Project LiNaBioFluid

Deliverable D2.4: Publication of results on bug cuticles

Reporting period	from	**01.07.2016**	to	**30.06.2018**
Report completed and released		**21.02.2017**		

1. Objectives and Detailed Description

The goal of D2.4 was to publically present the results of Task 2.2 (Characterisation bug cuticle) and Task 2.3 (Polymer replica of bug cuticle) in form of an article in a peer-reviewed scientific journal about the findings on the function of micro- and nanostructures of the bark bug cuticle for fluid transport using the Open Access model. Deliverable D2.4 is based on deliverable D2.3 and partially on D2.2.

We found that flat bark bugs *Dysodius lunatus* possess caudally oriented micro-ornamentation underneath the wings, around the glands that secrete an oily defensive liquid, as an antipredator adaptation. Even though the gland system is located on the dorsal surface, the substance is most likely evaporated at the region of wings' base. We suppose that specifically these microstructures contribute to the transport of the oily substance from the gland system to the wings of the bug. The micro-ornamentation consists of a periodical array of droplet looking like structures of around 10 µm in length, with an undercut. Along the scent gland channel, the microstructures show some variation. But in all cases, the microstructures have pointed tips which are oriented caudally, i.e. opposite to the bug head. The density and size of the structures are similar over the whole channel length. The wings of *Dysodius lunatus* are kept mostly in the folded state. The bug cuticle containing the drop-like structures and the wing together form therefore a closed capillary channel, and the oil transport occurs in the direction from the point ends towards the wider ends of these microstructures.

In our work study, we were using the micro-ornamentation found around the oil secreting scent glands underneath the wings of *Dysodius lunatus* as a model for surface patterning to assess the oil behavior in contact with the drop-like microstructure arrays. In order to produce these bio-inspired microstructures at real scale, the two-photon polymerization technique was used. A good directionality of oil transport was achieved, directly controlled by the direction of the pointed microstructures at the surface. If the tips of the drop-like microstructures are pointing towards the left side – the liquid front moves to the right, and vice versa.

These findings have been accepted for publication in the peer-reviewed journal "Royal Society Open Science" of the renowned British Royal Society. The article entitled "Bio-inspired polymer microstructures for directional transport of oily liquids" by C. Plamadeala, F. Hischen, R. Friesenecker, R. Wollhofen, J. Jacak, G. Buchberger, E. Heiss, T.A. Klar, W. Baumgartner, and J. Heitz will have full Open Access.

2. Evaluation of Goals and Resulting Actions

The expected goal for D2.4 was successfully reached on M20, i.e., the results of Task 2.2 and 2.4 were accepted for publication in form of an article in a peer-reviewed scientific journal using the Open Access model.

In parallel on M15, the results were presented to the public at the Bioinspired and Biointegrated Materials as New Frontiers Nanomaterials symposium at the Fall Meeting 2016 of the European Materials Research Society (E-MRS) by the first author C. Plamadeala. She is a young female researcher performing her PhD thesis within the LiNaBioFluid project at JKU and has been awarded the Best Presentation Award of the E-MRS for her contribution.

Interestingly, our system is homogeneous in the sense that the oil contact angles are similar for the substrate and the microstructures. The same applies for oily fluids in contact with micro-patterned or rough surfaces in tribology or microfluidics. Therefore, we anticipate that this research can lead to multiple industrial applications in friction and wear reduction.

Several further scientific articles and conference presentations on directional fluid transport controlled by microstructures inspired by the micro-ornamentations on bug cuticles are in preparation.