Abstract

This research is divided into two phases. First was the attempt to improve properties, especially electrical, of electrolyte for solid oxide fuel cell (SOFC), which has the highest efficiency amongst other types of the fuel cells. Electrolye types chosen were zirconia and ceria based ceramics. Second were the attempts to fabricate cells with various designs. The measurement methods were also developed in the lab.

Zirconia based electrolyte is the high temperature type. The experiments were conducted using uniaxial pressing and solid state sintering. Fabrication of core-shell structure zirconia was conduct using a solution coating method with ceria and yttria. The designed structure was tetragonal core and cubic shell. For the ceria based electrolyte which was designed to use in the intermediate temperatures. The dopants were samaria, gadolinia, and yttria with the use of cobalt oxide and ferric oxide sintering aids. It was shown that adding 1% Cobalt oxide resulted in lowering of sintering temperature to 200 °C. Improvement of ionic conductivity was also found, with the optimum grain interior conductivity of $1.14x10^{-3}$ ohm/cm, grain boundary $4.1x10^{-4}$ ohm/cm, total conductivity $3.0x10^{-4}$ at 350 °C.

Fabrication of SOFCs with various designs were as follows;

Design 1: Porous stainless steel support. The stainless steel powder used was the cheap commercial powder with large particle size. The main problem found with this design was how to densify the electrolyte as the large particles of the support also produced large intergrnular size of low firing shrinkage. To solve the problem by using the wet chemical synthesis of metal will raise the cell cost.

Design 2: Zirconia based ceramic (8YSZ) support. Studies of microstructure of the anodes (Ni-10GDC and Ni/Co-10GDC) on cell performance. The cathode was fixed to be lanthanum strontium cobalt ferrite (LSCF). The anode Ni-10GDC showed highest conductivity measured in 600-800 °C was 12.37×10^{2} -13.97×10^{2} $S.cm^{-1}$ and power density of 99 $mW.cm^{-2}$. The use of

$Ni_{1-x}Co_xO$ (x= 0.25-0.75) showed the highest power density of 111 $mW.cm^{-2}$ with the x = 0.25 anode composite.

Design 3: SOFC with porous alumina support. Fabrication was first done by slip casting in the plaster mould. The casted tubes, however, had too thick walls and thickness control difficulty. The extrusion was secondly selected. The pore former used was methyl cellulose (MC) and flour. Anode was prepared by mixing 10GDC and NiO powder and spray coating onto the tubes. Anyway, coating was unsuccessful. Interaction between the layers resulted in dense interlayer of the second phase inhibited the use of this support.

Design 4: SOFC with porous Ni-$NiAl_2O_4$ support. The cell was based on Ni-8YSZ anode and 8YSZ electrolyte and Pt cathode. The porous Ni-$NiAl_2O_4$ composite was at 50, 55 และ 60 wt% Ni and are named 50NO50NS, 55NO45NS และ 60NO40NS. The cells with 60NO40NS support showed the lowest power density of 43.3 mW/cm^2 at 800 °C due to the presence of cracks in the electrolyte layer. The highest power density of 94.5 mW/cm^2 was found on the cells with 55NO45NS support.