Design and Development of Metal Air Battery

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ABSTRACT

With advancement of portable electronic devices and electrification of transportation rises a need for more advanced battery systems that can power these systems. Tremendous research is ongoing in new battery technologies to satisfy the energy storage requirements. Batteries with high energy density, long cycle life, and safe and low cost are the need of the hour. Metal-air batteries seem to be promising candidates for the future battery requirements because of their higher specific capacity and energy density as compared with lithium-ion batteries. The aqueous alkali electrolytes, though widely used at present, may be suitably replaced by non-aqueous electrolytes, aprotic and ionic liquids for both primary and secondary batteries. Aluminum-air power sources are receiving increased attention for applications in portable electronic devices, transportation, and energy systems. The results of this work demonstrate the feasibility of AA ECGs as portable reserve and emergency power sources, as well as power sources for electric vehicles.

Keywords: Aluminum–air batteries, Batteries, Metal-air batteries

INTRODUCTION:

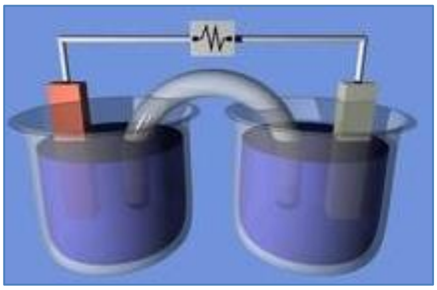

Figure 1: A voltaic cell consisting of two half-cells

During the last few decades, environmental impact of the petroleum-based transportation infrastructure, along with the fear of peak oil, has led to renewed interest inan electric transportation infrastructure. EVs differ from fossil fuel-powered vehicles. The electricity they consume can be generated from a wide range of sources, including fossil fuels, nuclear power, and renewable sources such as tidal power, solar power, hydropower, and wind power or any combination of those. The carbon footprint and other emissions of electric vehicles varies depending on the fuel and technology used for electricity generation. The electricity may then be stored on board the vehicle using a battery, flywheel, or super capacitors. Hence the developmentof different type of battery power EV started. Batteries come in many shapes and sizes, from miniature cells used to power hearing aids and wristwatches to small, thin cells used in smart phones, to large lead acid batteries or lithium-ion batteries in vehicles, and at the largest extreme, huge battery banksthe size of rooms that provide standby or emergency power for telephone exchanges and computer data centers. Figure 1, shows a voltaic cell for demonstration purpose. This cell consists of two half-cells which are linked by a salt bridge that permits the transfer of ions. Batteries convert chemical energy directly to electrical energy. In many cases, the electrical energy released is the difference in the cohesive or bond energies of the metals, oxides, or molecules. Batteries are designed such that the energetically favorable redox reaction can occur only if electrons move through the external part of the circuit. Batteries with high energy density, long cycle life, and safe and low cost are the need of the hour. Metal-air batteries seem to be promising candidates for the future battery requirements because of their higher specific capacity and energy density as compared with lithium-ion batteries [1]. Aluminum–air batteries, both primary and secondary, are promising candidates for their use as electric batteries to power electric and electronic devices,utility and commercial vehicles and other usages at a relatively lower cost [2]. The development of an aluminum-air electrochemical generator (AA ECG) and provides a technical foundation for the selection of its components, i.e., aluminum anode, gas diffusion cathode, and alkaline electrolyte [3]. The aluminum–air battery is considered to be an attractive candidate as a power source for electric vehicles (EVs) because of its high theoretical energy density (8100 Wh kg^{-1}), which is significantly greater than that of the state-of-the-art lithium-ion batteries (LIBs) [4]. Aluminium–air cells influence materials, including, aluminium alloy, oxygen reduction catalyst and electrolyte type, in the battery performance [5]. A battery consists of some number of voltaic cells. Each cell consists of two half- cells connected in series by a conductive electrolyte containing metal cations. One half-cellincludes electrolyte and the negative electrode, the electrode to which anions negatively charged ions migrate, the other half-cell includes electrolyte and the positive electrode, to which cations positively charged ions migrate. Cations are reduced at the cathode, while metal atoms are oxidized at the anode. Some cells use different electrolytes for each half-cell, then a separator is used to prevent mixingof the electrolytes while allowing ions to flow between half-cells to complete the electricalcircuit. Each half-cell has an electromotive force relative to a standard. The net emf of the cell is the difference between the emfs of its half-cells. Thus,if the electrodes have emfs ε1 and ε2, then the net emf is ε2- ε1, in other words, the net emf is the difference between the reduction potentials of the half-reactions.

METHODOLOGY:

The Al–air battery feeds directly to the electric power control system that runs the motor that drives the wheels of a car. A fully functioning Al–air battery has the following components, the Al–air battery, a crystallizerto control the composition of the electrolyte, CO_2 absorber, gas separator to separate out hydrogen from the electrolyte, and a cooling system for thermal control. The Al–air battery feeds directly to the electric power control system that runs the motor that drives the wheels of a car. A fully functioning Al–air battery has the following components, the Al–air battery, a crystallizerto control the composition of the electrolyte, CO_2 absorber, gas separator to separate out hydrogen from the electrolyte, and a cooling system for thermal control. Cut a piece of aluminium foil that is approximately 5 x 5 centimetres. Prepare a saturated salt-water solution: Dissolve salt in a small cup of water until some salt remains on the bottom of the cup. Fold a paper towel into fourths, dampen it with the solution and then place the towelon the foil. Add a 5grams of activated charcoal on top of the paper towel, which is gently crushthe charcoal into fine bits. Pour some of the salt-water solution onto the charcoal until it is dampened throughout. Make sure the charcoal doesn't touch the foil directly. This constitutes one cell which should produce about 0.7 volts with saltwater electrolyte. Stack several cells together, like a sandwich. This is your aluminum–air cell. Prepare your electrical device for use. If you are using a DC motor, attach a small piece of tape to the end of the motor shaft to serve as a “flag” so you can easily seewhen the motor is moving.

Figure 2: Aluminium cut into 5*5cm

Figure 3: Activated Charcoal spread onto Nickel Mesh 5*5cm

Figure 4 : Aluminium and Activated Charcoal wrapped to form a single cell

Figure 5: Electrolyte poured into the Aluminium and Activated Charcoal wrapped cell

RESULTS AND DISCUSSION:

Figure 6: The ready Prototype model of the single cell battery

The Prototype for Aluminium air battery is done and tested. The battery for single cell gave from 0.7V up to 1V. The reaction improves if it is done in a basic solution that supplies excess OH– ions. With potassium hydroxide electrolyte the 1.2 volts is produced with salt .7 volts per cell. A major problem in Al–air battery design is the short life of the cell as corrosion of aluminium happens and its rapid loss of charge. To prolong the life of the cell, the electrolyte can be displaced with an oleo phobic oil which stops the corrosion of anode during standby

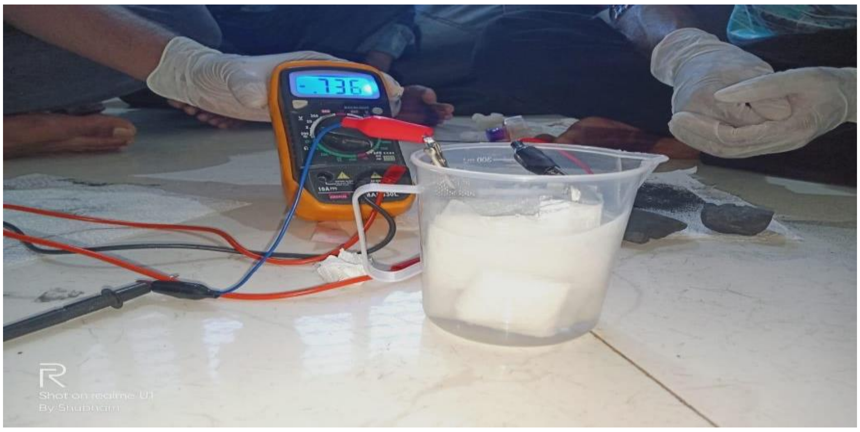

Figure 7: The single cell battery generating 0.736V

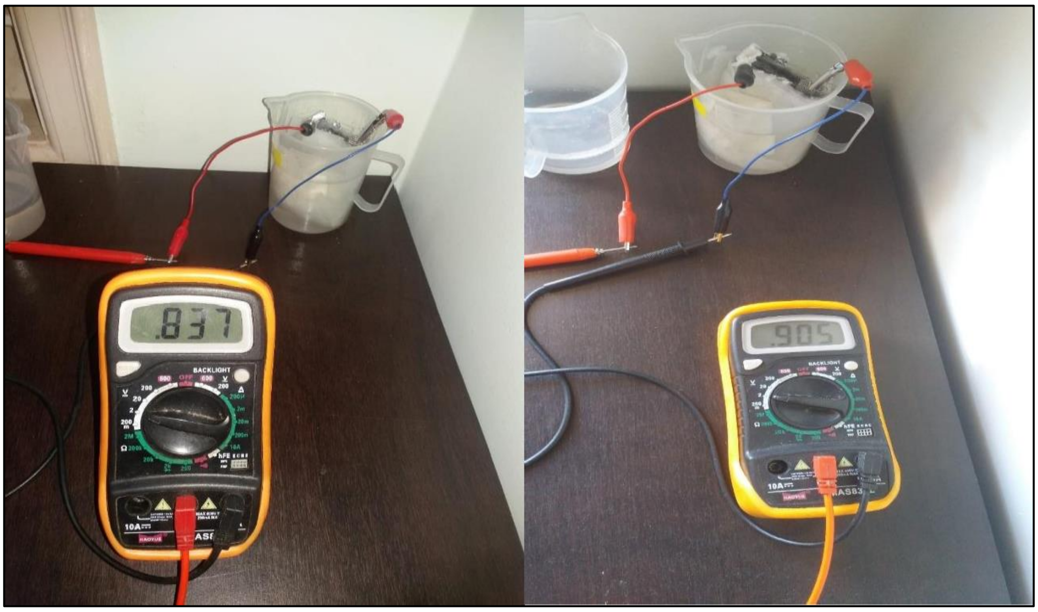

Figure :8 The single cell battery generating 0.837V and 0.905V

Figure :9 The single cell battery generating 0.945V

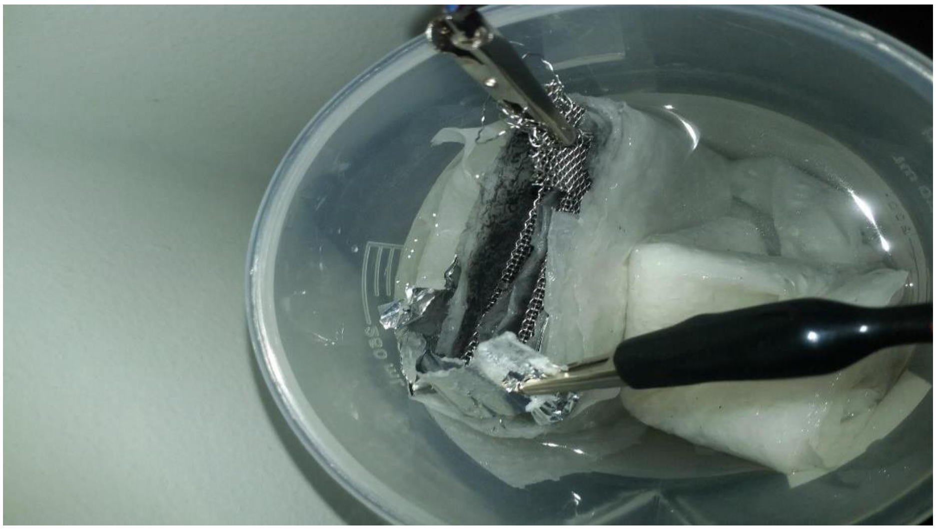

Figure 10: The single cell battery oxidising and developing a layer of salt (after 1 week)

Figure 11: The single cell battery oxidising and developing a layer of salt (after 2 week)

Figure 12 : The single cell battery oxidising and developing a layer of salt (after 4 week)

CONCLUSION:

Further research on Al–air battery needs to focus on optimizing the combination of cathode, anode, electrolyte and other battery components that will allow ease of scalability, good performance, andeconomic production. As of now, for anodes, there are plenty of Al alloys that offer distinctive benefits and would be more suitable as anodes for Al–air batteries in comparison to pure Al that istoo expensive for practical commercial purposes. For cathodes, carbonaceous materials are,in our opinion, the most attractive choice, especially given their versatility and relative lower cost. Electrolytes have conventionally been aqueous KOH, and the Al-batteries withKOH have not faced many disadvantages. The polymeric solid-state electrolytes and ionicliquids show great potential. The design and assembly of battery components need furtherinnovation although the widely accepted design utilizes a tri-slotted form. New designs may incorporate thin membranes for anode, electrolyte and cathode separation facilitating both the technological and financial viability of the Al–airbattery system.

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