TECHNISCHE UNIVERSITÄT DRESDEN

Fakultät Maschinenwesen Institut für Fertigungstechnik
Professur für Laserbasierte Methoden der großflächigen Oberflächenstrukturierung

Evaluation of PhD Dissertation:

Large surface functionalization by laser-induced micro and nanostructures

Submitted by Eng. Petr Hauschwitz

It is very well known that both the topography and chemistry of surfaces have a strong influence on their functionality. In this frame, methods capable to control the above mentioned characteristics are necessary to produce innovative product with advanced surfaces. Within different processing technologies, laser-based fabrication methods have shown to be capable to address many challenges in this area by producing micro, submicro and even nano-structures as well as by affecting the surface chemistry. However, a typical drawback of these technologies is their limited throughput.

In this frame, the PhD thesis submitted by Mr. Petr Hauschwitz shows an important amount of innovative work in the application of different laser methods such as direct laser writing, direct laser interference patterning as well as multi-beam scanning approaches in combination with high-power laser sources.

The doctoral thesis is composed of 8 chapters, which are presented in 121 pages including 25 figures (from chapter 1 to 5, excluding the published publications) and is supported by 131 references.

After a short introduction describing the motivation and objectives of the work, Mr. Hauschwitz introduces in chapter 2 the fundamental aspects related to functional surfaces. Here, some properties are described in detail, including superhydrophobicity, anti-icing characteristic and anti-bacteria (or antimicrobial).

Later in Chapter 3, the state of the art regarding different aspects in laser micro-processing are discussed. Chapter 4 focuses in the description of high-throughput and large-scale approaches for laser surface structuring. The chapter introduces important aspects, such as the characteristics of ultra-fast scanning systems (4.1), direct laser interference patterning (4.2), DOE and SLM based multi-beam approaches (4.3) and finally a summary describing advantages and disadvantages of the discussed methods.

Chapter 5 is dedicated to the description and discussion of the obtained results. In the different sub-sections (5.1 to 5.6), a summary of published papers is given, including;
(i) Fabrication of an non-fluorinated superhydrophobic surface on Al-7075 aerospace alloy by ps laser processing (using DLW with beam deamter of 80 µm at 300 mm/s);

(ii) Combination of nanostructure with laser-made micropillars for enhancement of water repellence of aluminum alloy (using a focused ns-pulsed laser in a first step and later defocused laser radiation);
(iii) Fabrication of superhydrophobic surfaces on Carbon Fiber Reinforced Plastics, utilizing both IR and UV Direct Laser Interference Patterning method, in combination with a chemical vapor deposition (CVD) treatment;
(iv) Large-Scale LIPSS Fabrication by 4-beam ps DLIP (using AISI 316L steel and a 1.7 ps laser operating at 1 KHz, obtaining 25 µm period structures decorated with LIPSS);
(v) Large-beam picosecond interference patterning of metallic substrates (also using the 1.7 ps laser sources, on stainless steel, invar and tungsten); and
(vi) Micromachining of invar alloy using multi-beam approach (with 784 beams using 1.3 ps laser source at 515 nm wavelength).

Finally, in chapter 6, the main conclusions of the work are presented.

Some aspects of the thesis should be discussed during the PhD defense, which are listed below:

- Mr. Hauschwitz should explain the structure of chapter 3. Its structure is quite unclear.
- In Chapter 5.4, there are some unclear sentences that should be addressed during the PhD defense: "...resulted in the fabrication of ~1016 LIPSS-structured microcraters in 5 ms (203 200 spot/s)...": what does the author mean with "1016 LIPPS?" and "203 200"?
- Since the title of the PhD is related to high-speed processing, it would be very necessary to address the reached throughputs for all used methods. Only in one paper the throughput information is presented. The same applies to the size of the processed areas.

In summary, Mr. Petr Hauschwitz has been able to develop different processing strategies using laser-based approach methods for producing structured surfaces. It has to be also mentioned that Mr. Hauschwitz is author and co-author of 8 peer-reviewed publications related to this doctoral thesis (6 as first author) and has also presented his results at 3 national and international conferences.

Based on these comments, I recommend the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague the acceptance of this work.

Dresden, 21 January 2021

Prof. Dr.-Ing. Andrés Fabián Lasagni