SYMPOSIUM

School of Aeronautics and Astronautics

The 2014 Research Symposium Series

*** Free Pizza ***

Monday, April 7, 2014

4:30 pm in ARMS 1021

An Analysis of the Effects of Temperature, Straining and Structural Arrangements on the Thermal Conductivity and Thermal Fiffusivity of Tropocollagen–Hydroxyapatite Interfaces

Tao Qu

The ability of a biomaterial to transport energy by conduction is best characterized in the steady state by its thermal conductivity and in the non-steady state by its thermal diffusivity. The complex hierarchical structure of most biomaterials makes the direct determination of the thermal diffusivity and thermal conductivity difficult using experimental methods. This study presents a classical molecular simulation based approach for the thermal diffusivity and thermal conductivity prediction for a set of tropocollagen and hydroxyapatite based idealized biomaterial interfaces. The thermal diffusivity and thermal conductivity values of tropocollagen-hydroxyapatite material systems with five different strain levels (10% compressive, 5% compressive, 0%, 5% tensile, 10% tensile) are calculated using the presented approach at three different temperatures (300 K, 500 K and 700 K). The effects of temperature, straining, structural arrangements, and size of simulated systems on the thermal properties are analyzed. Analyses point out important role played by the interface orientation, interface area, and structural hierarchy. Ensuing discussions establish that the interface structural arrangement and interface orientation combined with biomimetic structural hierarchy can lead to non-intuitive thermal property variations as a function of structural features.

Large Length-Scale Thermocapillary Flow Experiment Design

Samantha Alberts

This work focuses on the plausibility, design, and validation of a large length-scale thermo-capillary flow experiment. Large spaceflight liquid systems, such as current fuel tanks for Mars missions, inherently have spatial variations in temperature, which induce forces on the liquid-gas interfaces and generate thermo-capillary flows. To date thermo-capillary flows have been studied in small, idealized research geometries allowable in terrestrial conditions. Current large tank geometries (1-3 meters) are designed based on function rather than research, which leaves spaceflight system designers without the technological tools to effectively create safe and efficient designs. The design of a meter-long helical channel geometry permits the thermo-capillary flow experiment to fit a seemingly small ISS facility like the Fluids Integrated Rack. An initial investigation into the plausibility of this work determined the proposed experiment would produce measurable data. The computational portion of this work focuses on the investigation of functional geometries of fuel tanks and depots using FLUENT. The results of this work increase the understanding thermo-capillary flows and thus improve technological tools for predicting heat and mass transfer in large length-scale thermo-capillary flows. Without these tools, we are forced to design larger, heavier, vehicles to assure safety and mission success.

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