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Abstract

Laser polishing and structuring of tooling and functional surfaces

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Abstract:

Since its inception, laser polishing (LP) technology has been receiving an increasing attention as a plausible alternative to the conventional polishing techniques. The main driver behind the development of LP technology resides in the fact that >40% of the tooling cost is associated with high-cost and time-consuming manual polishing. By contrast, LP can significantly reduce these costs by the high level of automation and the precision provided through its coupling with CNC technology. Considering its potential applications in automotive, aerospace and biomedical industries, the Automotive Portfolio of the National Research Council (NRC), Canada has been actively engaged in the development of LP technology. Building on this activity, the main objective of the present report is to introduce some of the achievements and developments of LP technology at NRC over the past five years.

This presentation will focus on detail description of the laser-based polishing and surface functionalization processes, their advantages and disadvantages with respect to the conventical abrasive polishing techniques, and examples of LP process technical implementations along with examples of LPed parts and functional surfaces, e.g. for controlled wettability, friction, adhesion, drag, and hydro-/aerodynamics. Then common understanding the process physics, process classification and its variants, material and surface characterization, and modeling capability will be presented. In addition, effect of most critical process parameters, laser type and characteristics, laser path trajectory, and process planning methodologies on achieved surface quality and physical-mechanical characteristics, e.g. gloss, micro-hardness, metallographic structures, corrosion resistance and others. Along these lines, a statistical digital twin of the laser micro-polishing process will be introduced as a thermodynamic transfer function with associated thermophysical model of the rapid melting-solidification of H13 tool steel as induced by continuous wave laser irradiation.

Biography:

Evgueni Bordatchev is a Senior Research Officer and a Team Leader for Microfabrication and Surface Functionalization group at the National Research Council in London, Ontario, Canada. He received MSc, PhD, and DSc degrees in electro-mechanical engineering from Don State Technical University, Rostov-on-Don, Russia, in 1982, 1989 and 1996, respectively.

Since 1998, he is with National Research Council demonstrating national and international recognition as an expert in laser- and cutting-based high-precision micromachining, surface functionalization, laser polishing, micro/nano-optics, and micro-opto-electro-mechanical systems/sensors.

Recent Publications:

- 1.Temmler A, Walochnik MA, Willenborg E, Wissenbach K (2015) Surface structuring by remelting of titanium alloy Ti6Al4V. J of Laser Applications 27: paper S29103, 8 p.
- 2.Temmler A, Comiotto M, Ross I, Küpper M, Liu DM, Poprawe R (2019) Surface structuring by laser remelting of 1.2379 (D2) for cold forging tools in automotive applications. J of Laser Applications 31: paper 022017, 12 p.
- 3.Temmler A, Küpper M, Walochnik MA, Lanfermann A, Schmickler T, Bach A, Greifenberg T, Oreshkin O, Willenborg, E, Wissenbach K, Poprawe R (2017) Surface structuring by laser remelting of metals. J of Laser Applications 29(1): paper 12015, 12p.
- 4.Bordatchev EV, Küpper M, Cvijanovic S, Willenborg E, Milliken N, Temmler A, Tutunea-Fatan OR (2019) Preliminary characterization of light guide tooling fabricated by surface structuring by laser remelting. Proceedings of The 2019 IEEE Photonics Society Conference, paper 314, 2 p.
- 5.Bordatchev EV, Küpper M, Cvijanovic S, Willenborg E, Milliken N, Temmler A, Tutunea-Fatan OR (2019) Fabrication of edge-lit light guide tooling by surface structuring by laser remelting. Proceedings of 34th American Society of Precision Engineering 2019 Annual Meeting 71:84-89.

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