A study of the tactile friction behaviour between laser-textured metallic surfaces and counterpart polyurethane materials at low sliding velocities

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Moving surface interactions between rigid and compliant materials such as engineering metals and polymers or rubbers have a wide range of functional applications in the automotive, aerospace, machine building and medical industries. Laser texturing has proven to be beneficial in the frictional interactions between rigid material pairs [1] but the effects governing textural geometries on the friction mechanisms between rigid and deformable counterparts is still poorly understood [2] particularly at low sliding velocities, making it difficult to design textures for specific tactile performance.

This presentation explores the laser generation of textures of defined geometries using femtosecond pulsed laser processing of a 316 stainless steel and studies the frictional performance against a natural polyurethane, selected for its controlled compliancy. Basic texture designs consisting of parallel and cross hatched grooves of controlled area ratios and depths were produced for the investigations. Using a laboratory based tribometer, empirical investigations were conducted to study the influences of groove width, depth, separation distance and orientation on surface friction under dry conditions in the surface velocity range of 1 to 2 $mm.s^{-1}$.

The results show that the tactile friction interaction between the selected tribo-pair is significantly improved with parallel groove textures in an orthogonal sliding direction compared with 90^0 cross-hatched textures. The surface friction is most sensitive to groove width opposed to the ridge width between grooves, with grooves up to 200 micrometres wide corresponding to an ablated area ratio of 0.2 producing the lowest friction. Marginal gains in frictional performance were attained with groove depths of up to 15 micrometers, which contributed to the overall surface friction performance improvement of 19% achieved from texturing by picosecond pulsed direct laser writing.

[1] Sharma V, Pandey PM, (2016) Recent advances in turning with textured cutting tools: A review. Journal of Cleaner Production, 137, 701-715
[2] Kosukegawa et al., (2015) Friction of 316 stainless steel on soft-tissue-like poly (vinyl alcohol) hydrogel in physiological liquid, Tribology international, 82, 407-414