PhD Dissertation Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

Theoretical and Experimental Analysis and Optimization of Thermal Conduction in Electrochemical and Latent Heat Energy Storage Systems

By: Amirhossein Mostafavi

Advisor: Dr. Ankur Jain

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Teams

Abstract

Phase change heat transfer is used commonly for enhanced thermal management and energy storage in several engineering applications. The rate of heat transfer from a heat source into a phase change material (PCM) is limited by thermal properties and geometry, due to which, the use of metal fins protruding into the PCM has been investigated. This work derives and solves the governing energy conservation equations to determine the transient temperature distribution in the PCM due to the presence of a Cartesian fin. A perturbation method based solution for the Stefan problem with time-dependent temperature boundary condition is used to derive an equation for the fin temperature distribution. Results show that for a given total time available for heat transfer into the fin, the presence of a fin results in two competing effects – enhanced heat transfer into the PCM through the fin and reduced heat transfer into the PCM due to lower area of direct contact between PCM and heat source. This results in a non-monotonic dependence of total heat flow into the PCM on the fin size and shows that a fin larger than a certain optimal size may actually impede overall heat flow into the PCM. For a given total time, the optimal fin size is shown to be a function of the fin thermal conductivity. The theoretical work in this work extends the well-known governing equation for a fin in a single-phase medium to a fin in a phase change material, which is a much more complicated, transient problem.