CASE STUDY

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The Challenge

Drag reduction technologies represent a major area for industrial research due to their potential for substantial cost saving through improved fuel efficiency as well as reduced emissions. Passive skin friction drag reduction on aircraft can be achieved by altering the lateral momentum transfer in the near-wall region using flow-aligned micro-grooves called 'Riblets'. These bio-inspired surface structures mimic shark denticles and, depending on their geometry and local flow properties, can give drag reductions of up to 9%.

Adhesive Riblet films have been available for a number of years but have not been widely adopted due to their added weight and durability. The challenge of this project was to determine if Laser Surface Texturing of a paint layer could create Riblet-like surface structures that provide effective drag reductions, as an alternative to films.

In addition to aerospace applications, this technology could also be applied to marine vehicles, wind turbines or industrial flows in pipes.

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Innovation

Developed a validated Computational Fluid Dynamics approach to modelling riblet flows, capable of predicting the flow physics, and differentiating between drag increasing and drag reducing configurations with sufficient fidelity.

Using a state-of-the-art femto-second laser, performed a design of experiments to evaluate the best settings to texture painted aircraft surfaces, and produced samples with Riblet-like structures in the paint layer.

Optically profiled the samples produced and assessed their uniformity and effectiveness at reducing skin friction drag. using the validated CFD methodology.

Result

Through the CFD validation study we developed best practice guidelines for modelling riblets using LES CFD in terms of; domain sizing, computational mesh refinement, physics model initialisation, boundary-conditions, sub-grid and time-stepping strategies, and flow-through time averaging strategies to ensure that post-processed results are a true average.
This validated CFD approach gave very good prediction of the skin friction changes for the two test cases completed.
Using an infrared femto-second laser we could engrain riblet-like structures in a paint layer with good overall shape and uniformity.

Impact

Best practice guidelines for modelling riblets using LES CFD will be published in 2026, providing researchers with a repeatable process for reliably modelling the flow physics of riblets using a commercial CFD package, something that is not currently available in the literature.
This modelling approach indicated that LST samples have the potential to reduce skin friction drag by up to 7%.
Although further work is needed to optimise shape, it was demonstrated that femto-second lasers could engrain riblet-like structures in a paint layer, with good overall shape and uniformity.
Two early-career researchers gained valuable experience working with the MTC on an industrially relevant multi-disciplinary project.

Presented our preliminary findings at three prestigious events; a Royal Aeronautical Society CFD workshop in February 2026, at the Leeds Institute for Fluid Dynamics John Fox annual lecture event in February 2026, and to the Airbus UK Flight Physics DiPaRT workshop in March 2026

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The MTC has benefited substantially from collaborating with the Researchers in Residence, Luke and Amber, under Andrew's co-supervision, whose contributions have added value to both the technical delivery and collaborative nature of the project. The collaboration was further strengthened by the opportunity to support Luke and Amber's development as early-career researchers. Through technical guidance and discussion, particularly in modelling and simulation methods and laser processing techniques, the MTC was able to help bridge experimental work with analytical and computational approaches, enhancing the overall technical depth of the project." Dr Abhi Beechook, Advanced Research Engineer, Modelling & Simulation Team (MTC)

Andrew Shires

"Inspired by a student team project in 2022 that was jointly supervised with the Manufacturing Technology Centre, it has been a pleasure to see this idea developed through the RiR scheme and to demonstrate its feasibility. The scheme has given me access to the MTC's state-of-the-art laser facilities, in combination with high-fidelity CFD modelling techniques developed with both organisations working in close collaboration."

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