Through Thickness Thermal Conductivity Enhancement for 3-D Fiber Composites

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INTRODUCTION

◆ Motivation
  ◆ The low through-thickness thermal conductivity of laminated fiber composites restricts their applications in practical systems where heat needs to be removed efficiently.
  ◆ Small thickness implies the best way to extract heat from a composite enclosure is through its thickness direction.

◆ Objectives
  ◆ Understand fundamental limitations of thermal conductivity in existing composites and propose novel approaches.
  ◆ Address measurement issues for heterogeneous samples.

EXPERIMENTAL METHOD AND SETUP

◆ Fourier’s Law based thermal conductivity (TC) measurement setup

SETUP VALIDATION FE MODEL

◆ Axisymmetric FE Model

◆ Modeling approach: Allow for heat loss in radial direction and incrementally change sample conductivity k2 to match T1~T5 temperatures.

HEAT TRANSPORT IN HETEROGENEOUS SAMPLES

◆ Z- fiber composite samples

TC ENHANCEMENT APPROACHES AND MODELS

◆ Approaches
  ◆ Embed Z fibers
  ◆ Create a conductive coating

◆ Models investigated
  ◆ Conductive fiber in thickness direction with/without conductive coating
  ◆ Fiber distribution effect
  ◆ Combined effect of conductive coating and fiber distribution

TC ENHANCEMENT RESULTS

◆ Single-fiber unit cell model

◆ Fixed fiber volume fraction but different fiber distributions

◆ Combined models of fiber distribution with coating

FUTURE WORK

◆ Improve the validity of the model of conductive coated composite samples by manufacturing optimization, and experimental test with the TC measurement setup.

◆ Characterize and validate models of composites with different fibers of different TC, placement and structures.

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