H_2 Generator

Innovative method to realize both High Energy Efficiency and Facility Miniaturization

Prof. Hiroshi TAKAMURA (Tohoku University)
Prof. Hiroshige MATSUMOTO (Kyushu University)

1. Background

- High efficient and compact "PEFC(Polymer Electrolyte Fuel Cell)" for small and medium-sized offices and homes and high efficient and compact "Hydrogen Fueling Infrastructure" for Hydrogen Vehicles have been required strongly for wide spreading Hydrogen Society.
- Although the conventional "Steam Reforming" method is excellent, there are difficult problems to solve i.e. its slow starting characteristics, very difficult to reduce its size.
- The conventional "POX(Partial Oxidation of Methane)" method, which use the air as an oxidant, has weak points i.e. high cost, easy dilution of Hydrogen.

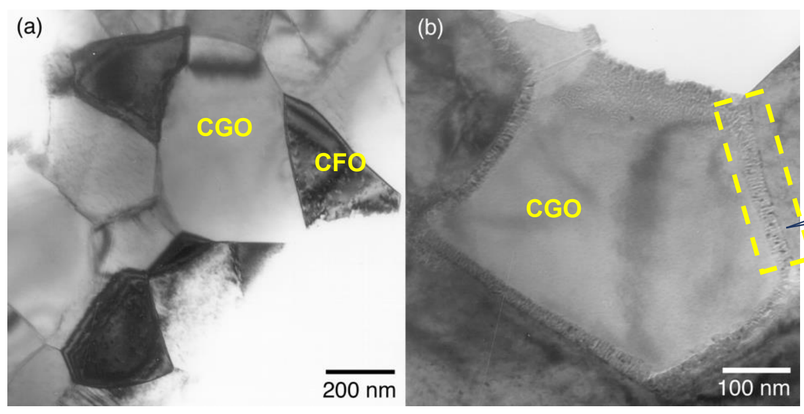
2. An Innovative "MPOX(Membrane separation process+POX)" method

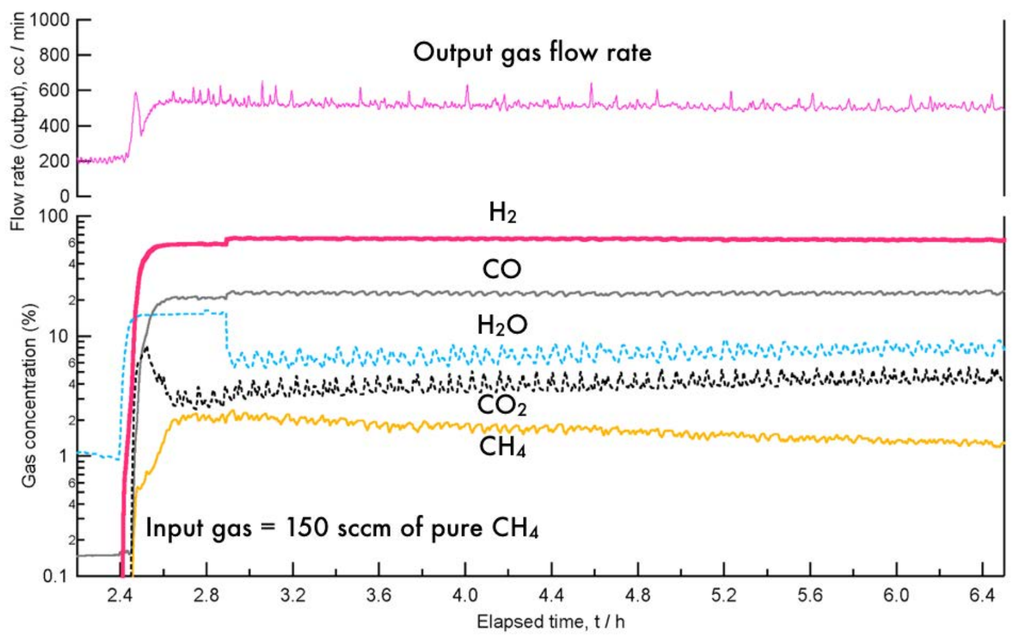
We developed and invented;

- the new hydrocarbon reforming method "MPOX(Membrane separation process+POX)" by using Oxygen Permeable Membranes, which can utilize a part of the Joule heat that is generated during the isolation of oxygen.
- the optimal "Oxygen-Permeable Ceria-based Membrane" which will realize the MPOX method.

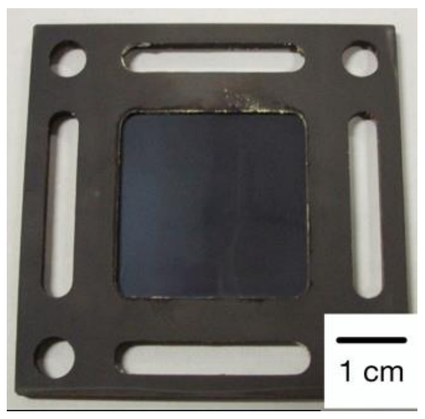
* MPOX effectively utilizes the free energy generated from partial oxidation reaction to oxygen separation.

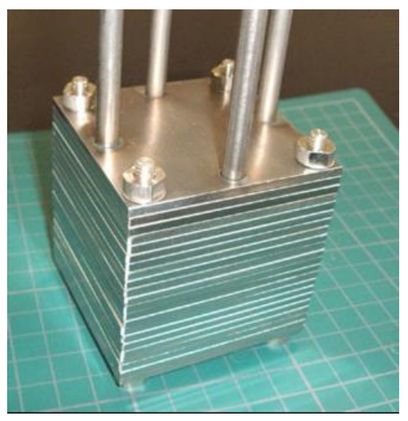
	Composition	Oxygen flux density μmol・cm^{-2}・s^{-1}	Temp ℃	Ref.
BSCF	$Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_3$	8.6	875	Shao et al, 2001
LSGF	$La_{0.7}Sr_{0.3}Ga_{0.6}Fe_{0.4}O_3$	8.2	1000	Ishihara et al, 2002
PSAF	$Pro_{0.7}Sro_{0.3}Fe_{0.8}Al_{0.2}O_3$	8.2	1000	Takamura et al, 2002
Ceria-MFO	$(Ce,Sm_0)O_2$-15vol%$MnFe_2O_4$	10.0	1000	Takamura et al, 2002
LBSFI	$(La_{0.5}Ba_{0.3}Sr_{0.2})(Fe_{0.6}In_{0.4})O_3$	10.6	1000	Aizumi et al, 2004





Flow rate and Compositions of reformate gas





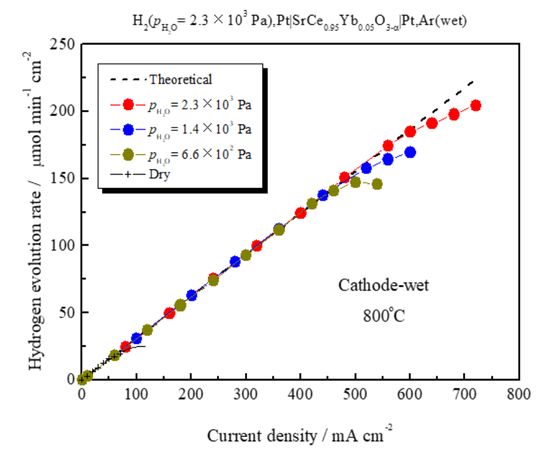
MPOX reformer module comprising of CSO.15MFO and ZMG232R (left) and its 20 stacks (right)

To produce 10 liter/min of hydrogen, 20 stacks module is required.

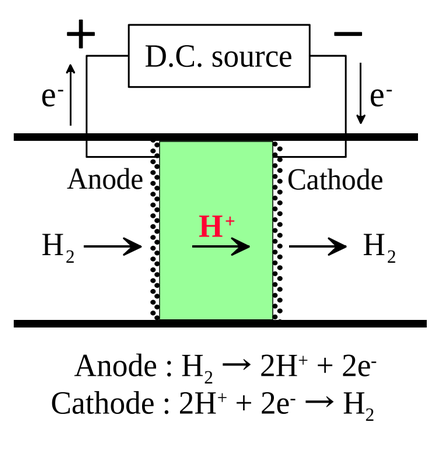
3 . New Hydrogen Separation Method by using "Proton"

- We invented a new Hydrogen Separation method by using "Proton-Conducting Metal Oxide Electrolyte".
- "Electrochemical Hydrogen Pump", only applied by DC voltage, leads to hydrogen separation via selective hydrogen transport from the Anode to the Cathode.

* The new method realize superior efficiency and high mobility comparing to the conventional PSA(Pressure Swing Adsorption) method and Pd-Ag alloy membrane separation method.



(Hydrogen pumping rate as a function of current)



(Electrochemical Hydrogen Pump)

4 . Patent Licensing Available

Patent No.: WO2007/046314 (JP, US, EP)
WO2003/084894 (JP, US)
WO2007/060925 (JP, EP)

JST/ IP Management and Licensing Group
Phone: +81-3-5214-8486 E-mail: license@jst.go.jp