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U-5 wt.%Nb, Ti, Ni 합금의 조직 특성 연구
Investigation on the Morphology of U-5 wt.% Nb, Ti, and Ni Alloys

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1. Introduction

KAERI has been developing the Advanced Spent Fuel Conditioning Process (ACP) which is reducing oxide spent fuel to metallic form in molten salts. Therefore this technology will reduce the decay heat, volume, and radioactivity from spent fuel by a factor of a quarter. But unalloyed uranium metal exhibits poor corrosion resistance and sometimes undesirable combinations of strength and ductility. It is known that alloying uranium with small quantities of elements such as niobium, titanium, hafnium, molybdenum and zirconium enhances the material's mechanical properties and increases its corrosion resistance without greatly reducing its density. Therefore we have been studying uranium alloys in a program, our objectives are (a) to determine which alloy addition would be beneficial to corrosion; (b) to determine the minimum alloy addition that would be suitable to Advanced Spent Fuel Conditioning Process; (c) to investigate oxidation rates of uranium alloys. In this study, we selected niobium, titanium and nickel as alloying elements to determine which elements would enhance the corrosion resistant and to investigate the microstructure and morphology of uranium alloys.

2. Experimental

The uranium, niobium, titanium, and nickel were added to the charge as the pure elements. The alloys investigated were melted in Arc melting furnace with allowable temperature above 3000 °C and cast into 300 ~ 400 mg plate. Specimens, with alloying content of 5 weight percent, were cut and took corrosion test in air, at 200 °C. The corrosion tests were performed in Thermogravimetric Analyzer(TGA) and morphology and cross section of specimens were investigated by O.M, SEM, and EDS. Unalloyed uranium and uranium alloyed samples for metallographic analysis were mounted and mechanically polished.

3. Results

U-Nb and U-Ti alloys have complete solid solubility above ~980 °C, ~890 °C respectively. We can see the primary rounded Ti as blocky particles in matrix. Because cooling occurs quickly, it will be the extent of coring in the final structure since there will be less chance for diffusion to take place. U-Nb alloy also contains more niobium than equilibrium amount at dendrite region. The as-cast microstructure of U-Ni alloy is the hypoeutectic constituent. U-Ni alloy shows a good resistant to corrosion and continuous, adherent, oxide film cover the surface uniformly. But it is consider that U-Ni alloy don't suitable to ACP, because of the low eutectic temperature.

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