Study of LST Surface Modification effect on friction and wear at lubricating condition

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초 록: Hemispherical dimples with diameter, ⌀ = 60 μm and depth, d= 30 μm were created on the metal and ceramics surfaces using INYA 10 watt Laser of 1064 nm wavelength. This study reports the influence of dimple pitch on friction and wear behavior rather than dimple size, depth and density. LST was performed on the specimens with dimple pitch and density in the range of 80 to-200 μm and 44 to 7 %, respectively. Surface topography was analyzed by using roughness measurement, scanning electron microscopy (SEM), and optical microscopy. Friction and wear characteristics were analyzed on textured surfaces at lubricating environment to observe the effect of surface texturing on reduction of friction and wear. Reduction on coefficient of friction was achieved by more than 70% due to the dual behavior of dimples as wear (debris) traps and lubricant reservoirs. Wear reduced significantly for the textured surface as compared to the polished surface. Moreover, the friction coefficient of the textured specimens reduced with increasing load and speed which may be attributed to the transition of lubrication regime.
Keywords: Laser surface texturing; Grey cast iron; dimple pitch; dimple density; Friction; Wear

1. 서론

For many applications, there is an increasing demand on significant stress sliding conditions lubricated by media such as oil, water, fuel etc. The tribological properties such as friction and wear play vital role for saving energy or increasing serviceability of automotive parts and engine.

It is known that tribological behavior of material is related to the topography of the material’ s surface [1, 2]. Smooth surfaces are particularly effective in reducing friction under boundary lubrication regimes. However, fabrication of a smooth finish on component surfaces is often not cost-effective. Besides creating surfaces with minimal roughness, incorporating special structures and features with different shapes and sizes onto the surface has been shown to be a viable means of controlling the friction and wear behavior of tribological components. Hence, one of the most effective and well known process of this kind is considered here as Laser Surface texturing [3, 4]. In this study, the influence of dimple pitch/dimple density on the tribological performance was determined using a tribological test facility with commercial engine oil as lubricant.

2. 본론

As shown in Table 1, roughness parameters of LSTed surfaces were measured using Surftest machine. It showed the change in roughness parameters with the alreration of dimple pitch. Cross-section of dimple observed through mini-SEM and dimple profiles through Profilometer were helpful for the confirmation of depth, size and pitch of dimples. Optical micrographs of LSTed specimens after suface modification was as shown in Fig. 1.

After surface topography analysis of specimens, ball-on-plate friction and wear test was carried out using micro-tribometer at lubricating condition. Significant variation in fricion coefficient was resulted on untextured and textured specimens. Friction coefficient reduced significantly for the textured specimens compared to untextured specimen. Specimen S150 exhibited the lowest friction coefficient among textured specimens with approximately 70% reduction in friction. However, specimen S80 exhibited highest friction coefficient. B. podgornik et. al reported earlier that the texturing has a detrimental effect on friction if it is not employed with favorable parameters [5]. According to roughness analysis, it had been already revealed that too much dense texturing will result unfavorable skewness and kurtosis of the specimen, much reduced contact area, an increased pressure, yielding negative effect on friction. Hence, Specimen with dimple pitch of 80 um exhibited highest friction coefficient.

Table 1. Roughness parameters of untextured and textured surfaces

Surfaces	Roughness parameters			
	Average roughness R_a(μm)	Skewness R_{sk}	Kurtosis R_{ku}	R_z(μm)
Polished	0.0155	-0.819	2.845	E-2002
S80	3.740	-0.599	3.873	26.512
S100	3.328	-1.245	5.720	26.567
S150	2.320	-2.191	10.549	25.332
S200	3.061	-2.188	8.835	26.771

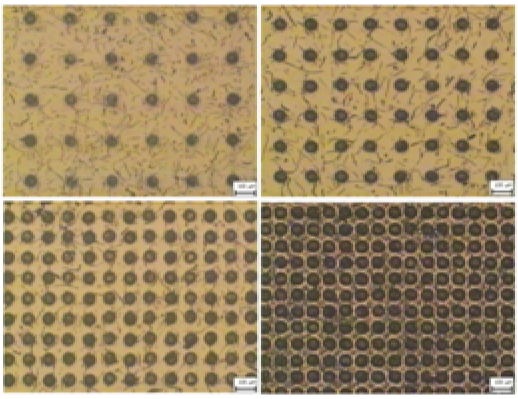

Fig. 1. Optical Micrograph of LST surfaces

After the analysis of wear tracks on the specimen, it had been calculated reduced wear volume and rate of textured specimens as compared to untextured specimen. The reduction of wear is mainly described by the reduced real contact area between the mated surfaces which transfers into the lesser worn area of the textured surfaces.

3. 결론

- Approximately ~70% reduction in friction coefficient exhibited after surface modification by LST in compared to reference specimen.
- Wear volume and wear rate was significantly reduced for textured surfaces except highly dense dimpled specimen.
- Too dense texturing might play negative effect on the reduction of friction due to unfavorable roughness parameters, more reduced contact area, much higher contact pressure.

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