§67. Basic Study on Surface Chemical Combination between Beryllium Metal and Hydrogen Isotope Gas

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Beryllium has been utilized as a moderator and/or reflector in a number of material testing reactors. Beryllium is also supposed to be widely used in fusion reactors as neutron multiplier and protective wall of plasma catcher. In fact, the nuclear properties of beryllium are its low atomic number, low atomic weight, low parasitic capture cross section for thermal neutrons, readiness to part with one of its own neutrons (n, 2n), and good neutron elastic scattering characteristics[1]. However, it is important to perform the characterization of the different grade beryllium such as the productivity, mechanical and chemical properties and the interactions under water and/or gas environment of for these issues. In this study, three kinds of beryllium were prepared and corrosion test of these beryllium samples were carried out for life time expansion under pure water.

The properties of three kinds of beryllium samples are shown in Table 1. Shape and purity of beryllium powder, and uniformity of grain are considered for the choice of beryllium materials. Especially, uniformity is changed from VHP to HIP. S-200F is the reference material as the reflector. S-65H was tested due to its higher purity and better isotropy than S-200F, and I-220H was tested due to its higher mechanical strength and better isotropy than S-200F. The corrosion test was carried out under pure water at 50˚C. In the test, the surface interactions of these beryllium samples were evaluated by X-Ray Diffraction (XRD) and X-ray Photoelectron Spectroscopy (XPS). Water analysis was carried out during the corrosion test by the pH/conductivity meter.

In the corrosion test, the pH of water in the vessel installed Be samples was almost 6 at a stationary value. The electric conductivity increased gently and the value was about 400μS/m. During the corrosion test, the white product was generated on the surface of each Be sample. Figure 1 shows the XRD patterns of each beryllium before/after corrosion test. In this figure, the (100), (002) and (101) peaks of beryllium were observed in each Be sample. These peaks of each Be sample decreased after the corrosion test and the decrease of peaks in S-200F was larger than that in I-220H.

Figure 2 shows the weight change of each Be sample during corrosion test. From the result, the weight change of S-200F was larger than that of I-220H. It seems that the weight change influenced by the content of BeO in each Be sample.

The surface analysis of Be sample (S-200F) before the corrosion test was carried out as preliminary examination. The peaks of Be and Be^{2+} were observed corresponding to 112.0eV and 115.2eV, respectively. From the result, contents of Be and BeO were 19.2% and 80.8%, respectively.

In conclusion, the surface change of each Be sample was observed by the corrosion test and influenced by the content of BeO. In future, the surface analysis of each Be sample after the corrosion test will be carried out by XPS.

Table 1 Properties of beryllium samples

Material	Beryllium Metal		
Grade	S-200F	S-65H	I-220H
Shape (mm)	ϕ10x1.5	ϕ10x1.5	ϕ10x1.5
Density (g/cm^3)	1.855	1.848	1.861
Grain size (μm)	10.3	6.9	5.6
Element (%)			
Be	99.00	99.40	98.60
BeO	1.00	0.70	1.90
O	-	-	-
Al	0.05	0.04	0.01
Fe	0.12	0.08	0.06
Si	0.03	0.02	0.02

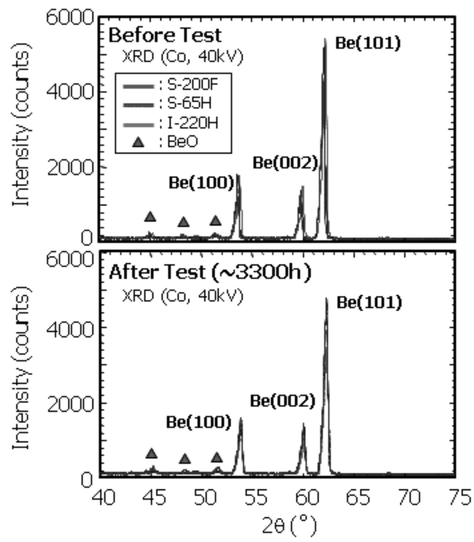

Fig. 1. XRD Patterns of Be samples before/after corrosion test.

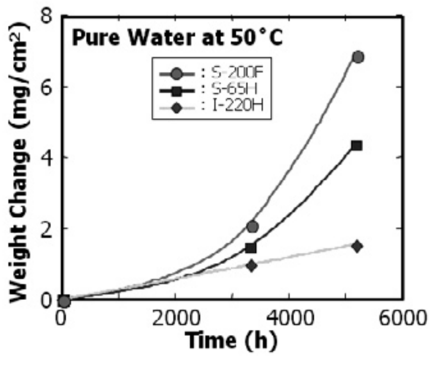

Fig. 2. Weight change of Be samples during corrosion test.

1) Beenston, J.B.: Nuclear Engineering and Design, **14** (1970) 445.