Abrasive wear of Fe-Cr-C PTA overlays for tillage tools

Thais Andrezza dos Passos[1)*], Henara Lillian Costa[2)], and Giuseppe Pintaude[3)]

[1) 3)] Surface and Contact Laboratory, Universidade Tecnológica Federal do Paraná, Brazil
[2)] Surface Engineering Group, Universidade Federal do Rio Grande, Brazil
*Corresponding author: thais.andrezza.passos@gmail.com

Crusher blades and subsoil rods used in soil preparation are prone to severe wear, thus requiring hardfaced layers. This work investigates abrasive wear in deposits for the tillage tool/soil tribological system. Initial identification of wear mechanisms in specimens collected after field use under real conditions was carried out. Wear-resistant Fe-Cr-C layers were deposited by plasma transferred arc (PTA). Rubber-wheel abrasion tests under two severity conditions were performed, and the wear mechanisms were compared to those found under field use. Abrasive wear was strongly correlated with the PTA deposits' microstructure, which identifies the best deposition conditions for tillage tools.

Keywords: tillage tools, PTA, hardfacing, wear mechanisms.

1. Introduction

Wear and corrosion of tillage tools require thick protective overlays to withstand severe use conditions. Analysis of wear performance of potential hardfacing should use methodologies able to reproduce wear mechanisms in the field under real conditions [1]. An important family of potential coatings for tillage tools involves Fe-Cr-C alloys [2], which can be reinforced with Vanadium. Plasma Transfer Arc (PTA) presents many advantages for the deposition of hardfacings, leading to high-energy concentration, low-dilution, and refined microstructure [3]. This work investigates the abrasion resistance of Fe-Cr-C deposits with and without Vanadium, using test conditions that reproduce the wear mechanisms found in the field. Deposition conditions are correlated with cooling rates, microstructure, and wear performance.

2. Methods

Specimens of coated commercial crusher blades and subsoil rods were collected after their use in soil preparation under real use conditions. After cleaning, wear mechanisms were identified using SEM. Energy-dispersive X-ray spectroscopy (EDS) and confocal microscopy (to quantify the worn surfaces) complemented this analysis. A welding equipment IMC Digitec A7ACPO 450 model was used at a flat position to produce Fe-Cr-C-V coatings onto A36 carbon steel plates (100mm x 200mm). The morphology and composition of the powders, evaluated by SEM/EDX, is presented in Figure 1. Single-layer deposits were obtained using a 50% superimposition between individual beads, with a maximum temperature of the previous bead of 40°C. Two thickness values for the plates (12.5 and 25.4 mm) were used to vary the deposits' cooling rate, monitored using thermocouples. Microhardness profiles, optical microscopy, and SEM/EDX investigated the microstructure of the deposits. Rubber-wheel abrasion tests evaluated the overlays' wear rates using two severity conditions (A and D) defined in ASTM G65. Wear mechanisms after the tests were compared with those found in the field.

3. Results and discussion

Figure 2 illustrates the wear mechanisms found in the subsoil rod. Region 1 in Figure 2-A is the coating (Cr, Ni W, C) and region 2 is the substrate (carbon steel). Arrows in Figure 2-B (substrate region) indicate grooving abrasion; the ellipses highlight regions where WC carbides were probably removed from the coating and embedded in the substrate; the squares delimit silica particles. The worn coating (Figure 2-C and -D) showed micro-ploughing of the matrix (arrows) and micro-cracking (ellipses).

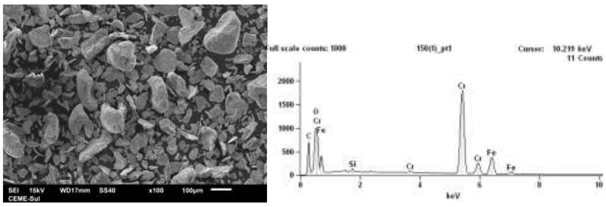

Figure 1. SEM morphology and EDX analysis of the Fe-Cr-C powder.

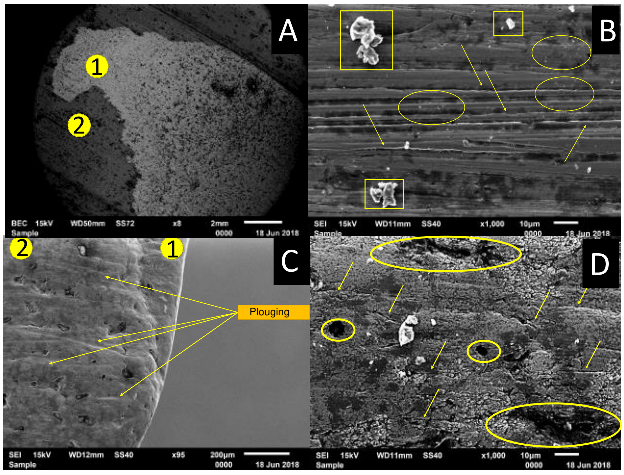

Figure 2. Wear mechanisms in the subsoil rod.

4. References

[1] J.H. Tylczak, J.A. Hawk, R.D. Wilson, A comparison of laboratory abrasion and field wear results, Wear, 225-229 (1999) 1059-1069.
[2] L. Xu, C. Vose, D. StJohn, Abrasive wear study of selected white cast irons as liner materials for the mining industry, Wear, 162-164 (1993) 820-832.
[3] R.P. Garcia, S.C. Canobre, H.L. Costa, Microabrasion-corrosion resistance of Ni–Cr superalloys deposited by plasma transferred arc (PTA) welding, Tribology International, 143 (2020) 106080.