Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Temperature sensitivity of surface tension-driven flows: Application to time-temperature integration JOHN THOMAS, LAWRENCE HUNTER, MICHAEL BOYLE, Johns Hopkins University Applied Physics Laboratory — The effects of time-dependent temperature fluctuations on surface-tension driven fluid flow inside a capillary are modeled using classical hydrodynamics. To begin, we use Newton's second law to derive a non-dimensional equation of motion that describes capillary flow as a function of system geometry, fluid properties, and fluid temperature. We use this model to examine how temperature excursions affect the instantaneous and long-term position and velocity of the fluid front inside the capillary. Next, we examine the combined effects of orientation change and temperature change on fluid movement through the capillary. Using this data, we show how to design a non-powered time-temperature integration device for recording the cumulative temperature exposure history of an asset or local environment. By selecting an appropriate fluid and capillary geometry, we show how such devices can be designed to exhibit arbitrary temperature sensitivities, operate over arbitrary monitoring periods (months to decades), and operate in a manner that does not depend on orientation.

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Date submitted: 26 Jul 2011 Electronic form version 1.4