**Abstract**

The high entropy nitride thin film (Cr$_{0.35}$Al$_{0.25}$Nb$_{0.12}$Si$_{0.08}$V$_{0.20}$)N with different processing parameters, such as substrate temperature and bias, were fabricated by RF magnetron sputtering system. In this study, this high entropy nitride thin film showed an outstanding mechanical property with over 35 GPa hardness and a high value of H/V$^2$. The low wear rate measured via the wear test can be correlated to the favorable mechanical property.

**Introduction**

The evolution of hard nitride coatings has been started from binary systems, ternary systems and now move to high entropy systems, which have been reported for its extraordinary properties, including hardness, structure stability, anti-corrosion and high temperature strength. By designing a non-equimolar system based on Cr and Al, the goal of this study is to develop an ideal protective thin film applicable in high temperature wearing field.

**Experimental Design**

(Cr$_{0.35}$Al$_{0.25}$Nb$_{0.12}$Si$_{0.08}$V$_{0.20}$)N thin films were first fabricated at various substrate temperature by RF magnetron sputtering, and the bias was applied at T$_{sub}$=300°C to improve its mechanical property. Subsequently, the wear test was carried out at 600°C to observe its anti-wearing ability in severe environment.

**Results and Discussions**

- **The influence of substrate temperature**

  (Cr$_{0.35}$Al$_{0.25}$Nb$_{0.12}$Si$_{0.08}$V$_{0.20}$)N thin films exhibited a stable FCC structure and showed a slight grain growth during elevated substrate temperature. The hardness increased to 31 GPa and almost retained with the substrate temperature at 200°C, 300°C and 400°C. The hardness improvement between ambient and higher temperature is probably caused by reduced defect contents.

- **The influence of applying bias**

  After applying bias at T$_{sub}$=300°C, the hardness and H/V$^2$ ratio showed a superior value of 35.24 GPa and 0.638, respectively. This enhancement is believed to be a combined result of severe lattice distortion and smaller grain size. The low wear rate of 5.7x10^{-6} mm$^3$/N·m$^{-1}$ obtained from wear test was attributed to the outstanding mechanical property.

**Conclusion**

The (Cr$_{0.35}$Al$_{0.25}$Nb$_{0.12}$Si$_{0.08}$V$_{0.20}$)N thin film with fcc structure has been successfully deposited. This nitride, exhibiting high hardness and high ratio of H/V$^2$, exhibits a potential in high temperature wearing applications.