Proceedings of the 3rd International Conference on Fluid Flow and Thermal Science (ICFFTS'22)
Seoul, South Korea - October 27 - 29, 2022
DOI: 10.11159/icffts22.001

Control of Local Surface Heat Flux using Dielectric Barrier Discharge Actuator

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Abstract

Dielectric barrier discharge actuator continues to be an area of strong research interest due to its broad practical relevance. Besides flow actuation for lift, drag and noise modifications, and reactive oxygen and nitrogen species generation for biological decontamination, these reactors found usage in controlling local surface heat flux of intricate surfaces important for scientific and industrial applications. Common convective or conductive cooling approaches have limited reach and due to their power and weight penalty are not very effective. Especially convective cooling methods include moving parts and thus suffer from reliability issues. As an alternative, plasma-based local heat flux modification is introduced as it can be very effective and are known for fast response even for hard-to-reach areas. These actuation devices do not have any mechanical components, can be applied to the receptive locations and are generally surface complaint. Plasma actuators can also be miniaturized to adapt a surface. Examples of plasma-based cooling include various non-linear electrode shapes like serpentine, horseshoe, and needle. Specifically, we will discuss research progress in how these electrode geometries can improve the energy efficacy for turbine blades and electronic surfaces using very low power. These actuators also induce local three-dimensional vortices which may be used in boundary layer flows for separation control and drag reduction introducing distributed roughness of a receptive surface. Realizable performance of these actuators under adverse weather condition will also be discussed.