# Surface Roughness Patterns for Passive Flow Control

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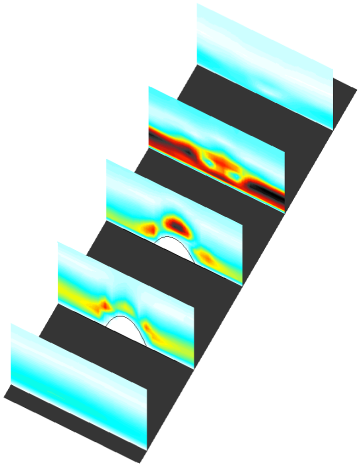
The potential for increased energy efficiency of aircraft has spurred efforts to develop laminar flow control technologies. Methods that do not require additional external sources of energy are especially seductive. Although surface roughness is demonstrably detrimental to boundary- layer stability in many scenarios, it is now known that rationally chosen roughness can also delay the onset of transition resulting in a reduction of drag due to skin friction. As part of an ongoing research effort exploring the use of streamwise streaks to attenuate growth of forced disturbances, this project follows a guiding principle of simplicity. Regular patterns of surface features are employed, which are extended in the flow direction and periodic across the span of the flow. These surface roughness patterns modulate the base flow in prototypical flat plate boundary layers. Compared with conventional surface roughness elements, the critical Reynolds number of a tested surface pattern is improved. This greater resistance to bypass transition admits the potential for applying this flow control method at higher Reynolds numbers, such as those encountered in flight. When Tollmien–Schlichting waves are imposed, the modulated mean flow disrupts the spanwise invariance of these disturbances (pictured). Experiments reveal that certain patterns inhibit the growth of T–S waves and result in significant increases in transition Reynolds number. This phenomenon is observed regardless of whether the unsteady disturbances originate in the boundary layer or as a series of convected vortices in the freestream.



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