Parameterization & CFD-based Modelling of Alicona-measured Roughness from HPC in-service Blades

Ilias Vasilopousol, Technische Universität Dresden

Surface roughness and its impact on fluid flows (regarding boundary layer formation, transition, loss generation, etc.) has been studied since many decades; however, it still is a relatively unexplored field with many open questions remaining. Specifically, the best parameters to characterize/model roughness are yet to be identified (usually the mean value or an equivalent sand-grain roughness parameter is used), which may well depend on the application at hand. To model the impact of roughness on the flow over a surface, the roughness function approach is most commonly used.

In this work, first, stripe measurements of surface roughness coming from the suction side of in-service compressor blades (provided by Rolls-Royce) are conducted, using a highly accurate Alicona measuring device. Then, these roughness distributions are used to construct the walls of zero-pressure-gradient channel flow simulations. Body-fitted unstructured grids up to 80M nodes are generated with the ANSA software, on which wall-resolved LES as well as RANS simulations with the k-o SST turbulence model are performed using the Rolls-Royce in-house CFD solver Hydra. The CFD setup is, first, validated on a smooth channel reference case against LES and DNS data from the relevant literature. Finally, after an attempt to identify the most important roughness parameters (given the limited database at hand), a new roughness function model is proposed, which could be then implemented back in the CFD solver to allow the prediction of the flow over a rough surface, without the need of actually resolving the roughness scales.