TOTAL SOLUTION OF METALLIC MATERIALS FOR SOFC

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Several kinds of metallic materials with various properties at high temperature such as good oxidation resistance, high electrical conductivity, low thermal expansion coefficient, and so on are expected to be applied for SOFC systems. According to the requirements for metallic materials for SOFC, some of new alloys were developed in this study in order to solve the problems which conventional alloys were not able to conquer.

(1)Development of Fe-Cr ferritic interconnector alloy

The effect of alloying elements on oxidation resistance and electrical conductivity of Fe-Cr ferritic alloys at 750-1000 degrees C in air was investigated. The combination of significantly improved oxidation resistance and low electrical contact resistance after exposure in air at 750-1000 degrees C was obtained by small addition of both Zr and La in Fe-22Cr ferritic alloy. Developed alloy, ZMG232, is supposed to suitable for interconnector material in planar-type SOFC system since it indicates much better oxidation resistance and electrical contact resistance than 430 alloy, as shown in Fig.1[1], and coefficient of thermal expansion close to YSZ.

(2)Development of oxidation resistant Ni-based alloy for capsule for gas separation

Oxidation resistant alloys will be applied for SOFC system besides interconnector since SOFCs are operated at a high temperature in the range of about 700-1000 degrees C. Furthermore, good heat crack resistance will be required for oxidation resistant alloys for SOFC because SOFC components are subjected to thermal cycles during service. In this study the effect of small additions of some alloying elements on oxidation resistance in air at about 1000 degrees C of Ni-based alloy, Alloy600, was investigated and as a result a new Ni-based heat resistant alloy, ASL528, was developed. Fig.2 shows a oxidation resistance in air at 1000 degrees C of ASL528, compared with Alloy600. From Fig.2, ASL528 has much better oxidation resistance than Alloy600. Moreover, Good oxidation resistance and heat crack resistance of ASL528 were obtained in air and H_2/H_2O atmosphere at 700-1000 degrees C.

(3)Development of low thermal expansion Fe-Ni-Co alloy compatible to YSZ for current collector

Pure Ni is usually applied for current collector because of its good oxidation resistance in fuel gas atmosphere, but pure Ni has much higher coefficient of thermal expansion than ceramics such as YSZ. With regard to thermal expansion compatibility, a low thermal expansion alloy will be a choice to replace pure Ni. In this study thermal expansion properties of Fe-Ni-Co alloys with various balances of Ni and Co contents were investigated in order to optimize the whole thermal expansion behavior from room temperature to about 1000 degrees C. Fig.3 shows one of the results of optimized alloy which has thermal expansion behavior close to YSZ.

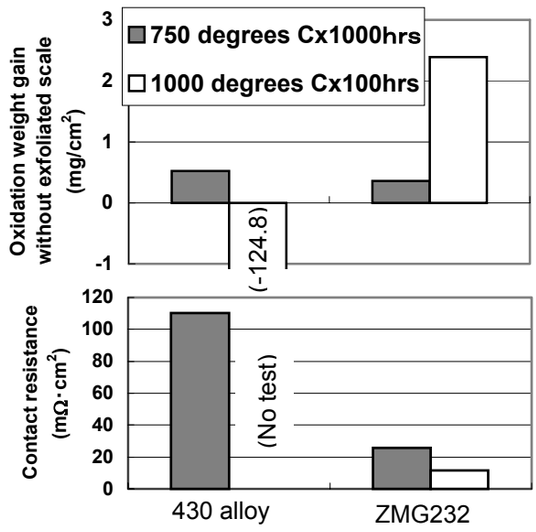

Fig.1 Oxidation resistance in air and electrical contact resistance of ZMG232 and 430 alloy[1].

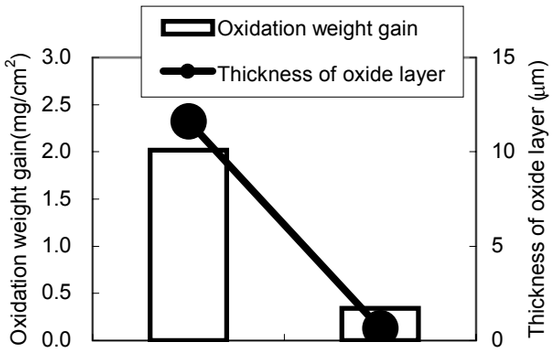

Fig.2 Oxidation resistance in air at 1000 degrees C for 100hrs of ASL528 and Alloy600.

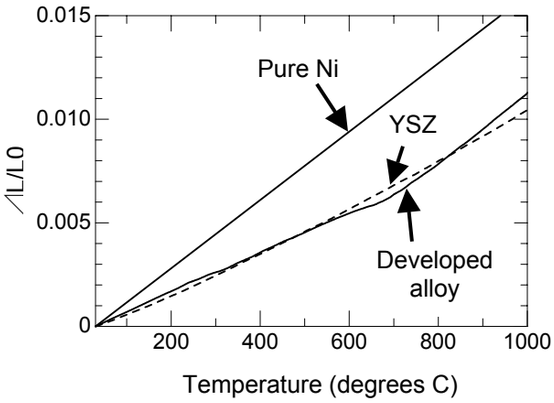

Fig.3 Thermal expansion curves of developed Fe-Ni-Co alloy, pure Ni, and YSZ.

Reference

1) T.Uehara, T.Ohno, A.Toji, in 5th European Solid Oxide Fuel Cell Forum, J.Huijsmans, editor, vol.1, p.281, European Fuel Cell Forum, Oberrohrdorf, CH (2002).