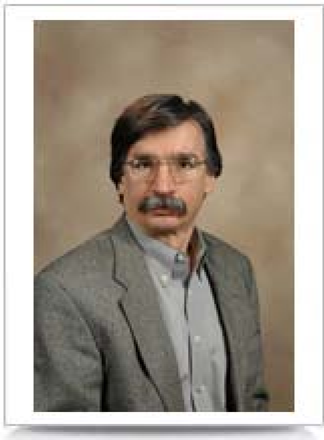
Femtosecond Laser Formation of Self-Organized Micro/Nanostructures on Metallic Surfaces and their Thermal/Fluids Applications

Professor George Gogos

Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln

Abstract

The use of micro/nanostructured surfaces has become very promising in research areas such as heat transfer enhancement, drag reduction/enhancement, anti-icing and bacteria growth prevention. Through the use of femtosecond laser surface processing techniques, we have demonstrated the control of self-organized micro/nanostructure formation on a wide range of metals including a number of stainless steel alloys, aluminum, nickel, titanium, Inconel 740H, Zircaloy-4 and copper. Three specific classes of structures are presented: above surface growth mounds (ASG-mounds), below surface growth mounds (BSG-mounds) and nanoparticle covered pyramids (NC-pyramids). These unique structures form through a balance of material ablation, fluid flow, and material re-deposition that is determined by the laser fluence and the number of pulses used during processing. Within each structure class, we present the ability to fine tune the size and shape of the surface structures. We demonstrate how the self-organized micro/nanostructures and changes in surface chemistry, produced through femtosecond laser surface processing, can be used to functionalize the wetting properties. Through pool boiling experiments we show enhanced two phase heat transfer characteristics, increased Critical Heat Flux and an extraordinary shift in the Leidenfrost temperature for delayed film evaporation.



George Gogos (University of Nebraska – Lincoln)

Dr. George Gogos holds a B.S. degree in Mechanical Engineering from the Massachusetts Institute of Technology (1980) and an M.S. (1982) and PhD (1986) degrees in Mechanical Engineering from the University of Pennsylvania. After he completed his studies, he joined Rutgers University as an Assistant Professor and in 1993 moved to the University of Nebraska – Lincoln as an Associate professor where he is currently a Professor and Graduate Director in the Department of Mechanical Engineering. He is also the Associate Director of the Center for Electro-optics and Functionalized Surfaces (CEFS). He conducts research in fuel combustion, with emphasis on droplet combustion, droplet vaporization at elevated pressures and microgravity combustion. In addition, he conducts research in a number of interdisciplinary areas that require his expertise in the thermal/fluids sciences, such as rapid DNA multiplication for detection of biological agents (rapid PCR development), blast wave mitigation, rotational molding and propane flaming for weed control in agronomic crops. Over the past seven years his research emphasis is on femtosecond laser formation of self-organized micro/nanostructures on metallic surfaces and their thermal/fluids applications. His research is funded by NSF, NASA, NIH, ARO, ONR, USDA, Boeing and other industries. He has co-authored more than 140 technical papers in archival Journals and Conference Proceedings. He teaches undergraduate and graduate courses in combustion, fluid mechanics, heat and mass transfer processes, thermodynamics and computational heat transfer and fluid flow.