Behavior of Microstructure and Corrosion Properties of Zirlo-Cr-Si-NM Metal Waste Form Alloys by Change of Si Content

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1. Introduction

Pyroprocessing has been studied based on the electrochemical separation technology in molten salts for the recycling of spent fuel (SF). In the pretreatment and electrorefining processes, various metal wastes including cladding hull tubes, NFBC (Non-Fuel Bearing Components), and NMs (noble metals) in the anode sludge are generated as a process waste in the pyroprocess [1]. Among them, Zirlo cladding hulls have the highest weight ratio, which reaches about 62 wt.%, excluding the SF, whereas NFBC has the highest volume ratio. Many researchers are studying technologies for the treatment of the metal wastes by melting or compaction, followed by a solidification process. The metal waste solidified by the melting process can easily be alloyed with other elements to improve the corrosion resistance and stability for long-term disposal. However, most of the studies have focused on the alloys based on stainless steel (SS) cladding materials and NM, which are generated from the fast breed reactors [2]. Since the pyroprocessing studying at KAERI is targeting the SF from PWRs (Pressurized Light Water Reactors), it is essential to develop waste form alloys that include Zr-based cladding hull wastes with NMs. In particular, by recycling the cladding hull waste and NFBC as a solidification medium for immobilizing the NMs, we can have a great advantage not only in the volumetric reduction effect but also in the reduction of the waste amount, and in the simplification of the waste treatment process.

In this study, Zirlo-Cr-Si-NM based alloys including all the metal waste components were fabricated by the induction melting process to evaluate the long-term disposal stability of the metal wastes generated from pyroprocess using microstructure analysis and corrosion tests.

Table 1. Composition of Metal Alloys

	S0	S1	S3	S5	S7
Zr	66.66	65.16	63.16	61.16	59.16
Cr	22	22	22	22	22
NM	10	10	10	10	10
Sn	0.56	0.56	0.56	0.56	0.56
Nb	0.78	0.78	0.78	0.78	0.78
Si	0	1.5	3.5	5.5	7.5
Total	100g	100g	100g	100g	100g

* NM(Noble Metal) : Mo, Ru, Rh, Pd, Re

2. Experiments

The induction melting process was performed using a silica crucible with 99.9% pure Zr, Cr, Si, and NM samples mounted in a vacuum arc melting furnace.

The metal waste form of about 3 x 3 cm^2 in size based on 100 g of the specimen was produced by melting at the temperature range of 1200^oC to 1400 ^oC and by slowly cooling down. The various Zr-Cr-Si-NM alloys were produced by controlling the content of Silicon. The prepared specimens were evaluated for soundness and long-term stability of the waste form by examining the microstructure and by corrosion tests.

3. Results and discussion

We fabricated five waste form specimens Zr-Cr-Si alloys by controlling the content of Silicon. All the waste form specimens were fabricated in almost uniform size and shape without any apparent cracks due to a slow cooling rate.

As a result of corrosion tests, the corrosion properties of S3 and S7 specimens were excellent. E_{corr} depending on the composition of specimens were shown in Fig. 1.

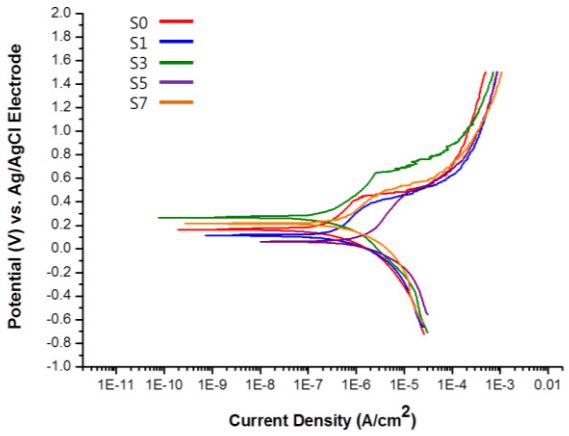

Fig. 1. Corrosion Properties.

4. Conclusion

In this study, we fabricated metal waste forms using an arc melting process and evaluated the performance thereof to recycle the cladding hull and NFBC wastes generated from pyroprocess thereby reducing the volume of the waste.

REFERENCES

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