9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Trial of elemental gradient functional thin films preparation by sputtering with mixed powder targets III

Hiroharu Kawasaki[1], Takahiko Satake[1,2], Akihiro Ikeda[2]
[1] National Institute of Technology, Sasebo College, [2] Sojo University
e-mail (speaker):h-kawasa@sasebo.ac.jp

Gradient functional thin films, such as simultaneously provide bonding surfaces similar to the base material and hard cutting surface to address, have been studied using plasma processes[1]. We have previously reported the preparation of A6061 thin films on sus304 steel via sputtering deposition. However, the A6061 plasma coating on SUS304 did not markedly increase the hydrogen-entry resistance under corrosive environments; we attribute this result to the difference in the crystal structure between the base material and the film. We also found that the hydrogen embrittlement prevention was improved by doping of small amounts of Titanium (Ti). Therefore, gradient functional thin films that have an greater Ti contents at the surface of the thin film in contact with the hydrogen gas, and a greater SUS304 content at the boundary with the base SUS304 may be an effective and low-cost strategy to prevent hydrogen embrittlement. In this study, we prepared gradient functional thin films for hydrogen entry prevention by a sputtering deposition method with powder targets [2].

To investigate the hydrogen-entry resistance properties, Ti doped SUS304 thin films were prepared using a conventional RF magnetron sputtering deposition system. TiO_2 and SUS304 mixed-powder target was used for Ti doped SUS304 thin-film preparation. The RF power of the deposition was 100 W, and the deposition time was 1 h.

Ti and Fe concentration ratio of the film were shown in Fig. 1. In this figure, the parameter was mass ratio in the mixed powder target. The mass ratio means the mass of TiO_2 and SUS powder introduced into the same target holder. From the results, concentration ratio of the Ti and Fe in the film was almost linearly changed with the increase in TiO_2 and SUS in the powder mixture.

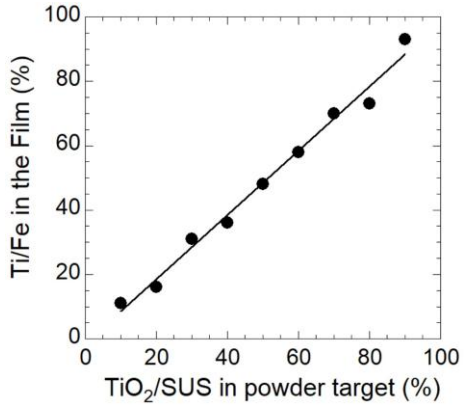

Fig. 1. Dependence of the Ti and Fe element mixture on the TiO_2 and SUS powder target mixtures.

Gradient functional thin films were prepared by sputtering using mixed powder targets. This deposition was almost same method of Ni/SUS gradient functional thin film which using 100% SUS304 powder, 10%TiO_2/90%SUS304 mixture powder, 20% TiO_2/80%SUS304, and so on [28]. Finally, 100% TiO_2 powder target was used. The RF power of the deposition was 100 W, and the deposition time was 1 h. The substrate surface was maintained at room temperature.

An XPS depth profile of the prepared film is shown in Fig. 2 with Ar ion etching performed for 5 min between each measurement, corresponding to etching of several tens of nanometers. These results suggest that the Ti concentration ratio of the prepared film decreased with the etching time. This result suggests that gradient functional thin films with variable Ti and Fe compositions were prepared by our sputtering deposition method with TiO_2 and SUS304 mixed powder targets. Our experimental results suggested that the Ti and Fe concentration ratio of the prepared films varied almost linearly with the TiO_2 and SUS304 content of the mixed powder target as shown in Fig. 1. The Ti/Fe concentration ratio can be controlled during the sputtering process by altering the powder target composition. Hence, XPS depth profiles suggest that the Ti and SUS304 composition varied almost linear changed with the etching times, as shown in Fig. 2. This results strongly suggest that Ti and Fe composition gradient thin film can be prepared using by sputtering with mixed powder targets.

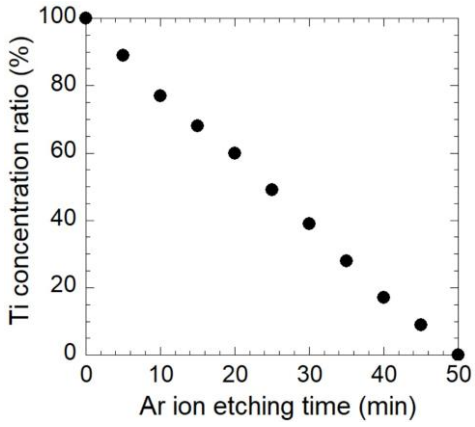

Fig. 2. Ti concentration ratio of the prepared film with Ar ion etching

References

[1] T. Matsuo, etal, Int. J. Hydrogen Energy **39**, 3542 (2014).
[2] H. Kawasaki, , etal, Jpn. J. Appl. Phys **58**, SAAD04 (2019).