Texturisation of engine components with shaped ultrashort laser pulses

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The aim of this work was to texturize surfaces of the DIN 16MnCr5 steel to reduce the coefficient of dynamic friction and wear between two surfaces. This material is used in engine components, such as pins and gears, and an improvement in these properties can represent a great savings of money for the automobile industry [1]. The texture element chosen was that of a spherical half-shell with dimensions of approximately 50 microns with element density varying from 10 to 20 %. The production of such elements was done with the use of ultra-short laser pulses from a Ti: sapphire system. Due to the size of the dimples (spherical half-shell) and the need for a high throughput, a real 3D machining becomes an unreasonable option, therefore, a percussion process that produces the desired structure becomes the best choice. This, however, cannot be obtained with a focused Gaussian beam where a hemispherical profile with controlled diameter and depth is sought. Thus, a donut profile obtained by the insertion of an iris in the path of the beam before its focalization was used. Obtaining the desired diameter and depth depends on the fluency and the number of superimposed pulses on each element. However, material extraction is not linear because of the incubation effects [2] that occur when there is an overlap of pulses in the same region of the material. Thus, besides the spatial conformation of the laser beam, an analysis of the dependence of the ablation threshold with the number of overlapping pulses was made through the D-Scan method [3]. With this methodology, dimples with semi spherical profile were obtained, with dimensions varying from 30 to 70 µm. After texturing, the surfaces were characterized by scanning electron microscopy (SEM), white light interferometry and confocal microscopy. Wear tests were performed to analyze the variation of the friction coefficient in texturing surface. After the tests, it was observed that the texturing with ultrashort pulses presents a great advantage in manufacturing of dimples, due to the precision and absence of thermal interaction between the laser beam and the material. In relation to the friction coefficient, the textured samples presented a reduction of the friction force and consequently of the friction coefficient, but an increase in the contact pressure between the studied surfaces was observed,due the tests were carried out in bordering conditions of contact.

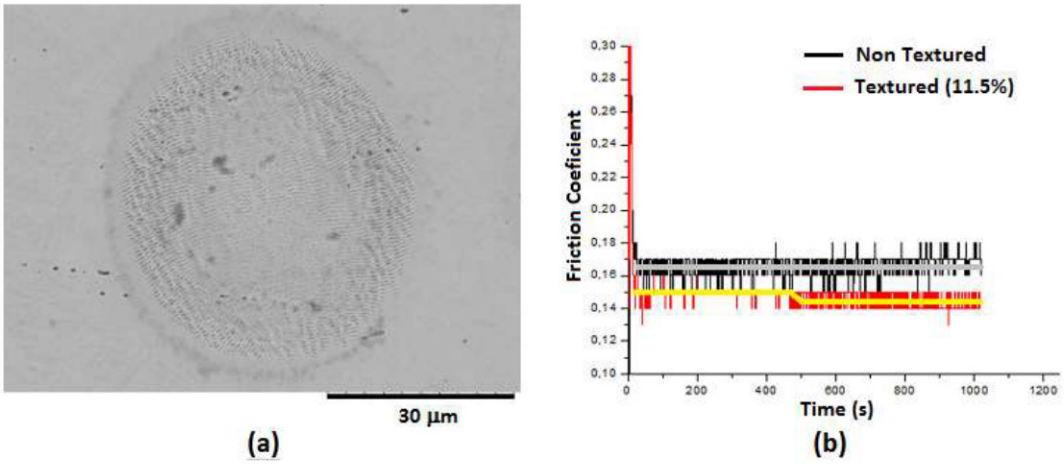

Figure 1 (a) Dimple of spherical half-shell shape produced by the overlap of shaped femtosecond laser pulses. (b) Coefficient of friction before and after the texturing showing a reduction of 18% in the coefficient of friction. .

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