중성자 흡수소재용 냉간 압연된 Gd-저합금 이상 스테인레스 강의 부식 및 마모성

Corrosion and Wear Properties of Cold Rolled 0.087% Gd-Lean Duplex Strainless Steels for Neutron Absorbing Material

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Abstract: 0.087 wt.% Gd-lean duplex stainless steels were inert arc-melted and cast in a mold. The micro-hardnesses of the rolling, transverse, short transverse directions were 258.5, 292.3, 314.7 HV, respectively. The 33% cold rolled specimen had the crystallographic texture that mainly (100) pole was concentrated to normal direction and (110) pole was concentrated in the center of normal and rolling directions. The corrosion potential and corrosion rate in artificial sea water were in the range of 105.6-221.6 mV_{SHE}, 0.59-1.06 mA/cm^2, respectively. The friction coefficient and wear loss of the 0.087 wt.% Gd-lean duplex stainless steels in artificial sea water were about 67% and 65% lower than in air, whereas, the wear efficiency was 22% higher. The corrosion and wear behaviors of the 0.087 wt.% Gd-lean duplex stainless steels significantly depended on the gadolinium phases.

1. Introduction

The more efficient storage of spent nuclear fuel is one of the most important issue in current Korean nuclear industry since the storage capacity is approaching to full capacity in short time. There are lots of materials like boron-stainless steels and borated aluminium alloys. Gadolinium containing lean duplex stainless steel has a good potential for the absorber containing structural material for the spent fuel rack and for the cell of the spent fuel transport and storage cask [1]. Although the Gd-lean duplex stainless steel is one of promise neutron absorbing materials, little information about its corrosion and wear behaviors has been still avaliable [2]. Hence, the objectives of this study are to characterize the lean Gd-duplex stainless steels, especially, their corrosion and wear behaviors.

2. Experimental Methods

The lean duplex stainless steels with gadolinium have been fabricated by using plasma arc melting (PAM-Plasma, Japan) mother alloys of Fe-Mo, Fe-Gd and Fe-Cr-Ni alloys and alloy elements like manganese (Mn>99.99, Samchang, Korea), silicon(Si>99.99, Samchang, Korea). Microstructure of the specimen was observed by scanning electron microscopy (Jeol, JSM-6400, Japan). Micro-hardness was measured with micro-Vickers hardness tester (HUATEC, DHV-100, China). The corrosion behavior in artificial sea water and the wear resistance were determined by potentio-dynamic method (Gamry, Gamry-100, USA) and pin-on-disk type wear tester (R&B, Triboss PD-102, Korea), respectively.

3. Results

The 33% cold rolled 0.087% Gd-lean duplex stainless steels had average grain sizes of the grains of t on the surface normal to ST, TD and RD directions were 6.58, 6.55, 10.66 [μm], respectively. The micro-Vickers hardnesses of the 33% cold rolled 0.087% Gd-lean duplex stainless steels with RD, TD and ST directions were 258.5, 292.3, 314.7 HV, respectively. The corrosion potential and corrosion rate in artificial sea water were in the range of 105.6-221.6 mV_{SHE}, 0.59-1.06 mA/cm^2, respectively. The corrosion rate depended on the cold rolling direction with increasing in the order of the surface normal to ST, TD and RD directions. The passivity was not present in both solution. The friction coefficient and wear loss of the 0.087% Gd-lean duplex stainless steels in artificial sea water were about 67% and 65% lower than in air, whereas, the wear efficiency was 22% higher.

References

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