Tribological performance of the laser surface treated CrZrSiN thin films

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Abstracts: Recently, surface texturing by atmospheric laser processing has been received lots of attention to improve the tribological performance of various surfaces and this laser texturing of surfaces could be considered in a large extent to improve tribological performance of PVD coated surface. Surface texturing could be performed by various manufacturing techniques such as indentation with hard materials , ion etching, abrasive jet machining, lithography, and Laser Surface Texturing (LST). Out of all these techniques, however it is generally accepted that laser surface texturing (LST) by atmospheric laser processing offers the most promising process as LST is very fast, environmentally-friendly, easy to control the shape and size of the microdimples. In this work various preliminary experimental results from the laser texturing on the PVD-coated steel substrate will be presented. Our results indicated that laser texturing definitely affect the tribological performance of the surfaces and the size as well as pattern type of laser texturing are one of the key factors. From the wear tests against an alumina counterpart ball at room temperature under oil-lubricated condition, laser surface texturing on the CrZrSiN films reduced the friction coefficients by approximately more than 5 times in the case of narrow patterned surfaces.

1. Introduction

Much attention has been paid to the surface texturing, which could induce the improvement of tribological properties by enhanced lubrication in many applications including cylinder liner], storage devices, MEMS, toolings. It was reported that the depressions made on the surfaces act as not only the sources to trap wear particles to reduce the ploughing component of friction but also reservoirs for liquid lubricants, capable of feeding the lubricant between the sliding surfaces. In this study, hard CrZrSiN films were coated on the surfaces treated by laser surface texturing with different patterns and the influence of surface texturing in terms of the wear behaviors of the CrZrSiN coating were evaluated.

2. Experimentals

In this work the laser texturing was accomplished by Marking Laser System (YLP-20, 20W) and detailed operating conditions are summarized in Table 1. Two types of LST patterns were made on the H13 steel substrate and their shape and dimensions are presented in Fig. 1. After LST process, the spatters formed during the LST process were polished away using SiC #400 papers and equally spaced patterns with dimples and honeycombs were produced over the entire sample surface (Fig. 1). CrZrSiN films of approximately 2μm were deposited on the silicon (100) wafer for the coating analysis and the laser surface textured AISI H13 steel by closed field unbalanced magnetron sputtering with vertical magnetron sources. The chemical composition of coatings was determined by glow discharge optical emission spectroscopy (GDOES: LECO GDS 850A) and the crystal phases were characterized by X-ray diffraction (XRD: D/max2200) with Cu Kα radiation (λ= 0.15418 nm). The hardness was measured using a microhardness tester (Fisherscope: H100CXYp) instrument with a load of 50mN. The surface and cross sectional morphologies were investigated by atomic force microscopy (AFM) and field emission scanning electron microscopy (FE-SEM: HITACHI S-4700). The wear property of coatings was evaluated using a ball-on-disk type tribometer with a 9.25 mm diameter

Al_2O_3 ball as a counterpart material. The test was performed in the room atmosphere temperature of 25℃ and relative humidity of 45 % without lubrication under an applied normal load of 5.0 N. The sliding velocity was 0.25 m/s with a wear track diameter of 35 mm and the total sliding distance was 1000 m.

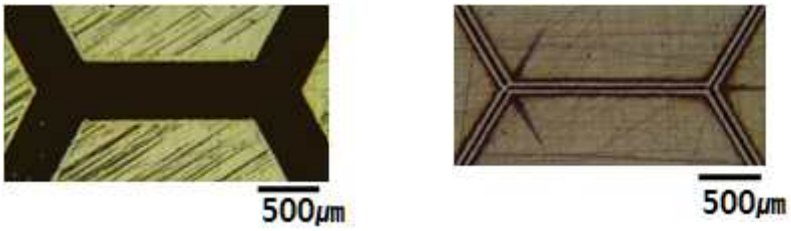
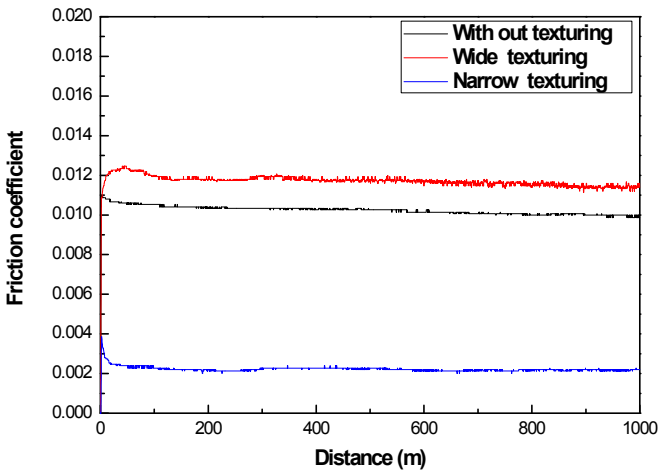


Fig.1 Typical laser surface patterns : wide vs narrow

3. Results and discussion

In this work CrZrSiN coatings were successfully synthesized by unbalanced magnetron sputtering and the coatings mainly consist of the crystalline and amorphous phases. The hardness of the CrZrSiN films decreased with increasing Si contents and the maximum hardness of approximately 33.5 GPa was measured. From the wear tests against an alumina counterpart ball at room temperature under oil-lubricated condition, laser surface texturing on the CrZrSiN films reduced the friction coefficients by approximately more than 5 times in the case of narrow patterned surfaces and further improvement on the tribological performance of the textured surfaces could be possible by optimizing the honeycomb-textured surfaces.



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