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SEAFRONT

Synergistic Fouling Control Technologies

Deliverable 1.20: Report on hydrodynamic behavior of switchable coatings

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Table of contents

1 Introduction

This deliverable relates to work package 1.2, which considers switchable coatings. TU Eindhoven and Fraunhofer have collaborated to manufacture fluoropolymer riblet coatings. The hydrodynamic performance of these coatings has been tested by partner TU Delft and is described here.

2 Partners involved

- Fraunhofer IFAM: Dorothea Stübing and co-workers – Manufacturing of the riblet coatings, preparation of samples for hydrodynamic testing.
- TU Eindhoven: Kees Bastiaansen, Sander Kommeren – Development, adaptation, and provision of material that is used for the riblet coatings.
- TU Delft: Wim-Paul Breugem, Henk Benschop – Provision of Plexiglas cylinders, hydrodynamic testing.

3 Description of technology delivered

3.1 Coating description

A new paint formulation to manufacture compliant coatings was developed by Eindhoven University. It is based on cross-linked fluoropolymer. They combined their formulation with the riblet manufacturing technique of Fraunhofer. Fluoropolymer riblets were produced with the automated riblet applicator. Because of limited manufacturing and measuring capacity, only one type of riblet coating was tested. The material had a storage modulus of 6.2 MPa and a loss modulus of 0.6 MPa at 25 °C. Figure 1 shows SEM pictures of the texture.

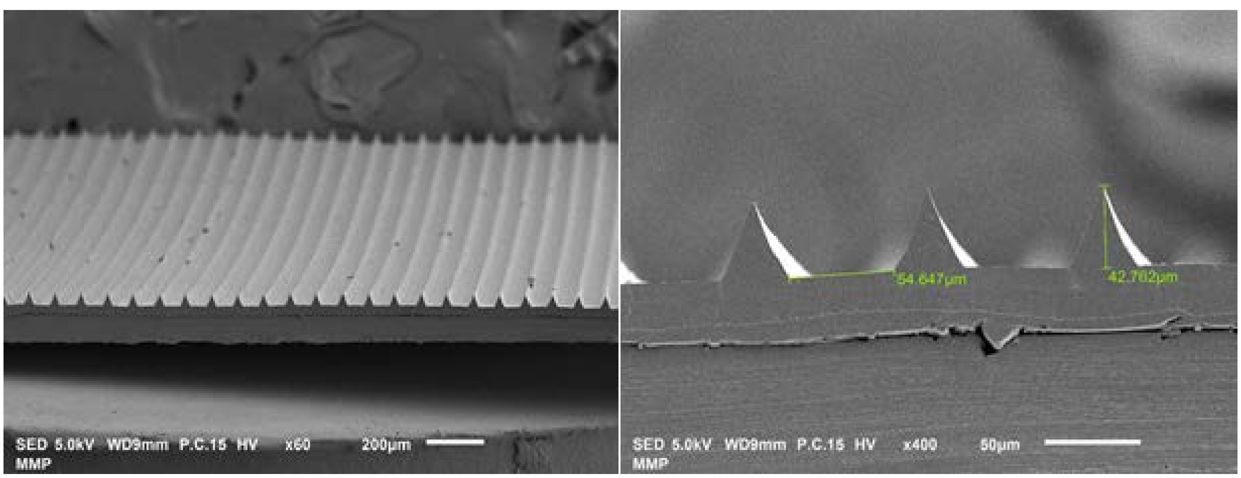

Figure 1 SEM images of the cross-linked fluoropolymer riblet coatings developed by Technical University Eindhoven in collaboration with Fraunhofer IFAM. Source: Technical University Eindhoven.

3.2 Experimental setup

The experimental setup is described quite extensively in Deliverable 1.15.

3.3 Results

The hydrodynamic performance of the provided cylinders is quantified with Figure 2. It shows the relative drag change as function of the Reynolds number. The two curves denoted as ‘TUE riblets’ correspond with the riblet coatings described above. The ‘new standard riblets’ refer to riblet

coatings that were manufactured by Fraunhofer in a conventional way with the same material that they have used originally.
For low Reynolds numbers, both TUE riblet coatings behave similarly, showing a drag reduction of around 3.5%. However, coating (a) detached at higher velocities, resulting in the relatively sudden drag increase around Re = 60000. This demonstrates an adhesion problem, like for some other coatings that were tested previously.
Coating (b) shows a better performance. The maximum drag reduction is 4.1%. That is about 2 percentage points less than the best-performing riblet coating from Fraunhofer. However, it is comparable to the riblet coatings from Fraunhofer with substandard quality of the riblet tips. We do not have sufficient information to determine whether non-optimal quality of the riblet tips also causes a slightly reduced performance of the TUE riblets.

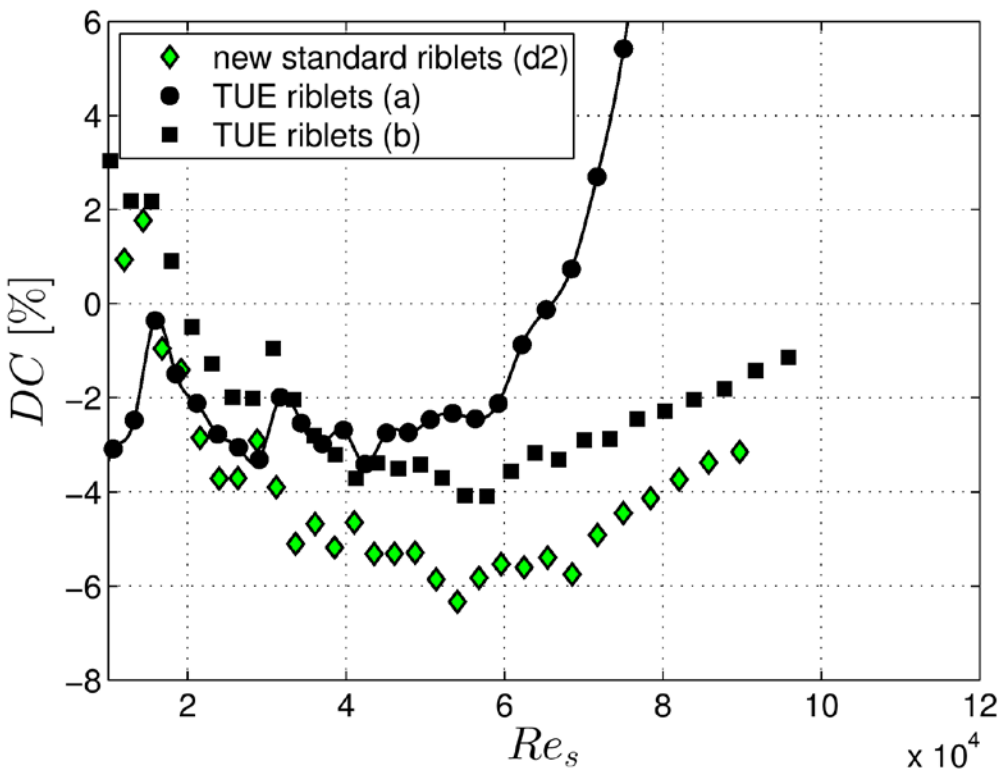

Figure 2 Drag change for the fluoropolymer riblet coatings.

4 Conclusions

The collaboration between Fraunhofer and TU Eindhoven resulted in the manufacturing of fluoropolymer riblet coatings. The coatings were applied to two Plexiglas cylinders. The hydrodynamic drag of these cylinders was measured with a Taylor-Couette setup. The results were compared with smooth (uncoated) cylinders.
One coating detached from the cylinder, which reveals an adhesion problem. The other coating exhibited a maximum drag reduction of 4.1% +/- 1 percentage point. This is somewhat less than the 6% reduction obtained with riblets of the same geometry that were manufactured previously by Fraunhofer. Further research would be required to reveal the reason for this difference. Possible reasons include substandard quality of the riblet tips or the use of another material.