수열합성된 Al-Cr-N-O계 도포층의 열전도 측정과 수학적 해석

Determination of Thermal Conductivity and Numerical Analysis of Al-Cr-N-O Composites Layer Formed by Hydro-thermal Process

김마로[a*], 양소은[b], 이종재[b], 김병두[b], 최 용[a]
[a*]단국대학교 신소재공학과(E-mail:planetmaro88@naver.com), [b](주)한국코팅(주)

Abstract : Composites layer of Al-Cr-Ni-O system was prepared on a steel plate by hydro-thermal process at 700 °C for 12 hours, which phase identification and thermal conductivity were determined. The composites layer consisted of aluminum nitride, alumina, chromium carbide and aluminium, which density was 3.7kg/m^3. The thermal conductivity of the coating layer determined by thermal data acquisition system was about 98.0 W/m/ which depended on the AlN content. Numerical modelling of the heat transfer behavior of the coating layer was well agreement with the empirical data.

1. Introduction

A ceramic coating material for a heat pipe of a boiler has characteristics such as high temperature corrosion resistance, high oxidation resistance and high thermal conductivity. In this study, hydrothermal coating of Al-Cr-N-O system was considered to improve its thermal conductivity which heat transfer behavior was numerically analysed by finite element method.

2. Experimental Method

Ceramic slurry of Al-Cr-N-O system was sprayed on AISI 4340 steel plate with 100x100x2 [mm] and was kept in a furnace at 700°C for 12 hours. Phase identification and microstructure observation were carried out by X-ray diffractometry (Rigaku, ULTIMA-IV, Japan) and scanning electron microscopy (COSEM, Korea), respectively. Thermal conductivity was determined by thermal data aquisition system (Agilent Technologies, U2802A, USA) with thermocouples at 5-points of the coating layer for every 10^{-3}sec. Numerical modelling of the heat transfer behavior of the coating layer was suggested and analyzed by finite element method.

3. Conclusions

(1) The composition of the coating layer formed by hydrothermal process was Al_2O_3:AlN:Cr_3C:Al=54.7:24.3:10.9 :10.1.
(2) Thermal conductivity of the layer was about 98.0 W/m/k, which was 68% of theoretical maximum thermal conductivity. The thermal conductivity depended on aluminium nitride content.
(3) Numerical modelling of the heat transfer behavior of the coating layer was well agreement with the empirical data.

Acknowledgement

Authors thank for Small and Medium Business Administration (Grant #: C0002603) for their financial support.

References

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