Towards industrial implementation of laser surface texturing as a tool for enhancing wear resistance and friction reduction on sliding surfaces

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Energy losses due to friction and wear of sliding surfaces and other tribological contacts account for 23 % of the world's energy consumption [1]. This figure justifies the need for technologies capable of mitigating friction and wear. Accurate laser surface texturing of micro-metric sized features on sliding surfaces have shown a significant decrease of friction coefficients, while improving the lifetime of the pieces due to an increased wear resistance [2,3]. However, there are few constraints that may act as a barrier for this technology to be implemented in industry. These are partly related to the cost of the equipment, as the required quality of the surface features usually implies the use of expensive ultra-short pulsed laser sources. In addition, laser surface texturing speed may result in excessively long processing times.

In this work, we first demonstrate the feasibility of using a cost-effective sub-nanosecond (ns) near-infrared (NIR) fibre laser source for the creation of different surface textures, which show friction reduction and an increased wear resistance. The surface pattern consists of arrays of micrometric-sized dimples and slots, with controlled depths and widths in the range of a few tens of micrometers. The resulting laser-textured surfaces show the required high-quality finishing, practically free of recast and molten redeposited material. Secondly, a 5-axes and a 4-axes laser systems, designed and built at Oxford Lasers, are respectively employed to demonstrate the scalability of the process to real components beyond flat surfaces. Different methods capable of creating the required features on pistons and on the inner surface of cylindrically-shaped pieces are presented. Dedicated tribological assays were carried out on test specimens, confirming a reduction on coefficient of friction (COF) of about 25 %, along with an increased wear resistance, which is quantified in terms of a significant reduction in the wear track widths of about 50 %.

[1] K. Holmberg and A. Erdemir (2017) Influence of tribology on global energy consumption, costs and emissions, Friction, vol. 5, pp. 263-284

[2] S.-C. Vlădescu, A.V. Olver, I.G. Pegg, T. Reddyhoff (2016) Combined friction and wear reduction in a reciprocating contact through laser surface texturing, Wear, vol. 358-359, pp. 51-61

[3] J. Schneider, D. Braun, C. Greiner (2017) Laser Textured Surfaces for Mixed Lubrication: Influence of Aspect Ratio, Textured Area and Dimple Arrangement, Lubricants, vol. 5(3), pp. 32-46.

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