A study on laser generated periodic textures on tungsten carbide cutting tool surfaces for the reduction of frictional forces

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The ever-increasing demands on mechanical machining necessitate the continual improvements of cutting tool performance to achieve the often incongruent factors of higher component throughput, improvements to surface finish, machined accuracy and an extended tool live. Machining and chip friction across the tool contribute considerably to the overall cutting efficiency during the machining process [1],[2]. The friction produced by the contact surfaces of the tool results in heat transfer into the workpiece and residual heat accumulating in the tool body [3]. This study aims to gain an improved understanding of the effects of laser processing of tool surfaces for frictional reduction. High definition textures consisting of periodically positioned dimples and grooves have been produced on a precision multi axis laser system containing near IR wavelength 50W/20W short (nanosecond) and ultra-short (femtosecond) puled laser sources. Textures having specifically designed area ratios were produced to allow the effects of texture design, orientation and the progressive effects of changes in contact area on the tool rake face to be studied during machining.
Data from laboratory tribology testing, two dimensional orthogonal turning and a purpose designed in-situ hot friction surface machining test have been captured for both wet (applied coolant) and dry machining setups with three different workpiece materials and machining parameter sets. Results from the individual tests were interrogated and correlations made between the specific textures and measured frictional forces. This study has demonstrated that the texture design, orientation and area ratio applied to cutting tool surfaces can influence the machining frictional forces under particular conditions. Results from this study offer the potential for upscaling of laser produced textures from orthogonal cutting tools into more complex turning and three-dimensional rotating tools for selected machining applications.

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