

NOBLE METALS IN SOFC CATHODES: PROCESSING AND ELECTROCHEMICAL PERFORMANCE

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Planar anode-supported solid oxide fuel cells (SOFCs) developed by the Research Centre Jülich consist of an anode substrate and an anode functional layer (Ni/YSZ cermet, YSZ = yttria-stabilized zirconia), a thin electrolyte (YSZ), a cathode functional layer (LSM/YSZ, LSM = $\text{La}_{0.65}\text{Sr}_{0.30}\text{MnO}_3$), and a cathode layer (LSM). With the aim to enhance the catalytic activity of the oxygen reduction reaction and thus to increase the current density, either Ag, Pd, or Pt was added to the cathode functional layer (CFL). In one experiment Ag was also added to the cathode layer. Four routes were used for the addition: infiltration of the cathode with a Pd solution, coating of the electrolyte with Pt, mixing of the LSM and YSZ powders with different metal precursors (Pt and Pd black, Pd/C, Ag powder, Ag_2O , Ag acetate, Ag citrate, Ag_2CO_3 , colloidal Ag, AgNO_3), and synthesis of LSM with the addition of AgNO_3 .

Electrochemical tests performed between 750 and 900°C on single cells ($50 \times 50 \text{ mm}^2$) did not show any electrocatalytic effect of the addition of Pt, but a significant change in the current-voltage curve with the addition of Pd/C (Fig. 1).

Electrochemical tests with the different Ag precursors revealed the following order in catalytic activity: Ag powder > Ag_2O > Ag acetate > Ag_2CO_3 > AgNO_3 > Ag citrate = colloidal Ag (Fig. 2). Improved current densities were obtained for cells prepared with Ag powder and Ag_2O in comparison to a corresponding Ag-free cell also sintered at 920°C. However, in comparison to a conventional cell with LSM/YSZ sintered at 1100°C lower current densities were measured. This can be explained by a weak adhesion between electrolyte and CFL resulting from the low sintering temperature of 920°C. Such a low sintering temperature had to be chosen because of the low melting point of Ag (962°C). A detrimental effect was observed for the addition of other Ag precursors due to decomposition of the precursors during sintering. This decomposition resulted in the formation of large holes in the CFL.

The current density of cells prepared with LSM synthesized with the addition of AgNO_3 is depicted in Fig. 3. Compared with a conventional cell (Fig. 2) the current density was not improved. This can also be explained by a weak adhesion between electrolyte and CFL due to the low sintering temperature of 920°C.

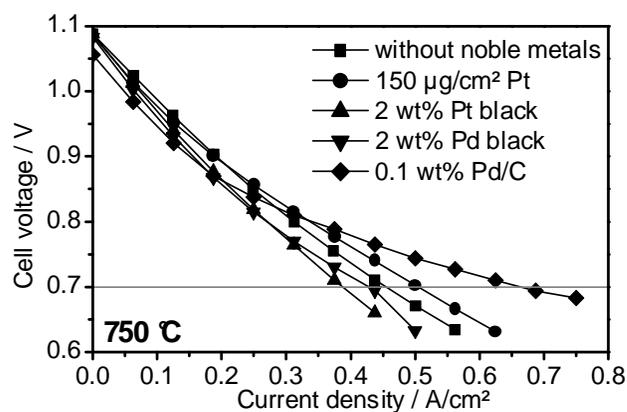


Fig. 1: Current-voltage curves of Pd- and Pt-containing cells in comparison to a corresponding cell prepared without addition of noble metals. Fuel: H_2 with 3 vol% H_2O , oxidant: air.

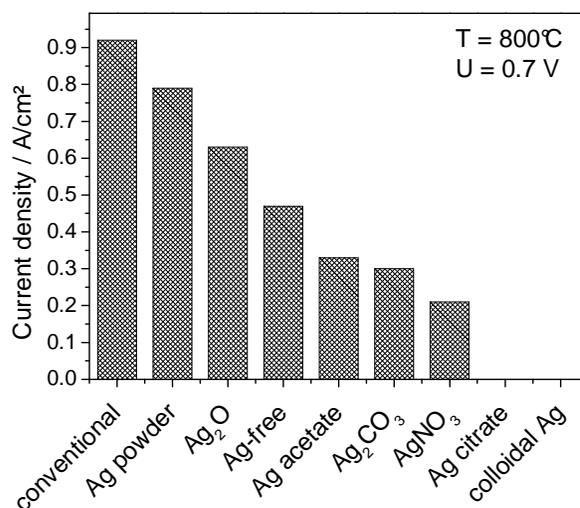


Fig. 2: Current density of cells prepared with different Ag precursors in comparison to an Ag-free cell also sintered at 920°C and a conventional cell sintered at 1100°C. Fuel H_2 with 3 vol% H_2O , oxidant: air.

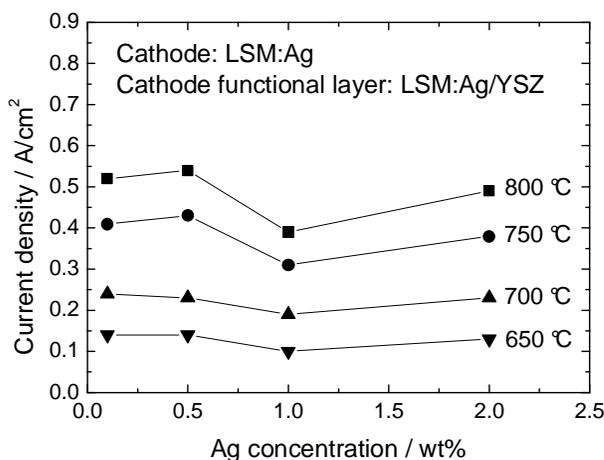


Fig. 3: Current density as a function of the Ag concentration. Sintering temperature: 920°C. Fuel: H_2 with 3 vol% H_2O , oxidant: air.