Experimental wear volume analysis on Al-Si-Cu laser textured cylinder liners using thin layer activation technique

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1. Introduction

The use of laser ablation in order to texture the surface of piston rings appears in the scientific community since about 2001. However the advantages of texturing the cylinder liners' surface are presented in terms of reduction of the friction coefficient and wear volume only at the end of the test [1]. This paper presents a technique based on partial thin layer activation (PTLA) to measure on-line the wear volume of a laser textured surface (LST) Al-Si-Cu cylinder liner while rubbing against a piston ring as counter acting part inside a model tribometer; the results are compared to the ones of the untextured samples used as references.

2. LST Procedure

The cylinder liner samples were textured using a Nd:YAG pulsed laser with a wavelength of 1.06 µm. The laser had a pulse frequency of 15 kHz and a nominal power of approximately 12.8 W. The complete sample was textured in a few seconds by focusing the laser beam on the sample surface through a mirror system. The optimal laser parameters were selected based on a preliminary study in order to obtain the desired micro-dimple morphology. The ablated spherical micro-dimples, characterized using a tip profilometer, had a depth of 6 ± 1 µm and a diameter of 67 ± 5 µm. The distance between dimples was 200 µm. This corresponds to a dimple areal density of 9 % ± 2 %.

3. Irradiation Procedure

The PTLA requires activating a part of the surface layer below the investigated material by a charged particles beam [2]. Aluminum (around 80 % in mass in the cylinder composition) was irradiated through the MGC20 Cyclotron set with a 24 MeV beam of Helium3; the resulting nuclear reaction is the following: $^{nat}Al(3He,x)^{22}Na$. Nanoidentation was used to ensure that no material changes happened on the samples surface due to LST and PTLA procedures.

4. Wear results

The prepared specimens were tested in the SRV model tribometer [2]. The couple cylinder liner and piston ring was put in reciprocating sliding motion (parameters shown in Table1) lubricated with a small stream of oil flowing in the contact zone and bringing the removed wear debris to the radiation detector.

Table 1 Wear test parameters

Wear Test Parameter	Value
Load	100 N
Frequency	50 Hz
Stroke	3 mm
Lubricant	Commercial Engine Oil
Lub. Temperature	120 °C
Test Time	5 h

There the activity is measured and then converted to wear volume. This on-line technique permits the evaluation of the removed wear volume and hence the wear rate during the different phases of the wear behaviors (i.e. running-in and steady state) as shown in Fig.1. Reduction in the friction coefficient for the LST samples was recorded in the order of 5 – 7 % as well.

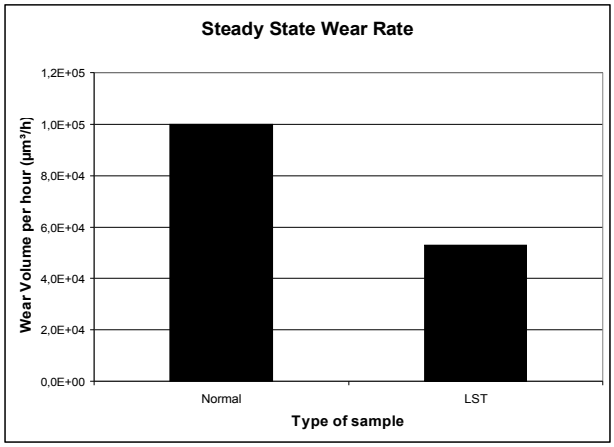

Fig. 1 – Linearization of the wear process and relative steady state wear rate

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5. References

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