Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

The transition to thermocapillary convection during evaporation
FEI DUAN, C.A. WARD, Mechanical and Industrial Engineering, University of Toronto, Canada — Experiments have been conducted to investigate thermocapillary convection in water during evaporation from a spherical liquid-vapor interface. The Marangoni number (Ma) is found to be an indicative parameter for the Marangoni transition. When Ma is less than 100, the interface is quiescent with a uniform liquid temperature, an interfacial temperature discontinuity, and a temperature gradient in the vapor phase. Thermal conduction provides the energy required to evaporate the liquid at the observed rate. When Ma is greater than 100, significant temperature gradients exist along the interface, and in each bulk phase. If thermocapillary convection is neglected, thermal conduction does not provide enough energy to evaporate water at the observed rate. To satisfy energy conservation, a new property of water, the surface-thermal capacity, is introduced. The local evaporation flux is then calculated from an interfacial energy balance, and statistical rate theory is applied to predict the local interfacial pressure. The mean of the predicted pressures agrees with the measured vapor-phase pressure.

Charles A. Ward
Mechanical and Industrial Engineering, University of Toronto

Date submitted: 02 Aug 2006 Electronic form version 1.4