Hydrogen Permeation of DLC-coated Stainless Steels

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ABSTRACT

In many metallic materials hydrogen present in the material is well known to have a negative impact on the mechanical properties of the material [1-2]. It is reported that the deposition of ceramic coatings such as Al₂O₃, TiN, and BN with a thickness of several micrometers can decrease hydrogen attack by a few orders of magnitudes [3-5].

In this study, the hydrogen barrier properties of the coatings of diamond-like amorphous carbon (DLC) were evaluated. The hydrogen permeation test was implemented under a differential hydrogen pressure of 400 kPa and temperatures of 573 K to 773 K, and the amount of hydrogen that permeated a sample was measured. In this study, the relationship between the hydrogen content in the coating and the hydrogen permeation properties of DLC coatings were examined.

It was confirmed that all coatings have an impact on decreasing the hydrogen permeation rate. Specifically, by coating stainless steel with a DLC coating, the hydrogen permeation rate was reduced to 1/1000 or lower compared to that without a coating. DLC coatings with a high hydrogen content had a high hydrogen barrier function.

For hydrogen diffusion in coatings, the movement of atoms through hydrogen trap sites such as pores in coatings, and crystal defects such as dislocations, are important. DLC coating is amorphous, and there are both sp³ and sp² bonds, and excess hydrogen may be found in the interstitial space and the above-mentioned hydrogen trap sites. In a DLC coating with high hydrogen content, these hydrogen trap sites are likely already filled with hydrogen atoms, and the movement of new hydrogen atoms could be limited.

REFERENCES