Assessment of parameters variations for treatment of CO_2 laser carburizing over AISI 4340 steel

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Poster proposal

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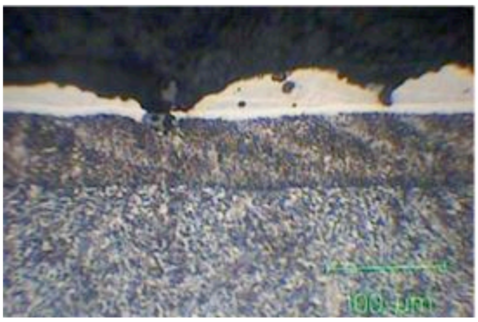
Abstract

This study evaluated the best parameters for the carburizing treatment using a CO_2 laser of low power over an AISI 4340 steel previously subjected to heat treatments of quenching and tempering. The coating process used a liquid dispersion of carbon black in ethanol and carboxyl methylcellulose. The laser power was kept constant at 125 W and the resolution is 600 dots per inch. The variable parameter of CO_2 laser was the speed. Two speeds were selected for the coating preparation: 1200 and 2000 m/s. After treatment, metallographic preparation and optical microscopy observation were performed in addition to the evaluation of parameter variations through hardness measurements and microscratch tests.

Observations of polished cross sections show that treatment produce a multiphase region successively composed of a superficial coated zone (CZ) with a high content of carbon and iron (carburized layer), a zone of interaction (ZI) affected by carbon diffusion and a heat-affected zone (HAZ). The laser treatment performed at a speed of 1200 m/s provided a greater inhomogeneity for the CZ (Fig. 1a) than the treatment carried out at a speed of 2000 m/s (Fig. 1b). The carburized layer presents Vickers hardness values in the order of 800 HV, much higher than the metal base (MB), 300 HV and the HAZ, 500 HV.

(a)


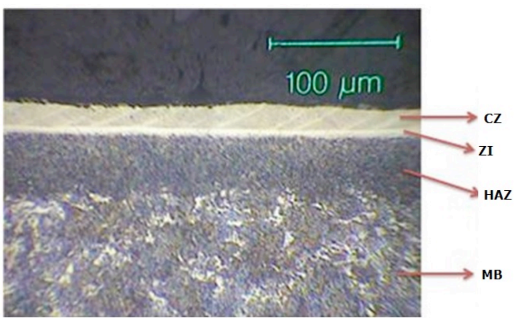
(b)


Figure 1: Polished cross section of AISI 4340 steel substrate with a carburizing treatment using a CO_2 laser treated at 1200 m/s (a) and 2000 m/s (b), showing different layers of treated surface: Coated Zone (CZ)*, Zone of Interaction* (ZI)*, Heat Affected Zone* (HAZ) *and Metal Base* (MB).

The scratch tests were realized using a Vickers slider over a distance of 5 mm at a constant sliding speed of 30 mm/min. Three progressive loading conditions were carried out: from 0 to 5 N, from 0 to 10 N and finally, from 0 to 20 N.

Low friction coefficients close to 0.1 are recorded, independently of load, but treatments performed at higher laser speeds show a greater stability (Fig. 2). The groove width and depth as a function of load was measured with optical profilometry along the sliding distance, in order to detect the appearance of the substrate on the groove base.

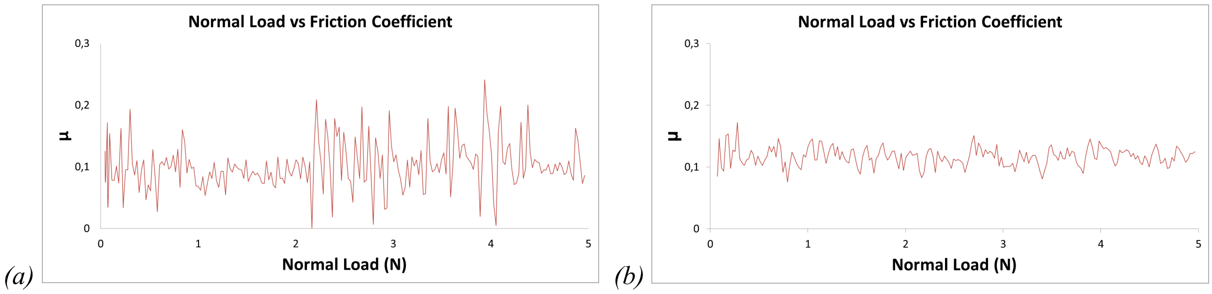


Figure 2: Friction coeficient as a function of normal load for samples treated with a laser speed of 1200 m/s (a) and 2000 m/s (b)

Finally, optical observations of the tracks reveal the damage changes during the sliding. For similar tests, with the same progressive normal load, the dimensions of the wear track look bigger for a coating prepared at a speed of 1200 m/s than at 2000 m/s. Deformation of the coating is the main accommodation mechanism, whatever the loading level, indicating a lack of the coating adhesion (fig. 3).

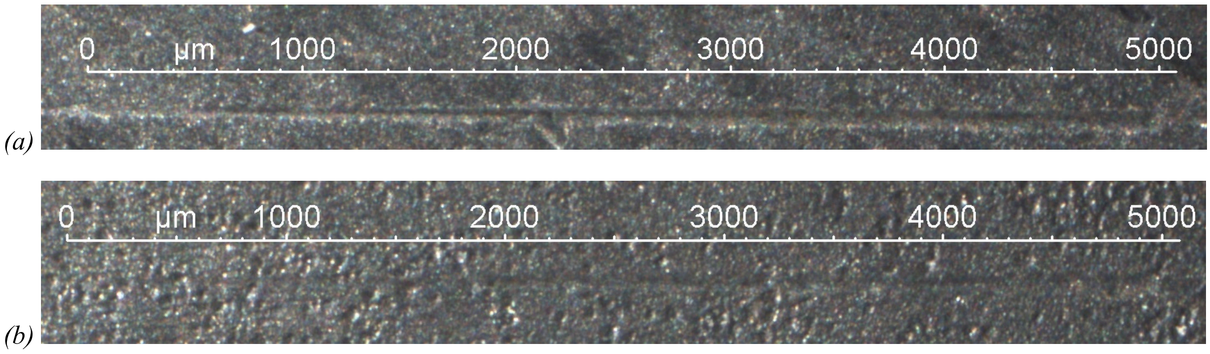


Figure 3 : Comparison in detail between scratch morphologies after microscratch tests of the surfaces treated at speed of 1200 m/s (a) and 2000 m/s (b). Normal load is progressivly increase from left to right.

Indeed, the laser speed of 2000 m/s provided the best results reached. This may be related to a better quality of coated zone, as a result of better carbon deposition on the surface.

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