MULTIPLE DROPLET IMPINGEMENTS ON NANOSTRUCTURED SURFACES FOR ENHANCED SPRAY COOLING

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ABSTRACT

Spray cooling has been studied thoroughly over the years in an effort to understand its unique heat transfer potential. Spray cooling is characterized by its ability to dissipate high heat transfer rates while maintaining relatively uniform surface temperatures. Despite of all the recent developments, liquid-surface properties such as contact angle and surface tension have been shown to limit the ability of spray cooling to dissipate high heat flux. Recent high-speed images of multiple droplet impingent events have revealed that liquid film thickness, impact crown morphology, and tangential velocity gradients tend to dominate the overall heat transfer process. All these aspects are intrinsically linked to surface morphology. Therefore, enhancement of heat transfer should be preceded by the design, fabrication and use of surfaces that reduce film thickness, promote constructive impact crown morphology, and facilitate greater tangential velocity gradients.

Recently, a new type of nanostructured surface has been designed, fabricated, and tested that reduces film thickness and contact angle by at least 30%. The nanostructured surface consists of nanopillars of 100 nm in height and 200 nm in diameter. The combination of spacing and nanopillar size has resulted in a thinner liquid film. The nanostructured surface was fabricated using the Step and Flash Imprinting Lithography (S-FIL) technique. Current work also includes the study of the relationship between the effective thermal diameter and heat flux when using nanostructured and bare surfaces.