INVESTIGATION INTO THE ASPERITY PERSISTENCE OF THE ROUGH SURFACE WITH A HARD COATING LAYER

K. Inose *, A. Kadiric
* k.inose@imperial.ac.uk
Imperial College London,
SW7 2AZ, United Kingdom

KEYWORDS
Coatings, Surface topography, Contact and adhesion, Asperity persistence

ABSTRACT
Hard metal coatings such as nickel or chromium plating are widely applied to tribological components to improve wear and corrosion resistance. Since these hard coatings can also accelerate the counterpart wear, their effect on asperity contact pressures and deformations should be carefully considered to ensure reliable operation of a coated contact. There exist several numerical models able to deal with coated rough contacts [1-4] but there have been very limited systematic studies of the affect of hard coating on asperity pressures. In this study, the influence of a single hard coating layer on the asperity contact pressure and deformations was investigated by combination of experimental and numerical approaches.

A series of indentation experiments were performed where a smooth hard steel roller was pressed into a softer rough surface: an uncoated plate or a plate with a hard coating of known thickness. The rough profiles were measured before and after indentation in the exact same location. 2D elastic numerical simulations using on in-house computed model similar and associated to [1, 3] were then performed to predict the asperity pressures in the roller contact on the measured indented profile. This hence gives a prediction of asperity contact pressure distribution in the actual loaded roller-flat contact having accounted for any plastic deformation of the asperities. Subsurface stress distribution is also predicted.

Figure 1 shows an example result for a 25 µm Ni coating on aluminium substrate. It is seen that the Ni coating reduced macroscopic plastic deformation. Figure 2 shows roughness profiles obtained by removing waviness from the original profiles in Fig. 1. It is evident that asperities on the coated specimen had undergone almost no plastic deformation even after a heavy loading of 275 N/µm which was sufficient for coated and uncoated specimens to be induced macroscopic plastic deformation.

Figure 3 shows the contact pressure and cumulative pressure distributions. The coated specimen had higher maximum contact pressure, while the trend in the low contact pressure region was similar for both specimens. Results are discussed in terms of asperity persistence with and without the hard coating i.e. the ability of asperities to carry a pressure that is much higher than that which may be expected to plastically flatten the asperity.

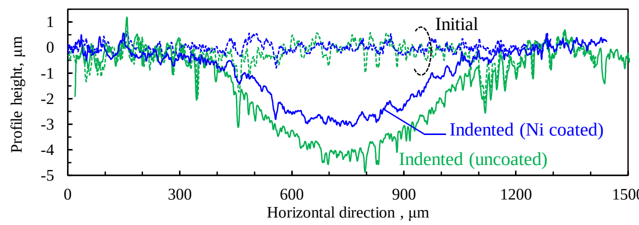

Fig.1 Initial and indented profiles

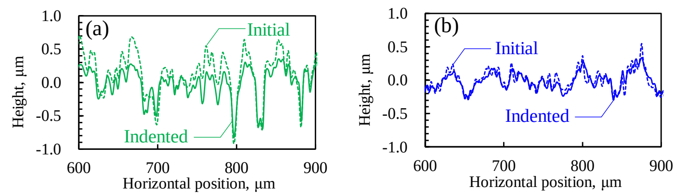

Fig.2 Roughness profiles of (a)uncoated and (b)coated specimens

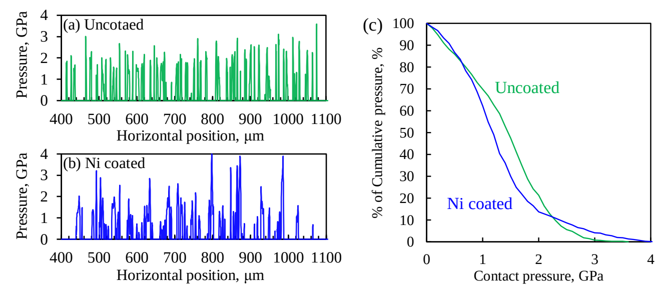

Fig.3 (a) and (b) Contact pressure, and (c) Cumulative pressure distribution obtained by numerical simulations

ACKNOWLEDGMENTS
KI wishes to thank Nippon Steel Corp. for financial support.

REFERENCES
[1] S. J. Cole and R. S. Sayles, ASME J. Tribol., 114, 1992, 334.
[2] T. Nogi and T. Kato, ASME J. Tribol., 119, 1997, 493.
[3] A. Kadiric, et al., ASME J. Tribol., 125, 2003, 720.
[4] J. Nyqvist, et al., Tribology Int. 87, 2015, 98.