§70. Study on Dissolution and Diffusion Behavior of Hydrogen Isotopes in Oxide Ceramics Using Tritium

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In this fiscal year, we had two tasks: 1) to examine the difference between single crystal and polycrystalline oxides (zirconia was used here) for the tritium (T) solubility, and 2) to set up an apparatus for exposing the oxides to tritium water vapor.

Task 1: T solubility of single crystal and polycrystalline oxides (zirconia)

Mirror polished single crystal (10x10x0.5mm^3) of cubic zirconia (13%Y_2O_3-ZrO_2(100)) and polycrystalline specimens were used as a specimen. The polycrystalline specimens were prepared with a sintering process using PSZ powders manufactured by Toso Co. Ltd (grades: TZ-3, TZ-6 and TZ-10, Yttrium contents of which ranged from 6% (TZ-3) to 20% (TZ-10)): The each grade powder was die-pressed into disks and then isostatically pressed at 200 MPa. The disks were sintered at 1773K for 20 h. The size of the disks was about 8 mm dia. and 1 mm thick. The densities of the disks exceeded 95% of theoretical ones. □ These specimens were heated at 873K for 1h in a vacuum, and then exposed to 133Pa of T-D gas mixture (T/(T+D)~ 0.17) at temperatures ranging from 673 to 873 K for 5h. After that, the specimens were quenched down to fix tritium distribution. The specimens were cut in halves with a diamond saw, and the cross sections of the specimens were also exposed to IP (TR2025, GE Health Care Co.) for 15 h, and photo-stimulated luminescence (PSL) intensities were obtained from IP reader (FLS7000, Fujifilm). The PLS values were converted to bulk tritium activities by calibration with a tritium standard sample (ART 123A, American Radiolabeled Chemicals, Inc.).

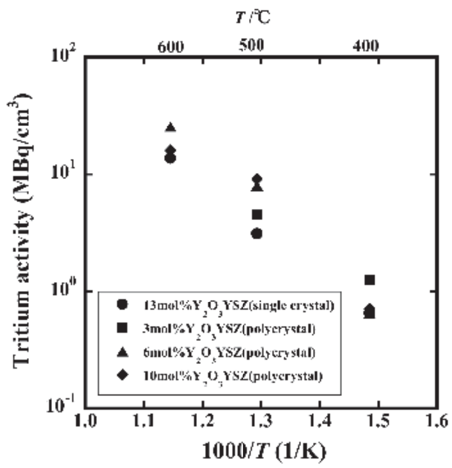

Fig.1 Tritium activities in single- and poly-crystalline zirconia.

Fig. 1 shows the temperature dependence of the tritium activities in the single- and poly-crystalline zirconia specimens. The data are somewhat scattered, but no clear difference appeared in those concentrations. From this result, it should be concluded that there are no clear influences of grain boundary and O deficiency (Yttrium content) on tritium solubility.

Task 2: Set-up of the apparatus for exposing the oxides to T water vapor

Fig. 2 shows the schematic apparatus for exposing the oxides to T water vapor set up in Hydrogen Isotope Research Center, Univ. of Toyama. After several check on the performance of the apparatus such as vapor pressure, recovery of the water vapor with a cold trap and T leakage out of the apparatus, an exposure experiment of several single crystal oxide specimens to T water vapor were carried out. Fig. 3 shows the hydrogen surface concentrations obtained from the T surface activity data including those of T-D gas exposure experiment previously obtained. The data were also scattered, but there were no apparent differences between T gas exposure and T water vapor exposure.

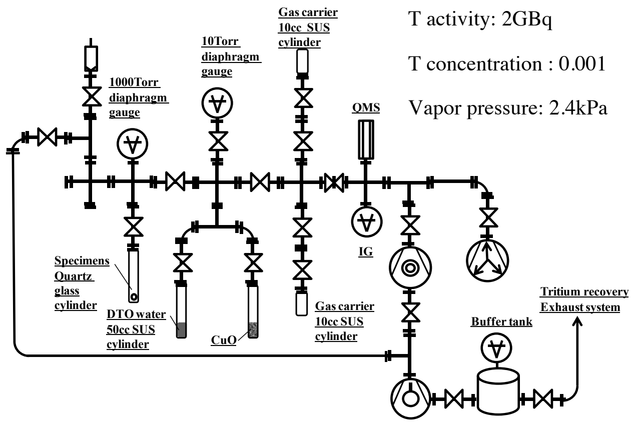

Fig. 2 Schematic apparatus for T water vapor exposure.

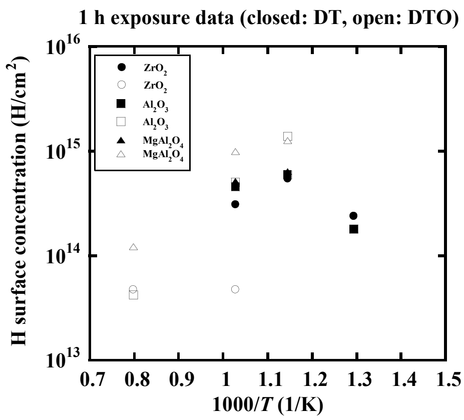

Fig. 3 Hydrogen concentrations on the surfaces of single crystal oxides (ZrO_2, Al_2O_3 and $MgAl_2O_4$) exposed to T gas (closed symbols) and T water vapor (open symbols).