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Shark denticles create a unique fluid flow, aiding in vortex and turbulence studies

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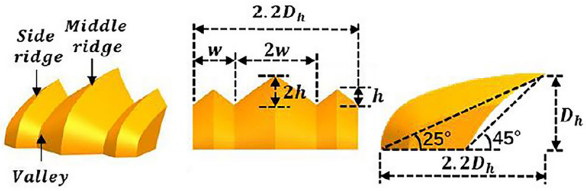
Their ridges result in unusual, unsteady flow patterns that include vortex generation and transverse fluid mixing.



Denticle replica

Contoured denticle

Shark skin is covered in millions of scales, called denticles. Though the denticles vary in morphology from species to species, they all include a number of longitudinal ridges, which result in a unique fluid flow that may be useful for vortex generation studies. Using a 3D-printed model of an *Isurus oxyrinchus* denticle – one of the fastest shark species, also known as the shortfin mako shark – Mao et al. examined the effects on flow.

In particular, the group was interested in observing the impacts on vortex generation and the unsteady flow behavior behind the denticle. Among several features identified in the flow patterns around the denticles, they noted a low frequency swinging motion as well as a hairpin-shaped vortex in the fluid in the central wake region, both of which contribute to the mixing of the fluids on either side of the wake.

“We estimate that the swinging motion of the fluid in the central wake region and fast detachment of the hairpin-shaped vortex would give a helpful understanding of the shark skin’s antifouling mechanism,” said author Yingzheng Liu.

To better monitor the unsteady flow structures, the authors magnified the denticle replica by a factor of nearly 150. They used a pump to drive the water flow and measured the wake dynamics and time-varying fields behind the denticle, comparing results from models with and without the denticle’s characteristic ridges to understand their impact.

Liu said their observations suggest the unsteady flow directly behind the denticle can serve as a good mechanism for intensifying turbulent wall heat transfer, which they plan to study further.

Source: “Unsteady flow structures behind a shark denticle replica on the wall: Time-resolved particle image velocimetry measurements,” by Qian Mao, Peng Wang, Chuangxin He, and Yingzheng Liu, *Physics of Fluids* (2021). The article can be accessed at https://doi.org/10.1063/5.0057699.