§7. Performance of Electrochemical Hydrogen Pump by a Proton-conducting Oxide for a Tritium Monitor

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We have a plan of deuterium plasma discharge using Large Helical Device (LHD) in the near future. Under the deuterium experiment conditions, tritium will be generated in each discharge shot. The exhaust gas containing tritium will be treated by the tritium recovery system and the disposal gas will be released from the stack. From the viewpoint of the public acceptance and the safety management, we have to monitor the low level of tritium in the exhaust gas and work environment. Therefore, we have proposed new tritium monitor by means of the concentration of hydrogen isotopes and removal of natural radioactive isotope such as the radon gas in air.[1)] As one of the candidate materials for hydrogen isotopes recovery, we have examined the application of proton-conducting oxides which have a function of electrochemical hydrogen pump at elevated temperature. They have attractive advantages such as: hydrogen extraction from hydrogen molecules and hydrogen compounds; control by electric current; no pressurization of supplied gas: hydrogen pump from low concentration gas to high concentration; strong against irradiation compared to organic polymer electrolytes; tritium is treated in the form of gaseous hydrogen.[2)]

For feasibility study, we manufactured an apparatus of the prototype tritium monitor system equipped with a proton-conducting oxide and a closed loop system. The volume in the closed loop system was about 2 liter. Then, we carried out the performance tests of the prototype one-end-closed tube made of $CaZr_{0.9}In_{0.1}O_{3-\alpha}$, which is superior to chemical stability and mechanical strength. The shape of the test tube was 14 mm in outer diameter, 12 mm in inner diameter and 340 mm in length. The platinum electrode was attached on both sides of the test tube and the effective area on the cathode electrode was 68 cm^2. In this experiment, wet argon gas containing with 1.1 % water vapor was fed to the anode and dry argon gas was fed to the cathode at 100 or 300 cm^3/min, respectively. The sample was heated up to 973K by an electric furnace. Then, the constant voltage was applied between the electrodes by a potentiostat. As the result, the maximum hydrogen evolution rate and the current were 0.95 cm^3/min and 0.22 A at 4.5 V as shown in Fig.1. The recovery rate of hydrogen was 80%. Subsequently, we evaluated the performance of hydrogen concentration using a closed loop system. As shown in Fig2, hydrogen gas in the closed loop increased in proportion to elapsed time. After 1 hour, hydrogen concentration reached the maximum 4.1 % at 0.28 A, 973 K. It corresponded to 3.7 times as hydrogen concentration rate on comparing feed water vapor concentration. It is necessary to improve the hydrogen pump performance for practical use as the result of experiments.

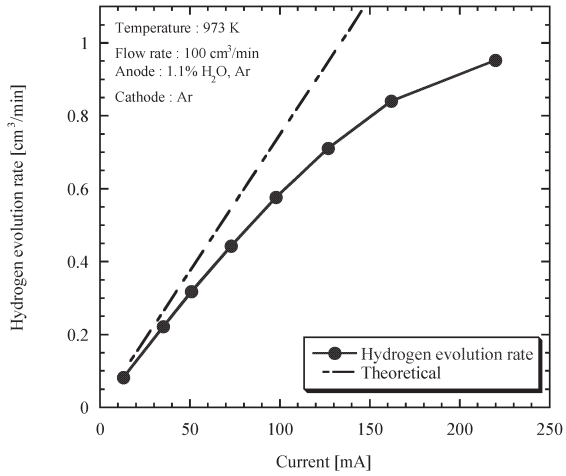

Fig. 1: Hydrogen pump performance as a function of current

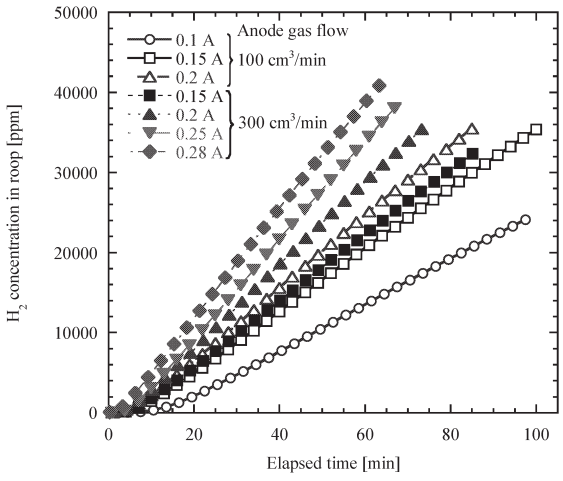

Fig. 2: Variation of hydrogen concentration in the closed loop system as a function of elapsed time and current

Reference

1) Asakura, Y. et al.: J. Nucl. Sci. Technol. **41** (2004) 863.
2) Iwahara, H. et al.: Solid State Ionics **168** (2004) 299.