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Adhesion of TiN、CrN and DLC Hard Coatings on Steel Substrate

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The adhesion of coating to substrate is a critical property of any coating system for mechanical integrity and environmental protection of the substrate. The measurement of the adhesion strength provides fundamental acknowledge in order to understand majors factors contributing to the adhesion of coating. The durability and longevity of a coating required that its adhesion is to be maintained [1].

In this study, TiN, CrN and DLC (diamond like coating) was coated on both SS41 and SKD11 substrate using CVD method. Several techniques have been developed to measure the adhesion strength of coating on steel. Lap shear test method is the most commonly used technique for this measurement. Due to bending, the test method should be modified [2]. The adhesion strength was then measured after modified lap-shear test. The fracture surface after lap-shear test was also investigated using scanning electron microscopy.

Fig.1(a) and (b) show the microstructure of fractured surface of CrN coated on SS41 and SKD11 substrate after lap-shear test, respectively. It demonstrates that 100% of fracture was observed from the interface between CrN coating layer and the steel substrate on both SS41 and SKD11 substrate. The average adhesion strength was measured to be 149.6MPa and 162.7MPa corresponding to CrN/SS41 and CrN/SKD11 specimens, respectively. The adhesion strength measured represents the interfacial shear strength between CrN coating layer and the steel substrate. Fig.2(a) and (b) demonstrate the microstructure of fractured surface of TiN coated on SS41 and SKD11 substrate after lap-shear test, respectively. In the specimen of TiN coated on SS41 substrate, the fracture was found from two areas; one from the coating layer and the other from the interface between TiN coating layer and steel substrate. While, in the specimen of TiN coated on SKD11 substrate, the fracture can only be observed from the interface between TiN coating layer and the steel substrate. The average adhesion strength was measured to be 245MPa and 254.1MPa corresponding to TiN/SS41 and TiN/SKD11 specimens, respectively. The TiN coating on SS41 and SKD11 substrate was found to have the best performance on the adhesion in this study. Fig.3(a) and (b) depict the microstructure of fractured surface of DLC coated on SS41 and SKD11 substrate after lap-shear test, respectively. It demonstrates that 100% of fracture was observed from the interface between DLC coating layer and the steel substrate at the specimen of DLC coated on SS41 substrate. While, the fracture was found only from the DLC coating layer at the specimen of DLC coated on SKD11 substrate. The average adhesion strength was measured to be 161.7MPa and 193MPa corresponding to DLC/SS41 and DLC/SKD11 specimens, respectively.

[1] Yuli Lin and G.-H Lee, 2001 Conference of Coating Technology, Lu-Gang, Taiwan, 2001.
[2] G.-H Lee, Master Thesis, Chung-Hua University, 2001.
[3] This research was supported by NSC93-2216-E-216-009 and CHU93-2216-E-216-009.

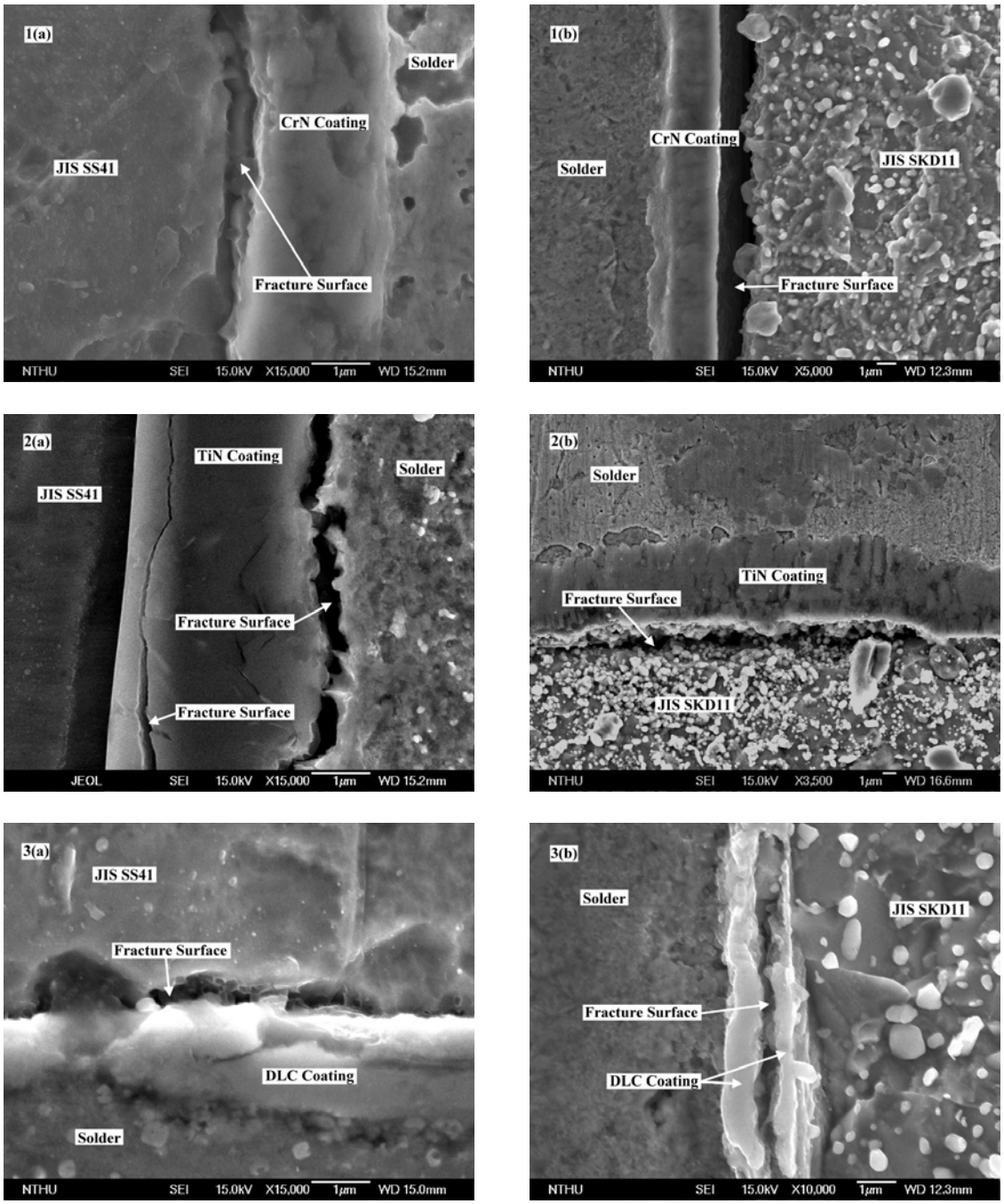

Fig.1 Fractured surface of CrN coated on (a) SS41 and (b) SKD11 showing that 100% of fractured area was observed from the interface between CrN coating and the steel substrate.

Fig.2 (a) Fractured surface of TiN coated on SS41 illustrating that fracture was found both from the coating layer and from the interface between TiN coating and the steel substrate. (b) The fractured surface of TiN coated on SKD11 demonstrating that fracture was only found from the interface between TiN coating layer and the steel substrate.

Fig.3 (a) Fractured surface of DLC coated on SS41 indicating that fracture was found from the interface between DLC coating layer and the steel substrate. (b) The fracture surface of TiN coated on SKD11 demonstrating that fracture was found only from the DLC coating layer.

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