The Effect of Nitrogen Coating Pressure on the formation of Macroparticles in TiN thin film coatings

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Fuel cells are systems that produce energy without emitting harmful greenhouse effect gases [1]. The biggest obstacle to the use of fuel cells in civil applications is their cost. One of the important components of the fuel cell is the bi-polar plates [2]. Within the scope of this study, the development of corrosion resistant thin films for metallic bi-polar plates are examined. Bi-polar plates of fuel cells can be produced from various materials such as graphite based, polymer based and metals. Due to its advantages such as formability and machinability, relatively low cost and low gas permeability properties, in this study, thin film coatings on metallic plates preferred and production parameters were studied [3]. Bi-polar plates responsible to the following versatile and imporant tasks in PEMFC. Tasks of bipolar plates[4];

- Keeping fuel cell components compactly together.
- Collecting and transporting electrical charges from the anode side to the cathode side.
- Homogeneus delivery of reactant gases to catalyst coated active surfaces through the flow channels.
- To provide mechanical support for the fuel cell stack to hold together and to withstand the clamping force applied on the stack.
- To transfer the heat relesed during the fuel cell operating process to the outside of the cell.

In addition to being one of the most costly parts with a rate of %45, bi-polar plates make up %80 by mass of a fuel cell [5]. Plates that corrode in a short time due to oxidation and reduction reactions in the PEMFC, working environment should be coated with protective thin films that can remain stable during the working process. Gold (Au), which is preferred due to its chemical stability and conductivity, however, it increases the cost of fuel cells. The main goal is to search for cost-performance efficient coatings on steel plates, which are frequently used in metallic bipolar plates. In this study Titanium (Ti) and Titanium Nitride (TiN) materials are preferred. Various Physical Vapor Deposition (PVD) techniques are used as a coating method. In this study Ti, TiN thin film coatings has been conducted on stainless steel plates with the Cathodic Arc Evaporation (CAE) technique. In order to prevent crack pitting related corrosion over the plate surface, macro and micro particle occurance has to be eliminated.

As can be seen in figure 1, SEM images shows that CAE coating pressure for N_2 and micro particle occurrence is strongly related to each other. Both macro particle size and macro particle count relation is given in figure2.

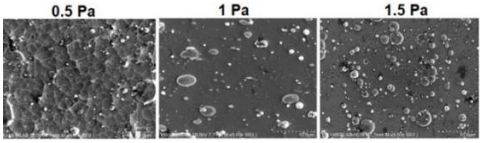

Figure 1. N_2 coating pressure relation with macro particle occurence.

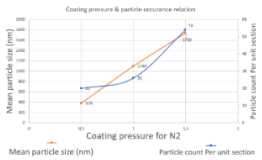

Figure 2. N_2 Coating pressure macro particle relation.

Ti inter layer TiN top layer coated serpentine type air funnel bi-polar plate is shown in figure 3.

Figure 3. Ti interlayer TiN coated serpentine air funnel BPP.

The present study provides insights into the importance of the coating pressure and macro particle occurrence relation.

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