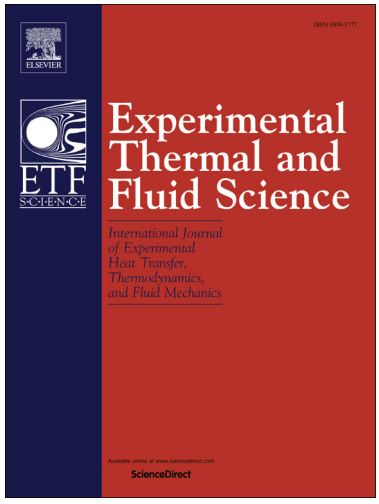

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Effect of nanosecond-pulsed plasma actuation on a separated laminar flow

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Abstract

An experimental investigation was carried out on the effect of unsteady periodic control on a separated laminar shear layer. Time resolved Particle Image Velocimetry (tr-PIV) was used to characterize a backward-facing step (BFS) flow (Re_h = 3600), periodically perturbed by a nanosecond Dielectric Barrier Discharge (ns-DBD) plasma actuator. Ensemble averaged vector fields indicate a decrease of reattachment length with increasing actuation non-dimensional frequency, reaching a minimum at a St_h = 0.32. Further increase of forcing non-dimensional frequency, up to 0.4, resulted into an increase of the reattachment length, which nevertheless remained shorter than the non-actuated case. Spectral analysis of the fluctuating fields revealed a change of the amplified frequency range for the actuated cases with respect to the base flow. Proper Orthogonal Decomposition (POD) analysis showed that actuation leads to a redistribution of energy among coherent spatial modes. Stability diagrams were calculated from mean velocity field data for each case via Linear Stability Theory (LST). Results indicate that stability of each actuated case changes with respect to the non-actuated case. Moreover, looking into the calculated growth rate for all the cases a more stable flow regime is observed for the cases of most successful reduction in terms of reattachment length. The effect of a pulsed periodic perturbation on the control of a laminar shear layer promotes the development of large structures, i.e. K-H vortices, due to inviscid-viscous interaction. These convect downstream resulting in a mean flow deformation (MFD) which causes a change of stability. New

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