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Passive drag reduction on a sphere using polyhedral designs

NIKOLAOS BERALTIS, KYLE SQUIRES, School for Engineering of Matter, Transport and Energy, Arizona State University, ELIAS BALARAS, Department of Mechanical and Aerospace Eng., George Washington Univeristy — It is established today that dimples are efficient in accelerating the drag crisis on a sphere reducing the drag coefficient at much lower Reynolds numbers when compared to a smooth sphere. Recently we reported Direct Numerical Simulations (DNS) demonstrating that the large difference in the minimum drag coefficient between a dimpled and smooth sphere in the post-critical regime comes from the dimples themselves as the flow separates and reattaches inside them. In this talk we propose a new class of geometries based on polyhedral designs resembling a faceted sphere. Wind tunnel testing and DNS demonstrate drag reduction by as much as 15% compared to a typical dimpled sphere, without affecting the critical Reynolds number marking transition to the post-critical regime. We utilize the experiments establish the behavior of the drag coefficient as a function of the Reynolds number for different geometries and then use DNS for selected cases to obtain a detailed understanding of the flow physics. We will show important differences in the evolution of the boundary layers between a polyhedral and dimpled sphere as well as their wakes that reveal the underlying mechanism for the reduction in the drag coefficient.

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