Characterization of WC-Co Coatings Corrosion Product by Raman Spectroscopy

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Abstract
In cermet coating such as WC-based coating, the coexisting of ceramic and metal results in micro-galvanic corrosion due to different corrosion potential of each element. In this study, WC-17wt%Co was used. The corrosion behaviour of the coating was evaluated by potentiodynamic test in two different electrolyte which are 0.5 M sulphuric acid and 3% by weight alkaline drilling fluid. This coating shows higher corrosion potential in acid electrolyte compares to in alkaline electrolyte. Clear passivation is seen for both cases. Raman shift is able to detect WO_3 and WO_3H_2O as a corrosion product after corrosion test.

Keywords: corrosion, WC, Raman shift

Introduction
Metal-ceramic composite or cermet coatings have become popular due to their enhanced wear and corrosion resistance properties. Cermets consist of ceramic particulate embedded in a metallic binder [1, 2].

In cermet coatings with both ceramic and metal present, these can have very different potentials. This results in micro-galvanic corrosion as discussed by Cho et al. [3]. It is found that corrosion of cermets happens at the interface between the ceramic and the metallic binder [4, 5]. This interface creates a place for micro-galvanic and/or crevice corrosion. As the ceramic has a low corrosion rate, it is seen that corrosion attacks the binder [5].

In the current work, the corrosion behaviour in acid and alkaline electrolyte was examined. Both WC-Co and WC-CoCr were used to see the effect of chromium in increasing the corrosion resistance of this coating type.

Experimental method
The corrosion test was carried out according to the ASTM standars G5:1994 and G6:1986 or BS EN ISO 17475:2008 using ACM Gill 8 potentiostats (ACM Instrument, Cumbria, UK). The samples were mounted with Dap-mount follow by grinding and polishing until 1 micron diamond grit. The surfaces around the tested area were covered with acid resistant stop-off lacquer. Two types of electrolyte were used in this study which is 0.5 M H2SO4 and 3% by weight of bentonite solution (alkaline drilling fluid). A three electrode cell arrangement was used with saturated calomel electrode (SCE) as a reference electrode. The Raman spectrometer was used to identify the corrosion product.

Result & Discussion
Fig. 1 shows Raman shift of the coating before corrosion test. WC and Co are seen. Fig. 2 and Fig. 3 shows Raman shift for WC-Co after corrosion test in acid and alkaline electrolyte respectively. WO_3 and $WO_3.H_2O$ were detected after corrosion

test in acid electrolyte, while no corrosion product detected after test in alkaline electrolyte.

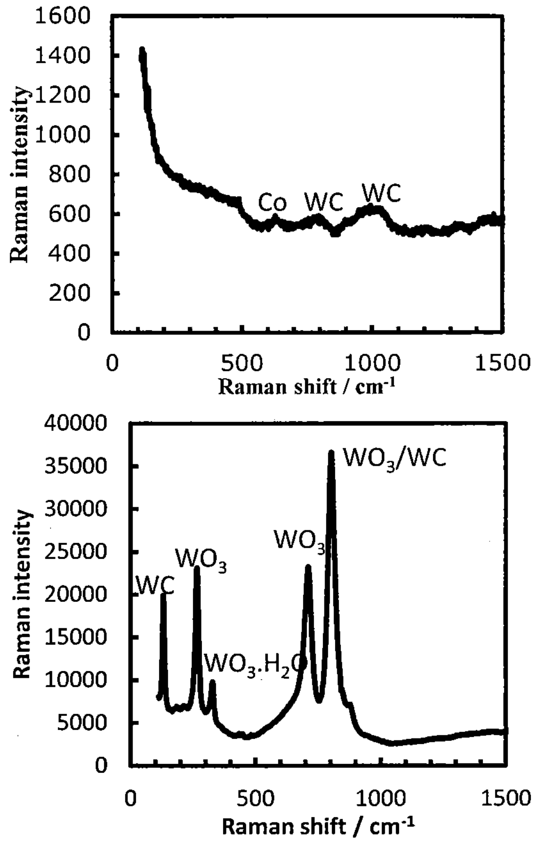

Fig.1: WC-Co Raman shift after corrosion test in acid electrolyte

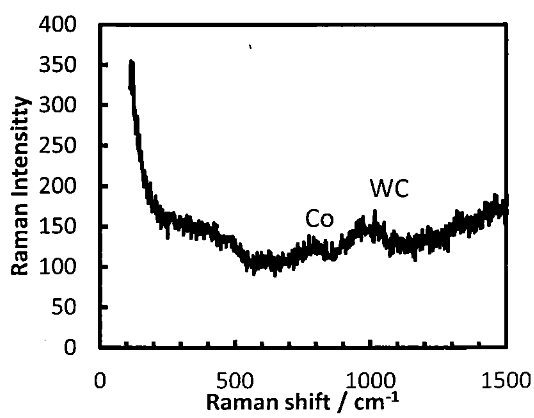

Fig. 2: WC-Co Raman shift after corrosion test in alkaline electrolyte

Conclusion

The corrosion behaviour of the WC-Co coating has been evaluated. It has been found that the corrosion resistance was higher in alkaline electrolyte than in acid electrolyte. The WO_3 and $WO_3.H_2O$ was detected as corrosion product after testing in acid electrolyte. The corrosion mechanism is control by cobalt dissolution followed by carbide detachment.

References

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