

Evaluation of Mechanical Properties of Ceramic Coating Layers with Nano-sized Silicon Oxides on a Steel Sheet

Youl Baik^{a,*}, Bo K. Kang^a, Yong Choi^a, So E. Yang^b, Jong J. Lee^b, Byung D. Kim^b

^aDepartment of Materials Science and Engineering, Dankook University, San-29, Anseo-dong, Dongnam-gu, Cheonan, Chungnam, 330-714, Korea

^bHankook Coating Co., 33-6 Sodong-li, Embong-myun, Asan, Chungnam, 336-860, Korea

*Corresponding author : youlboy@gmail.com

Abstract

A ceramic coating material with nano-sized silicon oxide on AISI 4340 steel for a thermal conductor at a high temperature was analyzed to find an optimum coating process. Average surface roughness of the coating layers prepared by dipping process was about 5.26 μm . Potassium silicate addition as a binder of the coating material tended to improve its hardness. A pencil scratch hardness testing showed that a loading more than 800 g made fragments of the coating layer.

1. Introduction

Ceramic coating with thermal conductivity is useful for a coolant tubing of a boiler [1]. Although several ceramic coating media have been developed, they have problems like blisters and cracks during service [2]. In this study, a ceramic coating material with nano-sized silicon oxide particles was selected and its physical and mechanical properties were determined.

2. Experimental method

Ceramic slurry with nano-sized silicon oxide was coated on AISI 4340 steel plates by a dipping-0.5 hour drying process at room temperature followed by drying at 500°C for 1 hour. Surface roughness and hardness of the final coating layer were determined by using a profilometer and a pencil scratch hardness tester, respectively.

3. Results and Discussion

A coating material with silicon oxide and chromium oxide was well deposited on the steel substrate. Visual inspection revealed that PS-P100 as a binder more effectively reduced blisters on the coated layer with the composition of 5.7% K_2O -17.9% SiO_2 than any other binders like Resbond 791 and Resbond 792. The average surface roughness of the coating layers formed by 3-times dipping process was about 5.26 μm . Potassium silicate in the PS-P100 tended to improve hardness of the coated layer. A pencil scratch hardness testing of the layer formed by one of optimum slurry compositions of $\text{SiO}_2 : \text{Cr}_2\text{O}_3 : \text{PS-P100} = 7 : 15 : 3$ showed that a loading more than 800-g made fragments of the coating layer.

4. Summary

A ceramic material with nano-sized silicon oxide on AISI 4340 steel was effectively coated by adding a binder of PS-P100. Average surface roughness of the coating layers formed by 3 times-dipping process was about 5.26 μm . Potassium silicate in the coating layer resultantly improved its hardness. Loading more than 800 g made fragments during a pencil hardness testing.

References

1. H. Wang, Y. Xu, M. Shimono, Y. Tanaka, M. Yamazaki : Materials Trans., 48 (2007) 2349-2352.
2. R. Prasher : Inter. J. of Heat and Mass Transfer, 48 (2005) 4942-4952.