$AuCeO_2/C$ – Enhanced Electrocatalytic Activity for Oxidation of Borohydride and Reduction of Oxygen

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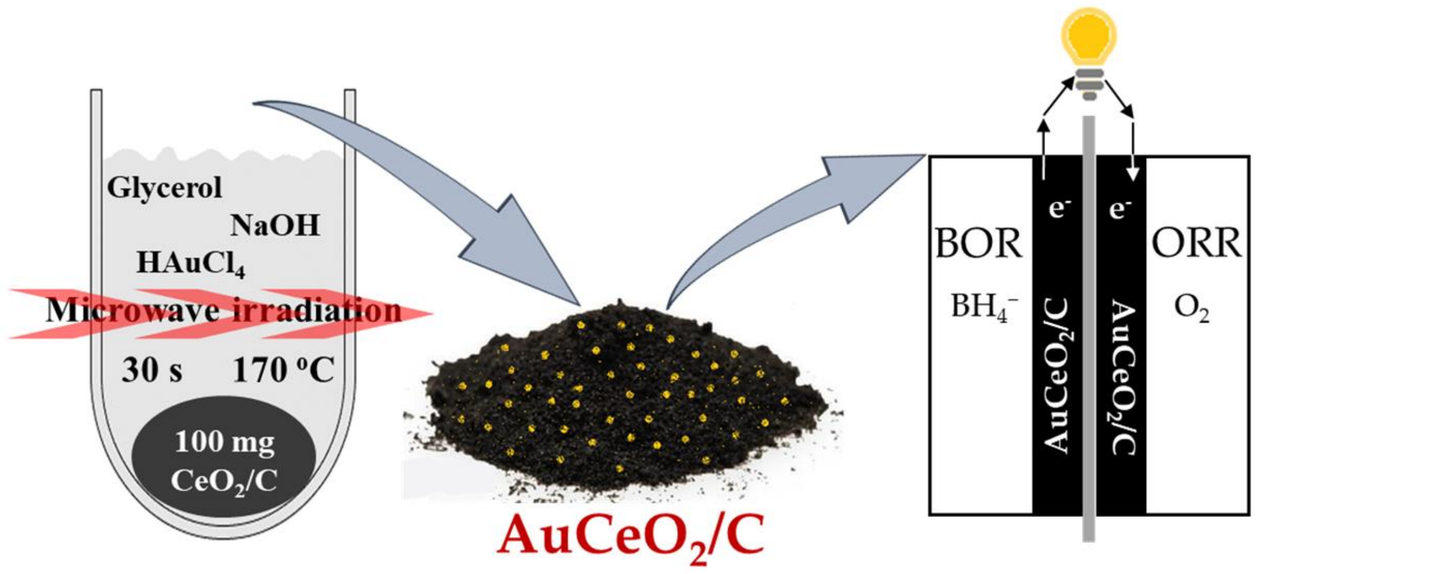
INTRODUCTION

In this era is crucial development of technologies that creates sustainable, highly efficient and of course green energy resources because of energy crisis and global warming. So this is the reason why fuel cells are one of the best alternative energy sources – it can convert chemical energy into electrical energy and do not contaminate the environment. Fuel cells are promising energy conversion devices that directly generate energy without intermediate mechanical link.

FABRICATION OF THE CATALYST



MATERIALS CHARACTERIZATION

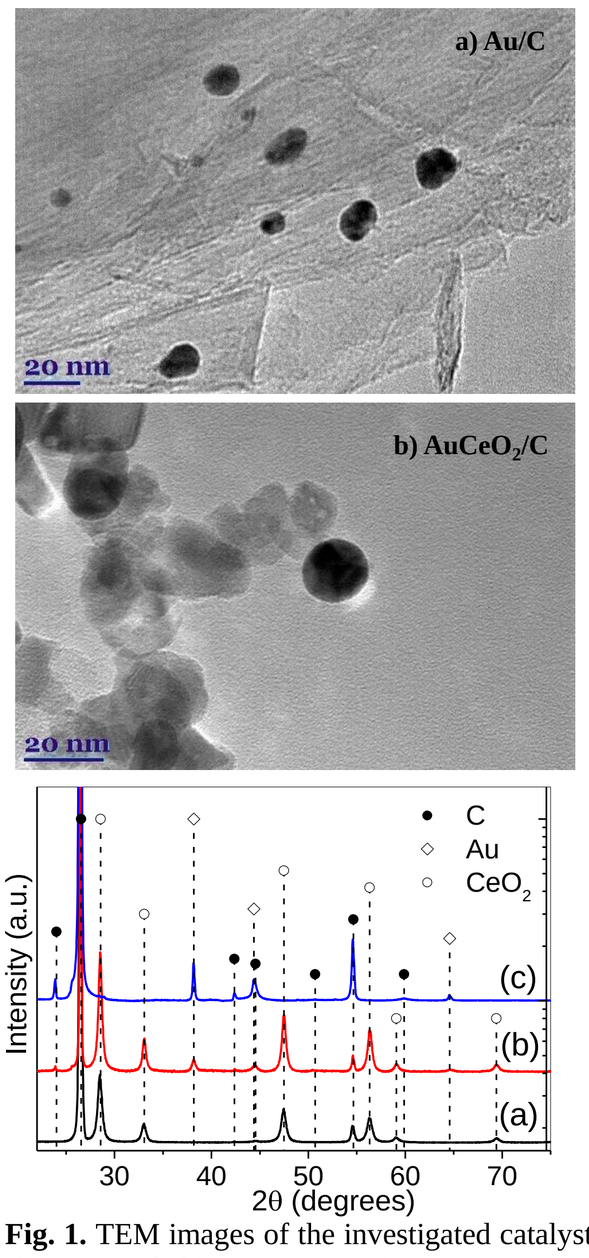


Fig. 1. TEM images of the investigated catalysts: a) Au/C and b) $AuCeO_2/C$; c) XRD patterns of the a) CeO_2/C, b) $AuCeO_2/C$, and c) Au/C catalysts prepared by the microwave irradiation method

BOROHYDRIDE OXIDATION

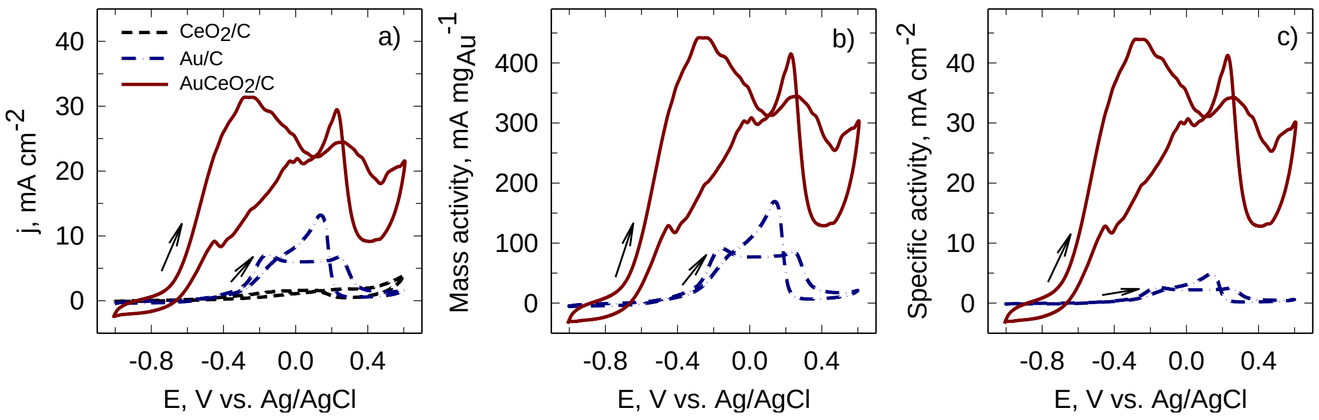


Fig. 2. Comparison of a) current density, b) mass , and c) specific activities of the investigated catalysts recorded in a 0.05 M BH_4^- + 1 M NaOH solution at 50 mV s^{-1}; 25 °C.

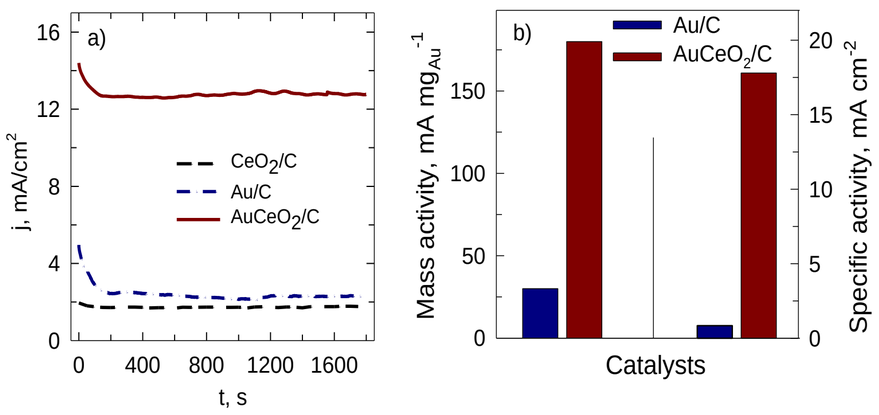


Fig. 3. Chronoamperometric data a) of the investigated catalysts studied in a 0.05 M BH_4^- + 1 M NaOH solution at the potential value of -0.26 V, b) mass and specific activity of the $AuCeO_2/C$ and Au/C catalysts calculated from the current density values at the end of the experimental period.

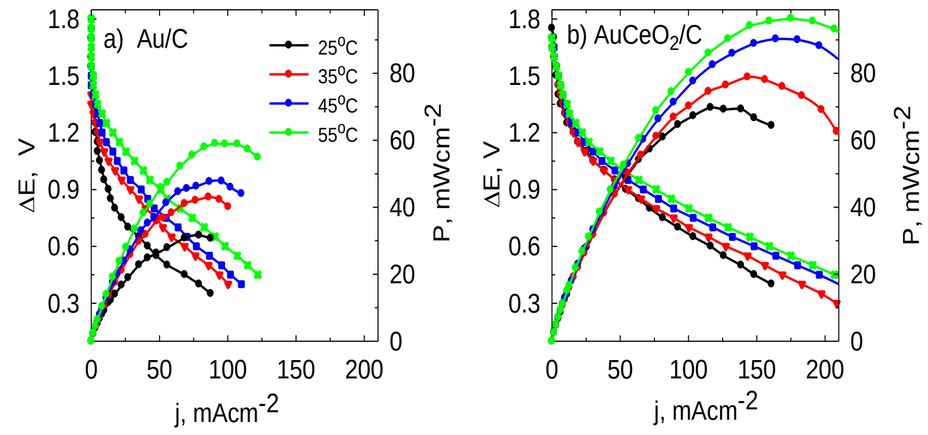


Fig. 4. Cell polarization and power density curves were obtained with the employed a) Au/C and b) $AuCeO_2/C$ catalysts as the anode at different temperatures for the $NaBH_4$-H_2O_2 using the anolyte of 0.05 M BH_4^- in 4 M NaOH and catholyte of 5 M H_2O_2 in 1.5 M HCl.

CHARACTERISTICS

Table 1. Electrochemical characteristics of investigated catalysts

Catalysts	ESA, cm^{-2}	Au loading, $\mu g\ cm^{-2}$	Onset Potential, V	j_F, mA cm^{-2}
Au/C	0.19	78	0.88	7.19
$AuCeO_2/C$	0.05	71	0.96	31.89
Pt/C	1.40	71	0.98	-

OXYGEN REDUCTION

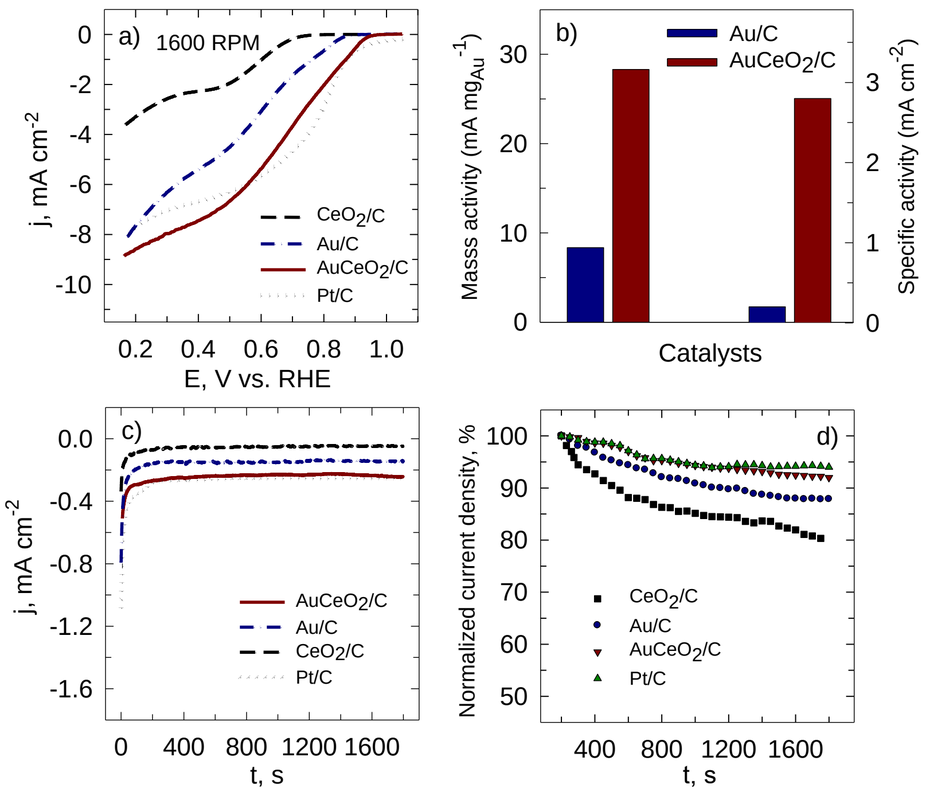


Fig. 5. Comparison of a) LSV curves recorded on the CeO_2/C, Au/C, $AuCeO_2/C$, and Pt/C catalysts in an O_2 – saturated 0.1 M NaOH solution at 1600 rpm; b) LSV oxygen reduction current densities at 0.8 V normalized by Au loadings and ESAs of AuNPs for the Au/C and $AuCeO_2/C$ catalysts; c) chronoamperometric curves recorded on the investigated catalysts at 0.55 V in an O_2 – saturated 0.1 M NaOH solution; d) chronoamperometric responses (percentage of current density retained vs. operation time) of all the catalysts.

CONCLUSIONS:

In summary, we deposited AuNPs on the CeO_2/C and C substrates preparing the $AuCeO_2/C$ and Au/C catalysts. Because of the synergistic effect between CeO_2 and Au in the $AuCeO_2/C$ catalyst, this catalyst exhibited an enhanced electrocatalytic activity toward the BOR and ORR compared with that of the bare Au/C and Pt/C catalysts. It has been found that the $AuCeO_2/C$ catalyst showed approximately 4.5 times higher electrocatalytic activity toward the oxidation of BH_4^-. Ca. 1.5 times greater power density values in direct $NaBH_4$-H_2O_2 fuel cell were obtained by employing $AuCeO_2/C$ as the anode as compared with those for Au/C. Moreover, the synthesized $AuCeO_2/C$ catalyst demonstrated similar onset potential (0.96 V vs. 0.98 V) of ORR and maintenance of initial ORR current density (92 % vs. 94 %) compared to commercial Pt/C.