Project LiNaBioFluid

Deliverable D3.3: Publication of results on laser-induced surface structures on inorganic materials

Reporting period	from	**01.07.2015**	to	**30.06.2016**
Report completed and released		**24.06.2016**		

1. Objectives and Detailed Description

The goal of D3.3 was to publically present project results of Task 3.1 at the traditional laser-matter interaction symposium at the Spring Meeting 2016 of the European Materials Research Society (E-MRS) in Lille France, associated with an article submitted to the symposium proceedings.

The results obtained until month M12 in Task 3.1: '*Laser-based mimicking of lizard structures'* and in Task 3.3 *'Characterization of fluid transport and friction/wear'* are the basis of this delivery.

On January 15th, 2016, an abstract entitled "*Mimicking lizard-like surface structures upon ultrashort laser pulse irradiation of inorganic materials*" [1] was submitted by BAM to the E-MRS Spring Meeting 2016, Symposium C "Laser-material interactions for tailoring future application", May 2nd - 6th 2016, in Lille (France). The abstract was accepted by the symposium organizers as a Poster presentation (presentation number C.PI.47). In cooperation with all WP3 partners and RWTH, the poster was prepared and presented to the public by BAM on May 3rd, 2016, during Poster session I of Symposium C (16:00 - 18:00). The publication will be announced on the webpage on the LiNaBioFluid webpage (www.laserbiofluid.eu).

In a joint WP3/WP4 telephone conference, one material (steel 1.7131) was selected to be focus of D3.3.

The results obtained until M11 were presented by partners BAM, FORTH, and Fraunhofer IPT to the other partners of the project and discussed during the annual consortium meeting in Linz in May 2016 (M11).

During M11/M12 the manuscript entitled "*Mimicking lizard-like surface structures upon ultrashort laser pulse irradiation of inorganic materials*" (associated with the above mentioned poster presentation) was prepared in cooperation of all WP3 partners and RWTH [2]. The manuscript was submitted to a special issue of the journal Applied Surface Science by BAM on June 16th, 2016. At release of this document, the manuscript has entered the peer review stage. The final publication date of the Applied Surface Science Special Issue (Symposium C conference proceedings) is expected for May 2017.

Once accepted for publication in Applied Surface Science and considering the associated copyrights, which will be transferred to the publisher Elsevier, parts of the content will be made available to the public on the LiNaBioFluid webpage (www.laserbiofluid.eu).

2. Evaluation of Goals and Resulting Actions

The expected goal for D3.3 was successfully reached by M12, i.e., the results of Task 3.1 were presented to the public at the E-MRS Spring Meeting in May 2016 in Lille (France) and an associated journal publication was submitted to a Special Issue of Applied Surface Science (conference proceedings).

Abstract [1] and manuscript [2] demonstrate the successful collaboration across the borders of WP2 and WP3. The manuscript [2] proves that the research in Task 3.1 was conducted fully in line with the work initially proposed in the GA. In more detail, two different laser processing strategies (I & II) were employed to mimic lizard-like surface structures on inorganic materials (steel) via ultrashort laser processing. In a single-step strategy (I), BAM and FORTH used fs-lasers to generate different self-ordered structures such as nano-ripples, grooves, and micro-cones, (see Figs. 4 and 6 in [2]), resulting in a classification scheme (morphological map) related to the laser processing parameters (peak fluence, effective number of pulses, see Fig. 5 in [2]). Wetting tests at FORTH revealed the hydrophobic nature of these structures (Fig. 7 in [2]), as realized by nature in non-moisture harvesting lizards (e.g. *Sceloporus jarrovi*, Fig. 1c in [2]). In an alternative two-step strategy (II), Fraunhofer IPT used ps-laser pulses to generate a micro capillary channel systems and additional dimple structures (Figs. 8 and 9 in [2]). The fluid transport in these hierarchical microstructures was successfully demonstrated by RWTH, as realized by nature in moisture harvesting lizards (e.g. *Phrynosoma platyrhinos*, Figs. 1a and 1b in [2]). In conclusion, both laser processing strategies successfully mimicked different natural archetypes of lizards.

The results go beyond the current state of the art of laser processing (see for example the review articles [3,4]), since the joint activities of all WP3 partners and RWTH allowed to explore a new biological archetype in a broadened processing approach (two different strategies I & II), resulting in the successful transfer of natural wetting and fluid transport functionalities to technologically most relevant materials, such as steel.

Deliverable D3.3 is complemented by Deliverable D3.2 *'Images of first results of lizard-like surface structures on inorganic materials'*, where a comparison of SEM images of micro- and nanostructures found on lizard skin and of similar laser-structures generated on hard inorganic materials will be published on the LiNaBioFluid website (www.laserbiofluid.eu).

References:

[1] U. Derra, H. Mescheder, K. Winands, P. Comanns, S. Kirner, J. Krüger, J. Bonse, E. Skoulas, G.D. Tsibidis, E. Stratakis, *Mimicking lizard-like surface structures upon ultrashort laser pulse irradiation of inorganic materials*, abstract accepted for poster presentation at the E-MRS 2016 Spring Meeting, May 2nd to 6th, Lille (France), Symposium C: Laser-material interactions for tailoring future applications.

[2] U. Hermens, S.V. Kirner, C. Emonts, P. Comanns, E. Skoulas, A. Mimidis, H. Mescheder, K. Winands, J. Krüger, E. Stratakis, J. Bonse, *Mimicking lizard-like surface structures upon ultrashort laser pulse irradiation of inorganic materials*, submitted to Applied Surface Science, 16.06.2016.

[3] K. Ahmmed, C. Grambow, A.-M. Kietzig, *Fabrication of micro/nano structures on metals by femtosecond laser micromachining*, Micromachines **5** (2014) 1219 – 1253.

[4] F.A. Müller, C. Kunz, S. Gräf, *Bio-inspired functional surfaces based on laser-induced periodic surface structures*, Materials **9** (2016), 476, doi:10.3390/ma9060476.