3.5wt.% NaCl로 오염된 콘크리트 기공 용액에서 아크 용사 공정에 의해 부착된 Al 및 Zn 코팅의 부식 성능

Corrosion Performance of Al and Zn Coatings Deposited by Arc Thermal Spray Process in 3.5 wt.% NaCl-Contaminated Concrete Pore Solution

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Abstract : The corrosion of steel rebar embedded in the coastal areas is corroding once the chloride ions ingress through the pores of the concrete. Therefore, in the present study, a 100 μm thick Al and Zn coating was deposited by an arc thermal spray process onto the steel. The corrosion studies of these deposited coatings were assessed in 3.5 wt.% NaCl contaminated concrete pore (CP) solution with immersion periods. The results show that the Al coating is more corrosion resistance compared to the Zn coating attributed to the formation of gibbsite (γ-$Al(OH)_3$) whereas Zn coating exhibits $Zn(OH)_2$ onto the coating surface as passive layer. The $Zn(OH)_2$ is readily soluble in an alkaline solution. Alternatively, γ-$Al(OH)_3$ on the Al coating surface is less solubility in the alkaline pH, which further provides barrier protection against corrosion.

키워드 : 강재, 부식, 코팅, SEM, EIS.
Keywords : steel, corrosion, coating, SEM, EIS

1. Introduction

Steel rebar exposed to coastal area where the chloride content is very high, severely corroded. Therefore, there are different techniques have been used to control the corrosion of embedded steel rebar in the concrete. The galvanizing of the steel rebar is one of the method to improve the corrosion resistance[1]. In hot dip galvanizing, Al is alloyed with Zn where it shows excellent corrosion resistance in concrete environment compared to conventional Zn coating on the steel rebar[2]. Moreover, the Al and Zn coatings can be applied by arc thermal spray process and there are no studies in the literature to evaluate the corrosion performance of these metals in the concrete condition. Therefore, in the present studies, we have deposited the Al and Zn coatings using arc thermal spray process and evaluate their corrosion resistance performance in simulated concrete pore (CP) solution contaminated with 3.5 wt.% NaCl solution with exposure periods.

2. Materials and Method

The plain carbon steel was coated with 1.6 mm diameter twin wires of Al (99.95%) and Zn (99.95%). The coatings were deposited by arc thermal spray process where the twin wires of each metal melted at arcing point and the molten metal particles were propelled by the compressed air and hit the steel substrate resulting deposition of the coatings[3]. The surface morphology of the Al and Zn coating was characterized by Scanning Electron Microscopy (SEM). The electrochemical studies of Al and Zn coatings were performed in 3.5 wt.% NaCl contaminated concrete pore (CP) solution with immersion periods.

3. Results and Discussion

The SEM of the Al and Zn coatings is shown in Figure 1(a) and (b), respectively. The Al coating exhibited dense and uniform morphology (Figure 1(a)) whereas Zn coating shows severe defects and pores formation as shown in Figure 1(b). In the case of Al coating, the wires are completely melted and the molten metal particles are in smaller size, which agglomerated and form a layer of

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coating, therefore, it shows dense coating morphology. Alternatively, Zn is melted at low temperature (melting point 420 oC) where during deposition of coating, most of the molten metal particles entrapped in the air and later randomly deposit, therefore, it shows severe defects4) and later cause corrosion. The corrosion resistance properties of these coatings are assessed in CP solution with immersion periods. The total impedance of these coatings are shown in Figure 1(c). The results show that initially both coatings are exhibited identical and lowest total impedance at 0.01 Hz due to the presence of defects. Moreover, as the immersion duration are increased both coatings simultaneously increase the impedance value and reached at maximum corrosion resistance after 27 days of immersion attributed to the filling of defects/pores by corrosion products formed during immersion. However, the Al coating exhibited higher impedance compared to Zn coating might be owing to the formation of stable corrosion products i.e. gibbsite (γ-$Al(OH)_3$). There is possibility that Zn coating forms unstable and soluble corrosion products, therefore, it shows lower corrosion resistance. There is reduction in total impedance of both coatings after 51 days of immersion suggesting about the dissolution of the coatings.

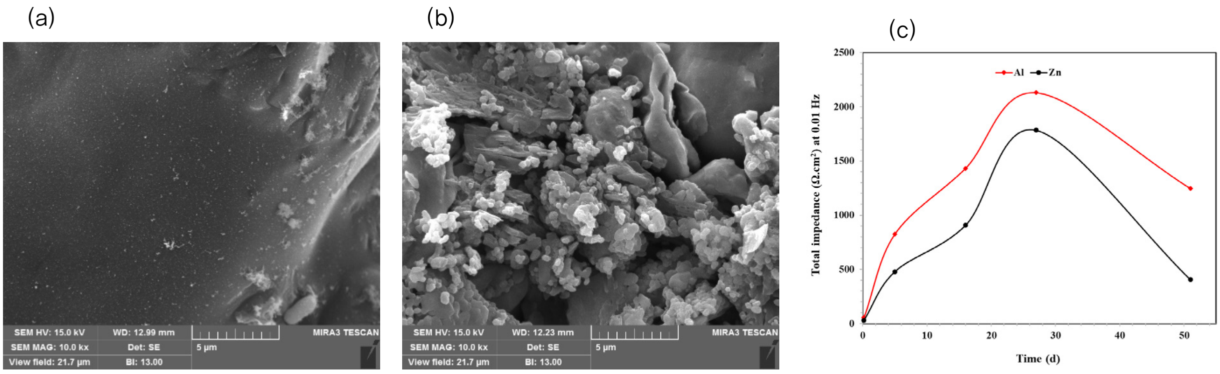

Figure 1. SEM of (a) Al, (b) Zn, and (c) total impedance of coating immersed in CP solution

4. Conclusions

Al and Zn coatings are deposited by arc thermal spray process and their corrosion resistance for suitability in concrete condition are assessed. The Al coating exhibit dense and uniform morphology whereas Zn possess defects and pores formation. The corrosion resistance of Al coating is greater than Zn attributed to the formation of stable corrosion products in CP solution. As the immersion periods in CP solution increased until 27 days, both coatings exhibit increment in impedance values but as the duration is extended, both coatings show deterioration.

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