

Co-deposition of Al-Cr and Al-Ni Alloys Using Potential Pulse Technique in Molten Salt

Mikito Ueda, Hirokuni Kigawa, and Toshiaki Ohtsuka
Graduate School of Engineering, Hokkaido University,
Kita-13, Nishi-8, Kita-ku, Sapporo, 060-8628 Japan

Introduction

TiAl inter-metallic compound is may be one of the next turbine blade materials of internal combustion engine. However the corrosion resistance of TiAl is not enough in a high temperature area. To improve the oxidation resistance in high temperature, we have proposed electroplating of Al-Cr alloy on TiAl in a molten salt as a surface treatment of TiAl, and reported that the corrosion resistance by high temperature oxidation of TiAl was improved by the Al- Cr electroplating.[1] Ni-Al alloy layer may also be effective for improvement of high temperature oxidation of TiAl. In this study, we investigated co-deposition of Al-Cr and Al-Ni alloy from AlCl_3 -NaCl-KCl molten salt containing CrCl_2 and NiCl_2 at 423 K.

Experimental

61 mol% AlCl_3 - 26 mol% NaCl- 13 mol% KCl mixture salt of 300 g was melted at 423 K. Grassy carbon (GC) plate was used as a test electrode. A pure aluminum plate was used as a counter electrode. A pure aluminum rod placed in a Pyrex glass tube was used as a reference electrode. To maintain electrical contact between the electrolyte and the reference electrode, a small hole was made by insertion of asbestos at the bottom of the tube. Electrolysis was carried out with a Hokuto-Denko HAG-5010 potentiostat.

Cyclic voltammogram was measured at potential from 1.4 to -0.4 V vs. Al/Al^{3+} with scan rate of 5mV s^{-1} in the molten salt containing CrCl_2 and NiCl_2 . Electrodeposition films of Al-Cr-Ni alloys were prepared by a constant electricity of 40 C cm^{-2} on the GC electrode at constant potentials from -200 to -400 mV in the molten salt. And electrodeposition by potential control pulse technique was also carried out. Electrodeposits were analyzed by X-ray diffraction (XRD) and electron probe micro analyzer (EPMA).

Results and discussion

Concentration of Cr ion and Ni ion in the molten salt were estimated to be 8×10^{-2} and 5×10^{-2} mol dm^{-3} at 423 K respectively. Cyclic voltammogram on GC in the

molten salt is shown in Fig.1. Small cathodic current of electrodeposition of Ni was observed at 800 mV vs. Al/Al^{3+} and cathodic current of electrodeposition of Al and Cr started to increase at potentials lower than 0 V. Anodic current appeared from 0 V to 700 mV. This anodic current may concern with dissolution of pure Al and Al- Cr intermetallic compounds. Dissolution of Ni was detected at 950 mV. Composition of electrodeposits under constant potential control were analyzed Al : Cr : Ni (at%) = 67 : 30 : 3, 78 : 20 : 2, and 88 : 11 : 1 at potentials of -200 , -300 , and -400 mV respectively. The amount of Ni in the electrodeposits was very small and decreased with decreasing potential. Al, Cr_2Al and Ni_3Al were detected at potential of -200 mV and Al and Cr_2Al at -300 and -400 mV by XRD analysis. For enhancement of Ni content, pulse electrolysis was performed, where deposition of Al-Cr-Ni alloy and dissolution of Al were repeated. In the pulse electrolysis, potentials, frequency, and duty ratio were changed for finishing an optimum pulse condition. Aluminum alloy containing 6 at% Cr and 22 at% Ni electrodeposited on the GC electrode under the following

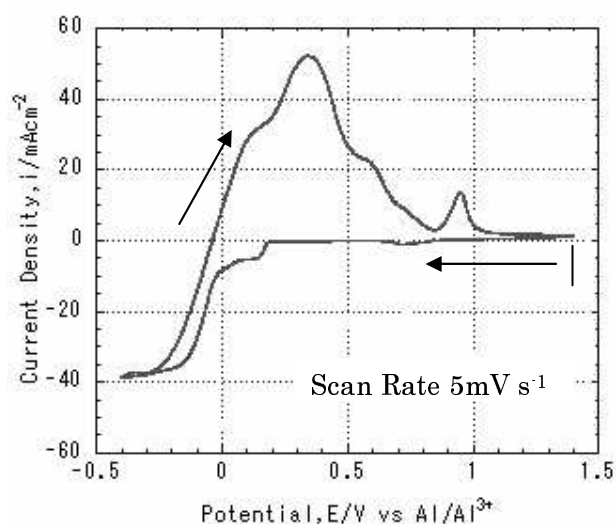


Fig. 1 Cyclic voltammogram for GC electrode in AlCl_3 -NaCl-KCl melt containing CrCl_2 and NiCl_2 .

[1] M. Ueda, D. Susukida, S. Konda, and T. Ohtsuka, Surface coating and technology, 176, 202-208, 2004.