인공해양환경에서 플라즈마 아크 용사 공법이 적용된 Al 및 Zn 코팅의 부식 방지 성능 평가

Anti Corrosive Performance of Al and Zn Coatings Deposited by Plasma Arc Thermal Spray Process in Artificial Ocean Water

잔 낫* 이 한 승**
Adnin Raihana Jannat Lee, Han-Seung

Abstract

The thermal spray coating process is being used to protect the metals and alloys from wear, abrasion, fatigue, tribology, and corrosion failure. Therefore, in the present study, Al and Zn was deposited by plasma arc thermal spray process onto the steel substrate and their performance was assessed. The bond adhesion result shows that Al coating has higher value attributed to compact, dense, and less porous compared to Zn coating which contain defects/pores and uneven morphology assessed by scanning electron microscopy (SEM). Electrochemical results show that the Al coating exhibited higher impedance value compared to Zn in artificial ocean water solution at prolonged exposure periods. However, both coatings show the increment in polarization resistance with exposure periods which reveal that porosity of coatings is filled by the corrosion products.

키 워 드 : 알루미늄, 징크, 강재, 플라즈마 아크 열, 부착 강도, 부식
Keywords : aluminum, zinc, steel, plasma arc thermal, bond adhesion, corrosion

1. Introduction

Steel is one of the widely used materials in construction due to its mechanical properties, tensile strength, thermal stability and so on. However, all environment causes corrosion of the steel which affects the economy of the world. Thermal spray coating method is quite popular in different sectors such as construction, automobiles, medical etc. for its low cost and better efficiency to reduce the corrosion rate [1]. In our present research, among different thermal spray coating, we have focused on plasma arc thermal spray process to deposit Al and Zn coating on steel substrate to compare the performance of both coatings in artificial ocean water at prolonged exposure periods.

2. Materials and Method

On sand blasted plate, pure Al and pure Zn (99.95% purity in both cases) was deposited with 1.6mm diameter wires. Atomizing gas was converted to plasma gas to deposit the coating on the steel substrate. According to KS F4716, the bond adhesion test was performed. Scanning electron microscopy (SEM) was carried out to identify the morphology of deposited Al and Zn coating by plasma arc thermal spray process. In artificial ocean water i.e. ASTM D1141 solution, the corrosion resistance properties of deposited coating were carried out at prolonged exposure.

3. Results and Discussion

The obtained average bond adhesion value is 6.22 and 4.84 MPa for Al and Zn coatings deposited by plasma arc thermal spray process, respectively. The Al coating deposited by plasma arc thermal spray process exhibited approximately 22% higher bond adhesion value compared to Zn coating. This higher bond strength indicates more compactivity of Al coating compared to Zn coating.

* 한양대학교 스마트시티공학과 석사과정
** 한양대학교 ERICA 건축학부 교수, 교신저자(ercleehs@hanyang.ac.kr)

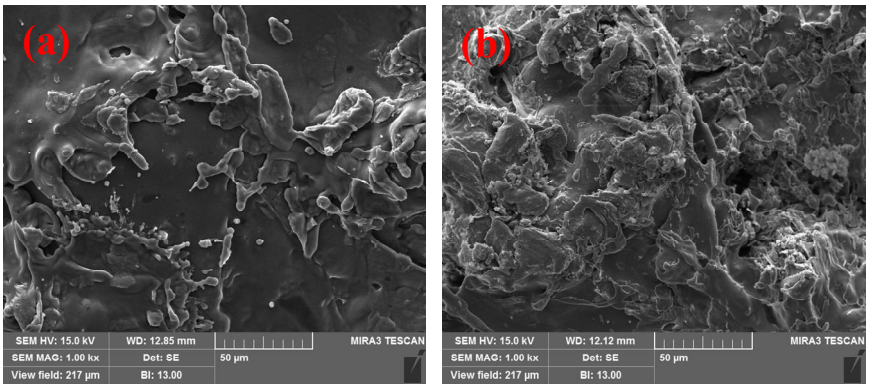

Figure 1. SEM image of (a) Al and (b) Zn coatings deposited by plasma arc thermal spray process

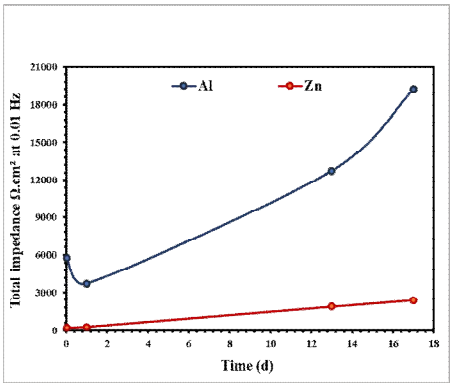

Figure 2. Total impedance of Al and Zn coatings in artificial ocean water with exposure periods

Figure 1 (a) and (b) respectively shows the SEM results of Al and Zn coating deposited by plasma arc spray process. It is clearly noticed that Al coating (Figure 1a) shows more impact and uniform morphology compared to Zn coating (Figure 1b) which proves the higher bond strength of Al coating deposited by plasma arc thermal coating process. The total impedance is studied (Figure 2) for both Al and Zn coatings deposited by plasma arc thermal spray process at the lowest frequency i.e. 0.01Hz in artificial ocean water for prolonged period whither Al exhibited much higher in total impedance compared to Zn coating. The initial impedance value is governed by morphology which can be seen from Figure 1 (a) that Al coating is exhibited compact, adherent morphology whereas at longer duration of exposure attributed to the nature of corrosion products. At longer duration of exposure, the impedance value of Al coating improved significantly compared to Zn owing to the formation of stable and protective corrosion products whereas Zn coating improved slightly in impedance value.

4. Conclusion

In this study, it is clearly shown that Al coating deposited by plasma arc thermal spray process was exhibited higher bond adhesion value, uniform and compact morphology as well as corrosion resistance properties in artificial ocean water solution with exposure periods compared to Zn coating.

Acknowledgement

This research was supported by basic science research program through the National Research Foundation (NRF) of Korea funded by the Ministry of Science, ICT and Future Planning (No. 2015R1A5A1037548).

References

1. Varun Panwar, Vikas Chawla, Neel Kanth Grover, A REVIEW ON DIFFERENT THERMAL SPRAY COATING PROCESS FOR INDUSTRIAL APPLICATIONS, IJLTET, 2019