APPLICATION**NOTE**

Alloys – STA/QMS

Hydrogen Emission from BRC-276 Zircaloy Under Water Vapor at Higher Temperatures

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Introduction

BCR-276 Zircaloy (Zirc-4) is a certified European Commission reference material. Zircaloys are common cladding materials in thermal reactors because of their low thermal neutron absorption cross-section and their excellent thermal and mechanical properties.

During the earthquake/tsumani-related accident at the Fukushima-Daiichi nuclear plant in Japan, hydrogen accumulated under the roof of the building and was ignited. One way to produce hydrogen under these extraordinary conditions could follow the relative simple chemical reaction (1):

$$Zr + 2\ H_2O \rightarrow ZrO_2 + 2\ H_2 + DH$$

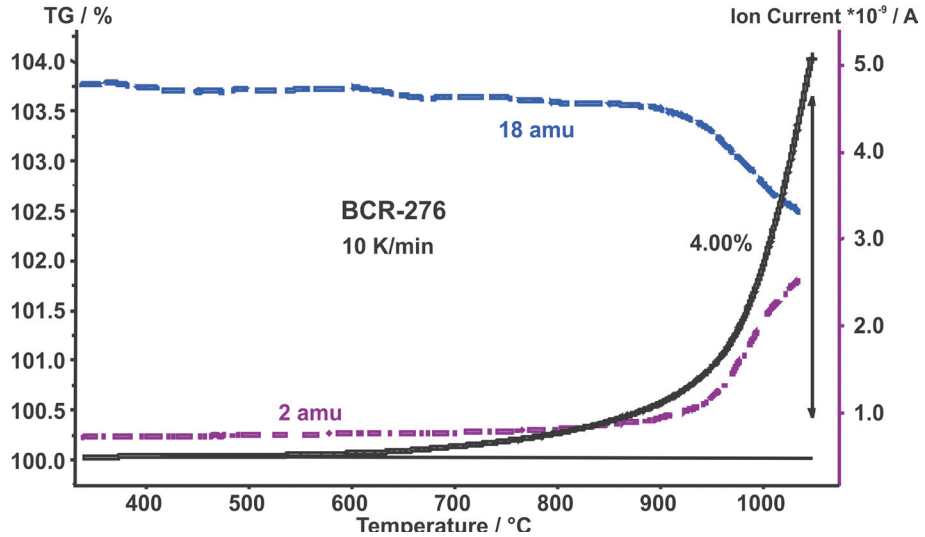
To confirm this reaction, some preliminary experiments were carried out and are described in the following.

Experimental

A NETZSCH STA 449 ***F3*** *Jupiter*® was equipped with a water vapor furnace and a QMS 403 *Aëolos*® mass spectrometer. Three cylinders of BCR-276 (sample weight approx. 600 mg) were placed on an alumina plate on a TGA sample carrier. The samples were heated at 5 and 10 K/min to 1050°C under N_2 and water vapor. The mass numbers of water and hydrogen were monitored with the mass spectrometer.

Results and Discussion

Figure 1 depicts the TGA curve (mass change) and the mass numbers of hydrogen and water versus temperature for the 10-K/min measurement. After the start of the weight increase due to oxidation (black curve), also the hydrogen level increases.



1 TGA curve and mass intensities of hydrogen (2 amu) and water (18 amu) of BCR-276 measured in water and nitrogen (heating rate of 10 K/min)

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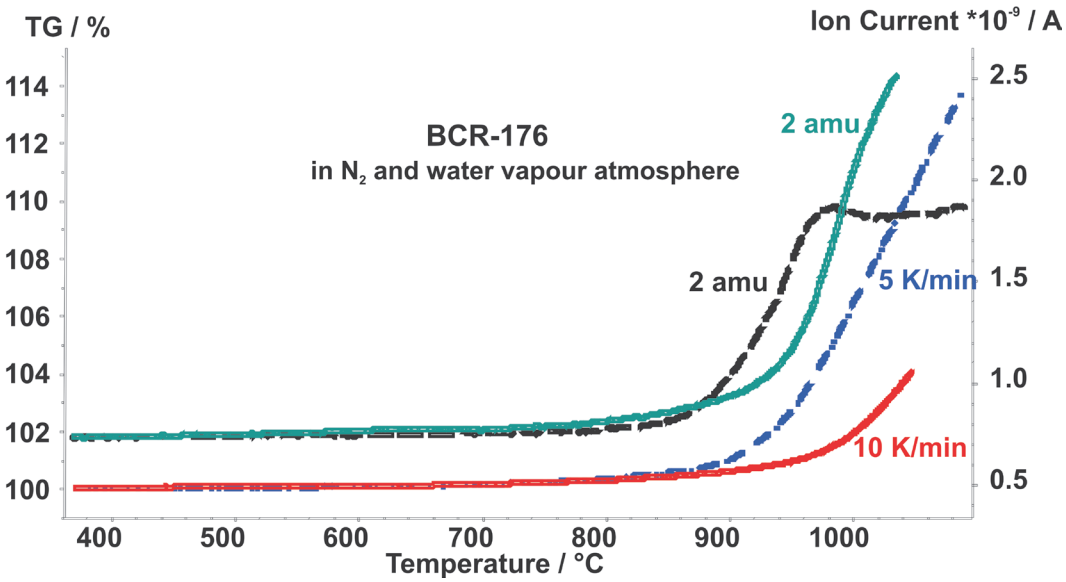
Simultaneously to the hydrogen increase, the water intensity decreases. The weight increase up to 1050°C amounted to 4 wt%.

The TGA curves and the intensities of hydrogen for the two measurements at 5 K/min and 10 K/min are compared in figure 2. At a heating rate of 5 K/min, oxidation and hydrogen evolution starts earlier than at 10 K/min. At about 950°C, the hydrogen evolution goes into a stable saturated state (constant level).

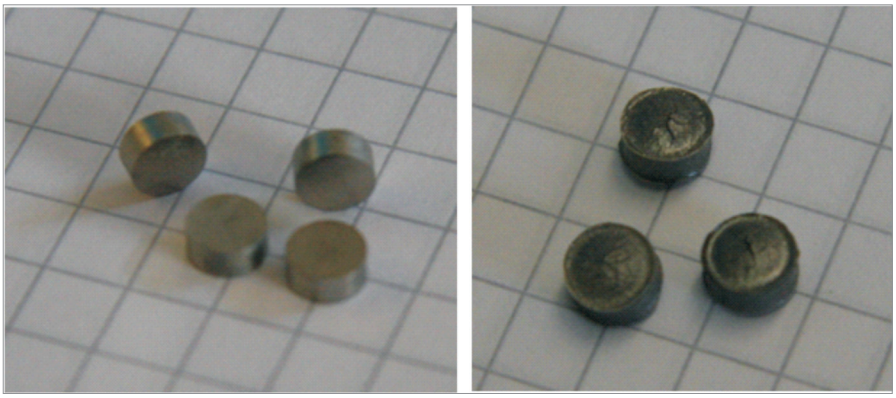
Figure 3 shows the sample before and after the measurement.

Literature

(1) M. Steinbrück, Hydrogen absorption by zirconium alloys at high temperatures. Journal of Nucelar Materials 334, p. 58-64



2 TGA curves and H_2 intensities of BCR-276 Zircalloy at heating rates of 5 K/min and 10 K/min



3 BRC-176 before and after the measurement

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