Tribologija in površinska nanotehnologija

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Tribological behaviour of different electrical steels during stamping process

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Introduction

Industries in packaging sector, automobile sectors etc. are using increasingly stamping process as sheet-metal working to get high quality product with less cost. The tribological conditions in sheet metal forming influences the flow of material in forming operations, the strain distributions of sheet material, extent of wear, and thereby the quality of products. During stamping, tribological conditions influences the quality of product and durability of process and tools. Therefore, the subject of friction during sliding contact between the surfaces of moving punch and stamped materials must be understood.

Experimental Details

For the present study, tribological testing procedure was designed so that fresh surface of investigated materials was always ensured.

The designed tribological tests are executed on four different grades of electrical steels being stamped in automobile companies.

Tribological tests of different steels are conducted against commercially available WC-Co ball for 10 sliding passes in dry conditions under the normal load of 190 N.

It is insured that, contact surface of steel sheets are fresh for each pass maintaining same counter surface of WC-Co ball. The sliding speed of 0.05 m/sec is maintained during the test with stroke length of 10 mm.

Materials

1) V1: Fully finished hardenrd steel sheet with Varnish (organic, on basis of epoxy resins, 4-5 µm thikness).

2) V2: Fully finished steel sheet with varnish (inorganic/organic hybride, 1-2 µm thikness).

3) N1 & N2: Semi-finished steel materials without varnish → two different producers.

Figure 1: VHT-2 tribotester (Bruker)

Results and discussion

Frictional beahviour

Frictional and wear behavior of materials are notably dependent on the number of passes during the testing. Coefficient of friction (COF) is increased for all the grades of steel with change in number of pass from 1st pass to 10th pass (see Fig. 2). It is found that material with varnish 2 showed highest friction. Comparing COF of semi-finished steels, material with high hardness showed high friction as compared to softer materials.

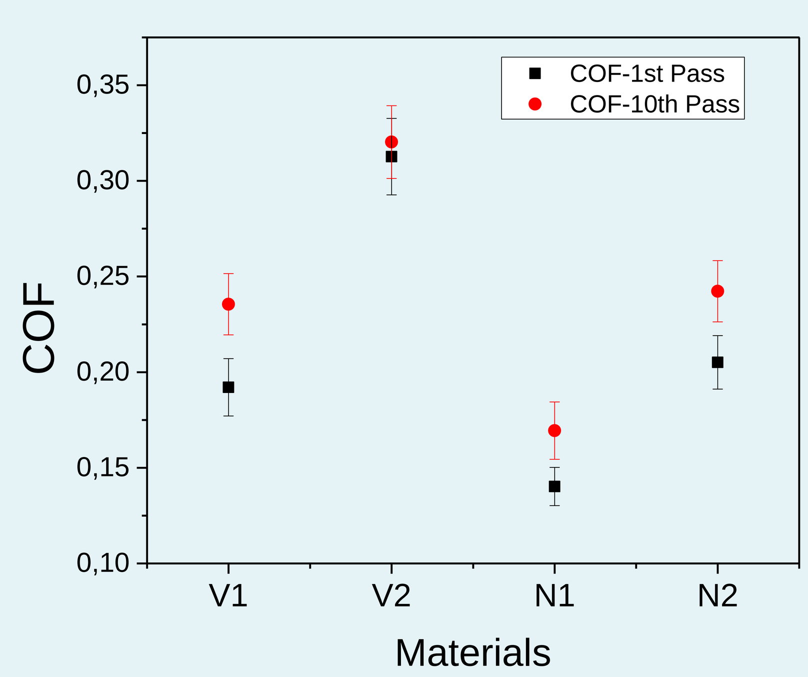


Figure 2:Coefficient of friction of different steels after 1st pass and 10th pass against WC-Co counterbody

Wear behaviour

Upon comparing the wear volume of steel materials after 1st and 10th pass, it was found almost unchanged/less decrease in wear volume after increase of number of pass most likely due to bluntness of counterbody after each pass. In case of steel with V1, varnish got removed up to 10th pass and therefore more wear is observed after increase in number of passes.

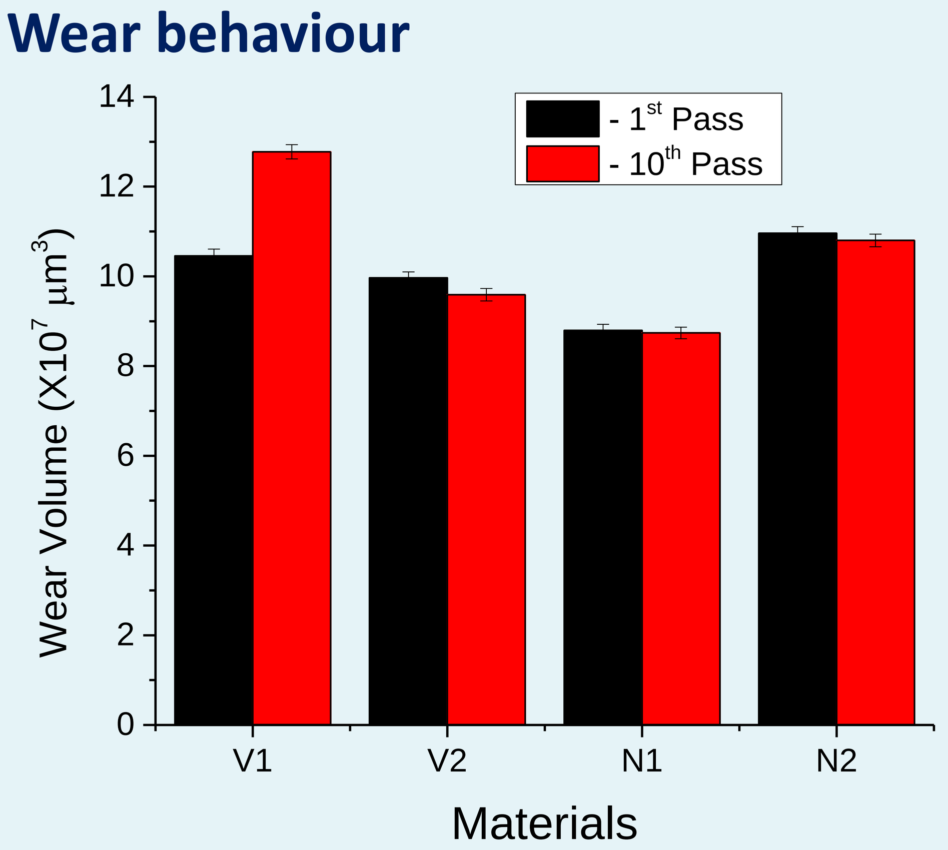
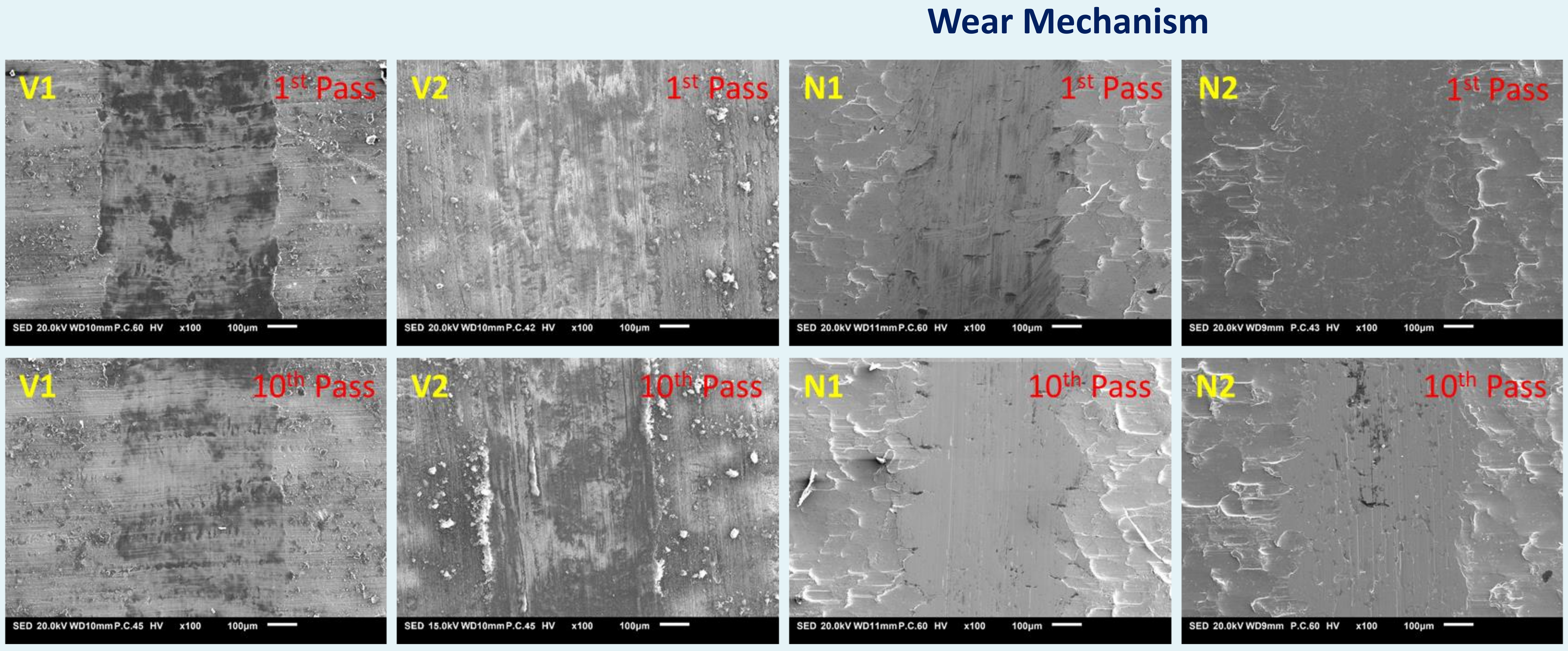


Figure 3: Wear volume of different steels after 1st pass and 10th pass against WC-Co counterbody

Wear Mechanism



SEM images of wear track for different steels are shown in Figure 4. Analysis of SEM images of wear scar revealed abrasion, ploughing, smoothing, and micro-cracking as dominant wear mechanism. Steels with varnishes (V1 & V2) showed more abrasion as compared to semi-finished steel grades without varnishes. Width of wear track for semi-finished steels decreased upon increasing the number of passes from 1 to 10, which is in aggrement with decrease in wear volume with number of passes (compare with Fig. 3).

Figure 4: SEM images of wear scar of different steels after 1st pass and 10th pass against WC counterbody

Conclusion

- Several grades of electrical steels were tested under conditions expected in stamping using tribotester device.
- Tribological behaviour of electrical steels shows dependency on the number of sliding passes.
- Material removal mechanisms like smoothing leads to lower friction, however spalling and micro-cracking lead to higher wear for steel.

Literature

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2. 2. J. Hardell, and B. Prakash, “High-temperature friction and wear behaviour of different tool steels during sliding against Al–Si-coated high-strength steel,” Tribology International 41 (7): 663-671 (2008).

Acknowledgment

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