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A novel aluminium-air semi-fuel cell operating with hydrogen peroxide co-generation

Georgi Agladze, Paata Nikoleishvili [1], Valentina Kveselava, Gigla Tsurtsumia, Georgi Gorelishvili, David Gogoli, Izolda Kakhniashvili

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Abstract

An original Al-air semi-fuel cell (SFC) system, operating with hydrogen peroxide (H_2O_2) co-generation was developed. The cell design was optimized and operating conditions were selected in the comparative study of different of anion-exchange MA-40, AMI 7001S and cation-exchange MK-40, NAFION 117 membranes, gas-diffusion electrodes (GDE) Black Pearls 2000 (BP 2000), Vulcan XC-72 (XC-72), nature and concentration of electrolytes (NaOH, KOH and NaCl). Their influence on electric characteristics (current density and generated power) and current efficiency of H_2O_2 generation was studied. The best results were achieved were using BP 2000 GDE in the SFC divided by anion-exchange membrane (AEM) with 6M KOH as an electrolyte. However, some acceptable results were achieved even using dilute chloride solutions. Finally, the scale-up experiments showed that the specific electric characteristics of the fuel cell (FC) enhanced at 15-fold increase of the electrode area.

Highlights

► The possibility of generation of H_2O_2 in original system of Al-air SFC was shown. ► It was study operation of different types of cathodes and ion-exchange membranes. ► Hydrogen peroxide was obtained by a rate 58.3 $mg h^{-1} cm^{-2}$ by 85% current efficiency. ► It was shown 15-times (electrode area 100 cm^2) scaled up Al-air SFC. ► Al-air SCF can generated H2O2 in diluted water (30 $g l^{-1}$ NaCl as a catholyte).

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Keywords

Al-air semi-fuel cell; Gas-diffusion cathode; Ion-exchange membrane; Hydrogen peroxide; Current–voltage characteristic

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> …For electric vehicle propulsion, aluminum contains approximately one-half the energy content of gasoline per unit weight and three times the energy per unit volume. Although, recently, Al-air batteries have high specific energy up to 0.4 W × h kg−1 [18], surpassing that of Li-ion batteries, the power density is still low and should be increased essentially [19–25]. Since high current densities of 800 mA cm−2 [18,26] could be attained at the anode, the achievable specific power density of Al-air cells is restricted by the cathode characteristics.…

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> …The anion-exchange membranes (AEMs) and cation-exchange membranes (CEMs) that have been used as interfaces between the electrode and the electrolyte can be used directly as electrolytes [51]. The application of AEMs and CEMs as electrolytes in Al–air batteries as replacements for the widely used aqueous electrolytes offers opportunities for future study [17]. Table 8 presents a summary of the polymer and solid-state electrolytes used in aluminum–air battery applications.…

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