip and a glass surface while varying the relative humidity, the scanning velocity and the temperature. We observe that it is possible to obtain the same friction versus velocity curves by fixing the sample temperature and varying the buffer humidity or by fixing the buffer humidity and varying the sample temperature. This behavior can be understood by introducing the concept of local humidity at the glass surface, which depends on the temperature. By using the well known macroscopic relationship between relative humidity and temperature we can fully explain our experimental results. This finding suggests that the water gas-liquid phase diagram is the same at the macroscopic scale as well as at the nanoscopic scale at a solid-gas interface. Furthermore, friction data for varying the scanning velocity provide mean nucleation times for capillary bridges formation. These times were found to alter from 3.5 ms up to 0.6 ms for temperatures ranging from 299 K up to 332 K. Natural logarithms of nucleation times plotted against inverse of experimental temperatures produce an Arrhenius plot and give a nucleation energy of 7.8×10^{-20} J for a nano-sized capillary bridge formation, in agreement with recent theoretical models. Our study provides the first direct experimental evidence of the thermally activated condensation of capillary bridges at the nanoscale.

Elisa Riedo
GeorgiaTech

Date submitted: 07 Dec 2004 Electronic form version 1.4