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Thermal Applications of Multifunctional Materials with Nanoscale Architectures

Abstract

Thermal management is one of the primary bottleneck to increasing performance in modern electronic devices ranging from laptops and smartphones to solar cells and batteries. The thermal engineering of such devices represents a multiscale materials challenge that ranges from the ever-shrinking transistor to the increasingly prevalent portable electronics. Many of these problems can be addressed through "thermal metamaterials", which are multifunctional thermal conductors that exhibit unique combinations of properties not available in nature. In this talk, I will discuss avenues to synthesize and characterize porous metal nanomaterials having functional architectures to address three specific challenges in thermal engineering. First I introduce the use of vertically-aligned copper nanowire arrays as thermally-conductive and mechanically-flexible thermal interface materials. Next I synthesize and measure the thermal conductivity of metal inverse opals, which are fluid-permeable and high-conductivity thin films for applications in microfluidic heat exchangers and microscale heat pipes. Lastly, I examine the use of porous metals infiltrated with a phase change material as high-rate thermal capacitors to buffer thermal transients. This talk aims to illustrate how we can push toward the extreme limits of thermal engineering by designing the architecture of materials at the nanoscale.

Bio
Michael Barako is a Staff Scientist in the NG Next basic research institute at Northrop Grumman Aerospace Systems and a visiting researcher at UC Irvine with Prof. Yoonjin Won. He received his Ph.D. in 2016 in mechanical engineering department at Stanford University under Professor Ken Goodson. His dissertation examined novel techniques in both nanomaterials synthesis and thermal physics as applied to porous metals having functional nanoscale architectures. He received his M.S. in mechanical engineering from Stanford University (2012) and his B.S. in mechanical engineering from Carnegie Mellon University (2010). Michael's work has received recognition by numerous institutions, including the *IEEE ITHERM* Outstanding Paper and Best Poster Awards, Stanford *MRS* Art of Science Award, Stanford Centennial Teaching Assistant Award, and the National Defense Science and Engineering Graduate Student Fellowship.