Short Communication

Study of Electrodeposited Ni-TiAlN Composite Films

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A study results of electrodeposited Ni-TiAlN composite films is reported. The composite film was electrodeposited from electrolyte solution of 0.38 M Ni2SO4.6H2O, 0.17 M NiCl2.6H2O and 0.49 M H3BO3 adding with various electrodeposition current from 2 mA to 4 mA and TiN and AlN powder from 2 gr/lit to 8 gr/lit. The morphology and compositions were characterized by using SEM/EDS while the crystal structure was characterized by XRD. The results show that the morphology and structure of composite films were influenced by electrodeposition parameters such as electrodeposition current and nitride particle concentration. The evolution of surface morphology and structure was occured as the electrodeposition current and nitride particles concentration were increased. The smoothest and uniform film surface was achieved at high electrodeposition current. However, the agglomeration and initial spalling film were occured at high nitride particles concentration. Structure analysis of the films revealed the presence of TiN and AlN crystalline in the composite film.

Keywords: Electrodeposition, Ni-TiAlN composite film, tungsten carbide, morphology, composition, structure.

1. INTRODUCTION

Development of thin coating or film onto a material is a method to protect the material from external influences such wear and corrosion. The wear is occured due to the mechanic interaction between two or more materials cause a friction while the corrosion is due to chemical interaction between material and corrosive ions. The rate of wear and corrosion can be prominent at high temperature operation. In thin film development, electrodeposition is a method to develop a film onto a material or substrate that work based on the electrochemical process. Electrodeposition is a film growth process onto a material through the electrochemical reduction from an electrolyte solution [1]. In the process, the charges are transfered between electrode rod surface and ionic solution or electrolyte under applied potential or current. Electrolyte is liquid solution containing ionic species in
3. RESULTS AND DISCUSSION

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Smooth film surface morphology.

Increasing thickness of the Au film deposited by electrochemical deposition current is required to produce a compact and uniform Au film. However, if the current density is not high enough, the Au film will not be smooth enough. The particle size increases with increasing current density, which causes the Au film to become rough. This is the reason why the Au film deposited at a higher current density is not as smooth as the film deposited at a lower current density.
The influence of TiN and AlN concentrations on the surface morphology of Ni-TiAlN.

The evolution of crystal growth depends on the nucleation and grain growth velocity. The higher crystal growth is due to high nucleation velocity and low grain growth velocity. A low nucleation velocity results in a smaller number of nuclei, leading to larger grain growth.
Figure 3. XRD analysis on structure of Ni-TiAIN composite film on electrodeposition current of 2 mA, 1 mA, and 0.4 mA.

The effect of electrodeposition current on structural change of Ni-TiAIN composite films are shown in Figure 3. The XRD peak of Ni and TiN in 2 mA does not decrease, indicating that the films are still present. The peak of Ni and TiN in 1 mA and 0.4 mA decreases slightly as the electrodeposition current was increased from 2 mA to 0.4 mA.

In this study, the effect is prominent at high particle concentration. Further decrease in electrodeposition current causes a decrease in the intensity of the peaks. This phenomenon may be due to the deposition of Ni/TiN film during the electrodeposition process.
The effect of various electrodeposition current and initial particle concentrations on surface roughness and surface morphology and wettability of Ni-TiAIN films have been studied. The evolution of surface morphology and wettability of Ni-TiAIN films is shown in Figure 4. The effect of various electrodeposition current and initial particle concentrations on surface roughness and surface morphology are shown in Figure 5. The addition of nickel significantly increased the agglomeration of nickel particles of different sizes in the composite surface. The effect of Ni and AlN particles on structure are shown in Figure 4. The peak of NiN increased and the increase of peak nickel intensities were observed.
However, the agglomeration and initial spalling film were occurred at high nitride particles concentration. At high electrodeposition current and particle concentration, TiN crystal peaks tend to decrease slightly while AlN crystal peak increase as the nitride particles concentration is increased. AlN crystal peak is higher than TiN crystal indicating AlN crystal size is larger than TiN crystal size.

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References


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