International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-07, Issue-02, MAY 2021

Tribological Behaviour Of Laser Surface Textured AISI 52100 Steel

S. Raja Durai, Assistant professor, Loyola Institute of Technology, Chennai, rajumechsr@gmail.com

R. Kumutha, Assistant professor, Loyola Institute of Technology, Chennai, kamaleshmp@gmail.com

N. Abinash, Student, Loyola Institute of Technology, Chennai, abinashsm123@gmail.com

P. Sasikumar, Student, Loyola Institute of Technology, Chennai, ksasi5923@gmail.com

K. Vaitheesvaran, Student, Loyola Institute of Technology, Chennai, vaitheekuppusamy@gmail.com

Abstract : AISI 52100 is a standard grate Alloy steel. Increase in the lifetime of a component is done either by alloying with numerous appropriate materials before its producing. This study makes an attempt to enhance the service lifetime of AISI 52100 steel by modifying the surface through laser surface texturing process. And then wear tests were performed during a pin on disc equipment as per ASTM G-99 standard. The coefficient of friction, the wear rate and wear coefficient were determined on uncoated and laser surface textured pins. Finally determine good wear properties material is uncoated or laser textured material.

Keywords —AISI 52100, Coefficient of friction, Laser surface texturing, Uncoated, Wear rate, Wear properties.

I. Introduction

The principal aim of laser surface texturing to reduce the wear rate, coefficient of friction of the material and increase the lifetime of material. R. Kumutha & S. Ilaiyavel [1] To increase the life time of the component to determine the wear rate, coefficient of friction to compare and better material chosen at uncoated and coated material using wear testing method. SP Joshua, PD Babu[2] To improve the durability American iron and steel institute 52100 chromium steel in this work the effect of laser surface texturing analyzed with the different patterns of circles and ellipse comparing with untextured samples the wear behavior was investigated using the pin on disc tribometer. P Sivaiah, U Bodicherla [3] In the experimental investigation three types of cutting were considered two ware surface textured tools and third nontexture tool. taguchi analysis was carried out the performance during machining of AISI 52100 steel under MQL cooling condition.To determine the low surface roughness and tool flank wear. P Sivaiah, M Guru Prasad, M Singh [4] In this work textured tools performance was evaluated during turning of AISI 52100 steel under MQL and compared the obtained results with the untextured tools under MQL conventional cooling techniques. Y Gerbig, G Dumitru, V Romano, V Spassov [5] The tribological performance of laser textures was studied as function of the pore depth and diameter unidirectional sliding test and the laser textured surfaces tested under those condition were produced by a well established na laser technique using Q switched Nd:YAG laser.

II. Experimental Procedures

A. Material Properties

Alloy steels contain different varieties of steels that exceed the composition limits of Mn, C, Mo, Si, Ni, Va, and B set for carbon steels. AISI 52100 alloy steel is known as a high carbon, chromium containing low alloy steel. The chemical, physical, mechanical compostions are given in tables.

Table.1 Chemical Composition

ELEMENT	CONTENT(%)
Iron, Fe	96.5 - 97.32
Chromium, Cr	1.30 - 1.60
Carbon, C	0.980 - 1.10
Manganese, Mn	0.250 - 0.450
Silicon, Si	0.150 - 0.300
Sulfur, S	≤ 0.0250
Phosphorous, P	≤ 0.0250

 DOI : 10.35291/2454-9150.2021.0242

ISSN : 2454-9150 Vol-07, Issue-02, MAY 2021

B. *Laser Surface Texturing*

The length of material is 25mm and diameter of the material is 8mm. And the material is before laser texturing process we have develop the circular square pattern in AUTO CAD Software for laser texturing purpose.First AUTO CAD software opened in laptop and new file is selected, 10mm dia circle drawing drawed.And small size of circle, square are draw at 10mm circle. The small circle diameter is 0.5mm and small square side length is0.25mm.The small circle and square horizontal distance is 1.5mm and vertical distance is 1mm. And number of small circle, square are drawed in 10mm circle.The each small circle, square is 'hatch' comment is used to form lines. And the HATCH line distance is 0.020mm.The HATCH line are converted to individual line by using explend comment. And the process is saved at pattern 1.dxf file format.

Figure 1. Laser Surface Texturing Machine

C. *Wear Test*

Wear performance of materials are commonly obtained from testing carried out in pin-on-disc equipment to ASTM G99 standard procedure. The photographic view of the pin on the disc is shown in. It gives a laboratory standard method to carry out sliding and abrasion wear tests. The tests were carried out under 10 N applied load and for sliding velocity of 0.3 m/s for a constant sliding radius of 10 mm. In all the cases coefficient of friction, wear rate and wear coefficient value are noted in uncoated material and laser surface textured material.

Figure 2. Wear Testing Machine

III. RESULT AND DISCUSSIONS

A. *Coefficient Of Friction*

Test procedures were employed with the pin on disc tests at 0.3m/s. The wear, Frictional Force and time were obtained at a load of 10 N for every 10 min sliding. The Plot of friction coefficient versus sliding distance for the uncoated, laser texturing are shown in Figure 5.1. This shows the Characteristic feature of the diagrams is that the friction coefficient values decreases as the Sliding distance increases at laser surface texturing. The dry friction of uncoated material around 0.9 and laser surface texturing can decrease the friction coefficient by 0.807.

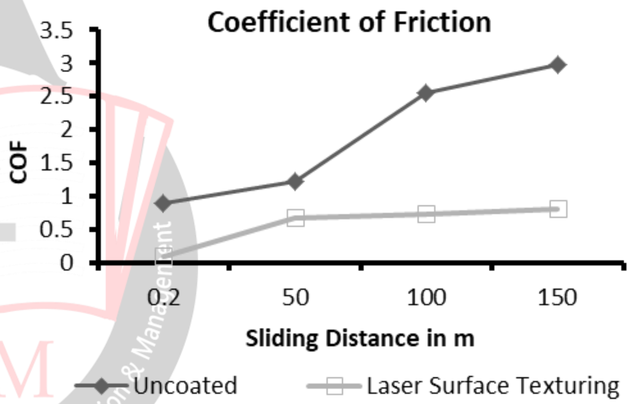

Figure 3. Coefficient of Friction

B. *Wear Coefficient*

Steady-state wear was proposed by Archard V=KsPL/3H where V is the volumetric loss of material after sliding for a distance L and load P normal to the wear surface. H is the Brinell hardness number of the pin while Ks a dimensionless standard wear coefficient. For known values of V, P, L, and H the standard wear coefficient can be calculated from the equation Ks=3HV/PL. Volumetric wear loss can be calculated from the weight loss W and the density. L. J. Yang expressed that the higher initial running – in wear rate, has a higher value initially in the transient wear regime and will reach a steady – state value when the wear rate becomes constant. Figure 5.2 shows the variation of wear coefficient with sliding distance. It is observed that wear coefficient decreased due to increase sliding distance. However under the same conditions laser surface texturing material is low wear coefficient.

DOI : 10.35291/2454-9150.2021.0242

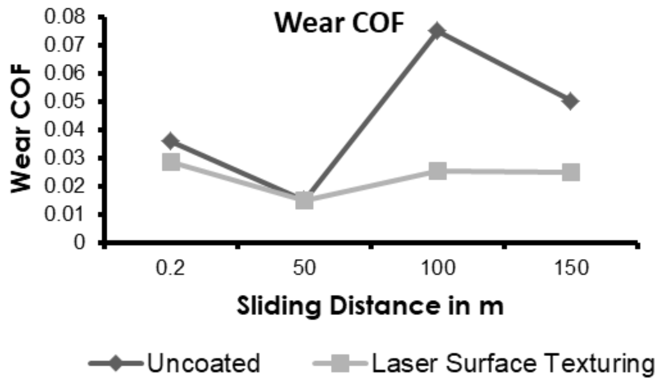

Figure 4. Wear COF

C. Wear Rate

The wear rate is calculated from the equation:

Wear Rate = Volumetric Wear Loss / Sliding Distance.

Wear rate of laser texturing compared uncoated material Very less Wear loss. In pins and it exhibits the less Wear rate.

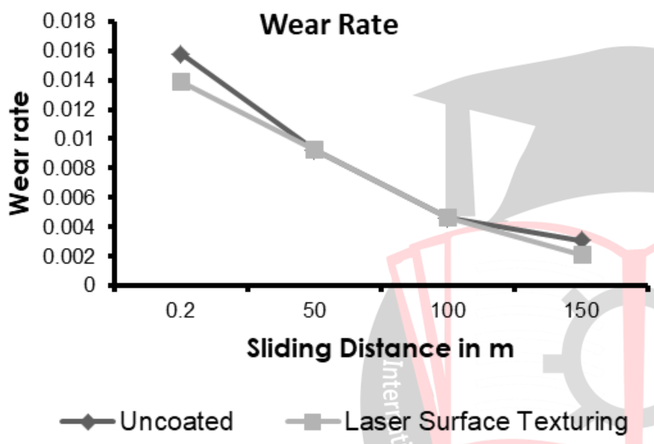

Figure 5. Wear Rate

IV. Conclusion

The Wear coefficient of uncoated, laser textured material were examined under 10 N loads at sliding velocity of 0.3m/s using a pin on disc apparatus and the results are summarized as follows:

- Laser surface textured material shows very low coefficient of friction compared uncoated material. The coefficient of friction is around 0.807 under 10 N loads with sliding velocity of 0.3 m/s. The reason is laser surface textured has improved its properties in terms of both frictions and wear.
- Laser surface textured material shows very low Wear coefficient compared with uncoated material. The Wear coefficient of friction is around 0.0250 under 10 N loads with sliding velocity of 0.3 m/s.
- Wear rate of laser surface textured material is lesser than uncoated material because of Very less Wear loss.

Acknowledgement

The Authors are thankful to Loyola Institute Of Technology for providing the continuous support. The authors would also like to thank Dr. v. Balaji , Professor, Head of the Department, Mechanical Engineering, at Loyola Institute Of Technology, Chennai, for his support towards the project. The authors would like to thank the Management and Dr. Sujatha Anand, Principal of Loyola Institute of Technology, for their constant encouragement in all endeavors.

References

[1] R. Kumutha, S. Ilaiyavel, ‘Study of tribological behavior of conversion coated high carbon high chromium steel’ International Journal of Mechanical and Production Engineering Research and Development. Vol. 8, Special Issue 8.(2018).

[2] S. P. Joshua, P. D. Babu, ‘Effect of laser textured surface with different patterns on tribological characteristics of bearing material AISI 52100’ Springer(2020).

[3] P. Sivaiah, U. Bodicherla, ‘Effect of surface textured tools and minimum quantity lubrication on tool wear and surface roughness in CNC turning of AISI 52100 steel’ springer(2020).

[4] P. Sivaiah, M. Guru Prasad, M Singh, ‘Machinability evaluation during machining of AISI 52100 steel with textured tools under minimum quantity lubrication a comparative study’ springer(2020).

[5] A. Attanasio, D. Umbrello, C. Cappellini, G. Rotella, ‘Tool wear effects on white and dark layer formation in hard turning of AISI 52100 steel’ Elsevier wear 286, 98-107.(2012).

[6] L. Zhou, G. Liu, Z. Han, K. Lu, ‘Grain size effect on wear resitance of a nanostructured AISI 52100 steel’ ELsevier Scripta materialia 58(6),445-448.(2008).

[7] C. Mao, Z. Zhang, J. Zhang, X. Huang, D Gu, ‘An experimental investigation of affected layer formed in grinding of AISI 52100 steel’ Springer the international journal of advanced manufacturing technology 54(5),515-523.(2011).

[8] Y. Gerbig, G. Dumitru, V. Romano, V. Spassov, ‘Effects of laser texturing on technical surfaces’ Springer MRS online proceedings library 750(1),1-6.(2002).

[9] U. Sudeep, N. Tandon, R. K. Pandey, ‘Friction and vibration behaviours of lubricated laser textured point contacts under reciprocating rolling motion with highlights on the used laser parameters. Elsevier, procedia technology 14,4-11.(2014).

[10] R. Viana, MSF de Lima , WF Sales, ‘Laser texturing of substrate of coated tools performance during machining and in adhesion test. Surface and coating technology 276,485.(2015).

 DOI : 10.35291/2454-9150.2021.0242