Numerical modeling of flow control by plasma actuators

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Progress done in the understanding of atmospheric plasma discharges have launched new activities in flow control problem. Thus, new microactuators using plasma have been designed and manufactured to change the properties of a flow and then improve aerodynamic performances of aircraft (see [1]). Dielectric Barrier Discharges and Corona Discharges generate a cold plasma which transfer the charged particles momentum to the neutral. Such devices are efficient for subsonic flow control but fail to modifiy high velocity flow. In the last decade, DBD detailed modeling have been proposed and implemented leading to good qualitative results ([2]). A significant effort has been also done in the field of numerical methods to reduce the CPU time and perform simulation of discharges over a long time ([3]) . Plasma Synthetic Jet ([4]) actuators change the flow by generating a high velocity jet from a microcavity in which an arc is triggered. A modeling of Synthetic jet have been recently proposed coupling the arc developement inside the microcavity and the external flow. An other class of actuators use the plasma energy deposition in the flow that is more efficient at high flow velocity. It has been proved by numerical simulation that repetitive nanosecond-pulse DBD could modify a $50m/s$ flow by energy deposition. For supersonic flow control, devices using laser and microwave have been developped and simulated. Numerical modeling predict a large modification of the structure of the flow (bow shock modification) leading to a significant reduction of the drag coefficient [5].
The purpose of this talk is to present the recent works on the flow control by plasma actuation.

References

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