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A Study on the Wear Characteristics of Aluminum for Aircraft with Ti Thin Film Deposited

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1. Introduction

Material failure is mostly caused by the growth of cracks on the surface. Various plating methods are being studied to prevent such surface cracking.

Thin film deposition technology is a technology that is the basis of science and technology. It means surface treatment technology that improves the performance of the base material or gives additional functions to the base material, which means coating other materials on the surface of the base material [1]. The improvement of the mechanical properties of the metal through the thin film has been developed in many ways as one of the main methods for strengthening the surface of the material, and among the thin film deposition techniques, the development of the thin film layer using the PVD equipment is becoming more important.

Ti has a density of about 57% of steel, which is very light, has good mechanical strength, and is wear resistant. In addition, Ti can be used in a wide variety of applications either by metal itself or by alloying with various metals.

In this study, we investigate the friction and wear characteristics of Ti, which is well known as a material for improving the wear resistance of various tools and molds with excellent abrasion resistance, by depositing each thickness on 505 series Al by DC magnetron sputtering which is one of thin film deposition technologies.

2. Materials and Experimental methods

In order to deposit Ti, the sputtering equipment of Fig. 1 was used. Table 1 shows the conditions used for sputtering. This is based on the results of previous studies. The wear test was carried out using the TRIBOSS PD-102 wear tester shown in Fig. 2. Each of the specimens was polished to a thickness of Ø = 32 mm and h = 25 mm, and the surface of the material was polished to # 1500 so that the surface deposition could proceed smoothly. Thereafter, the specimen was fixed to a wear tester and a chrome steel ball was attached to the end of the pin, and the test was carried out using the pin on disk method. The rotational speed of the pin was set to 60 rpm, the test time was set to 30 minutes, and the load was set to 200 g. SEM(scanning electron microscope) was also used to observe the wear track.

Fig.1 Photograph of wear tester

Table 1 Sputtering conditions

Film Material	Ti
Thickness(nm)	500, 1000
Base Vacuum	5.0×10^{6} torr
Working Vacuum	2.0×10^{3} torr
Plasma Factor	200 w
Temperature	RT

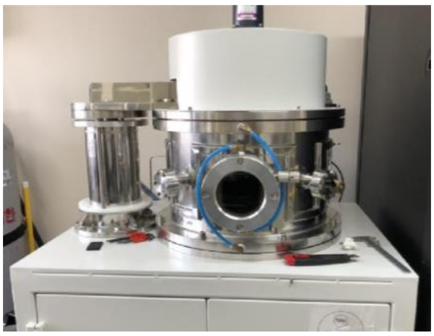

Fig.2 Photograph of sputtering system

3. Results and Discussion

Figure 3 and Table 2 show the change in coefficient of friction for each test specimen. The specimens deposited with 500 nm of Ti showed a higher coefficient of friction than those of the base material, but the specimens deposited at 700 nm had a lower coefficient of friction than the base material.

Figure 4 is the SEM observation of the change in the width of the wear track of the material. Table 3 shows that the width of the wear track of the Ti thin film deposited at 500 nm was the narrowest and the Al 505 Ti 750 nm specimen showed no significant difference from the base material. The chips were observed on the surface of the wear track, and relatively small amounts of these chips were observed in the Ti-deposited specimens. It was observed that the wear resistance of the specimen deposited with Ti of 500 nm was the best.

Table 4 shows the amount of wear of Ti thin film. The Ti thin film deposition showed lower wear than the base metal. The time required for the base material to start to wear due to the high wear resistance of the Ti thin film was relatively long. Therefore, it was found that the wear resistance of Al 505 Ti 500 nm film specimen was the most excellent.

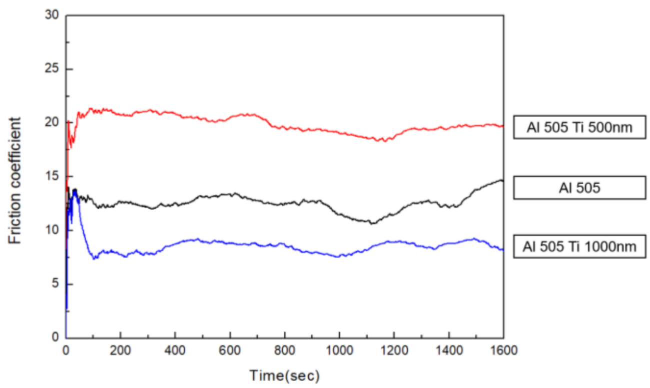

Fig.3 Friction coefficients of each cases

Table 2 Average friction coefficient

Type	Friction Coefficient (average)
Al 505 no film	12.75856
Al 505 500nm film	19.88611
Al 505 1000nm film	8.563293

Table 3 Relations of wear track

Type	Wear Track(mm)
Al 505 no film	1.833
Al 505 500nm film	1.548
Al 505 1000nm film	1.864

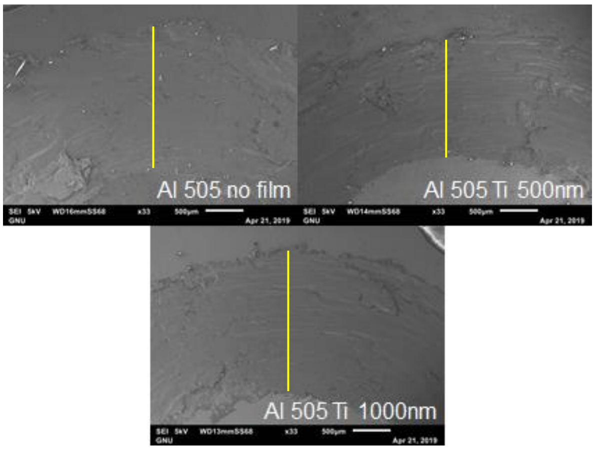

Fig.4 Photograph of SEM wear track (x33)

Table 4 Wear loss of each cases

Type	Wear loss(g)
Al 505 no film	0.0071
Al 505 500nm film	0.0045
Al 505 1000nm film	0.0057

4. Conclusion

In this study, the Ti on the 505 series Al was deposited and tested by pin on disk method. The results were as follows

In the graph of the coefficient of friction, it is confirmed that the deposition of Ti thin film affects the improvement of wear resistance of the material because the Al 505 Ti 500 nm specimen shows higher value than the base material.

The wear track and wear amount showed a tendency to increase in inverse proportion to the friction coefficient. In the comparison of the wear amount table, it was confirmed that wear resistance was improved when the Ti thin film was deposited as a result of the result that the Ti 500 nm specimen had lower wear amount than the base material.

Acknowledgment

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References

[1] H. S. Yu and H. B. Park, Study on the Improvement of wear properties of Automobile elements in Titanium alloy Coated, *The Journal of Korea Navigation Institute,* 17 (5) (2013) 574-580