METAL -AIR BATTERIES

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Abstract:

The everlasting need of power leads to increase in demand for power sources of high energy density and stability for emergent electrical vehicles and portable electronic devices, rechargeable batteries have attracted extensive interests. Among the emerging battery technologies, metal–air batteries (MABs) are under intense research and development focus due to their high theoretical energy density and high level of safety. Although significant progress has been achieved in improving battery performance in the past decade, there are still numerous technical challenges to overcome for commercialization.

Metal-air batteries have much higher theoretical energy density than lithium-ion batteries, and are frequently advocated as the solution toward next-generation electrochemical energy storage for applications including electric vehicles or grid energy storage. Yet they have not fulfilled their full potentials as limited by challenges associated with the metal anode, air cathode and electrolyte. These challenges would have to be properly resolved before metal-air batteries can become a practical reality and be deployed on a large scale. Here we survey the current status and latest advances in metal-air battery research for both aqueous (e.g. Zn-air) and non-aqueous (e.g. Li-air) systems. The general technical issues confronting their developments are overviewed, and our perspective on possible solutions is offered.

Keywords : *Electro chemical Energy Storage, Zn-air ,Li- air*

INTRODUCTION

lithium-ion batteries play the most important role, and have deeply penetrated every corner of our life since its advent. It is now generally believed that further improvements on Li-ion battery can bring in at most additional 30% increase in energy density. Such an upper limit means that it would be difficult to achieve long driving ranges (e.g. 500 km) when conventional lithium-ion batteries are used to power electrical vehicles (EVs). New chemistry and systems are therefore being actively sought with a targeted energy density of 500 Wh /kg.

Metal-air batteries (which broadly include those running on oxygen or air feedstock) have gained revived interest. They are assembled from a metal anode and an air-breathing cathode in a proper electrolyte. Metal-air batteries combine the design features of both conventional batteries and fuel cells. They have large theoretical energy density about 3~30 times higher than those of lithium-ion batteries

METHODOLOGY

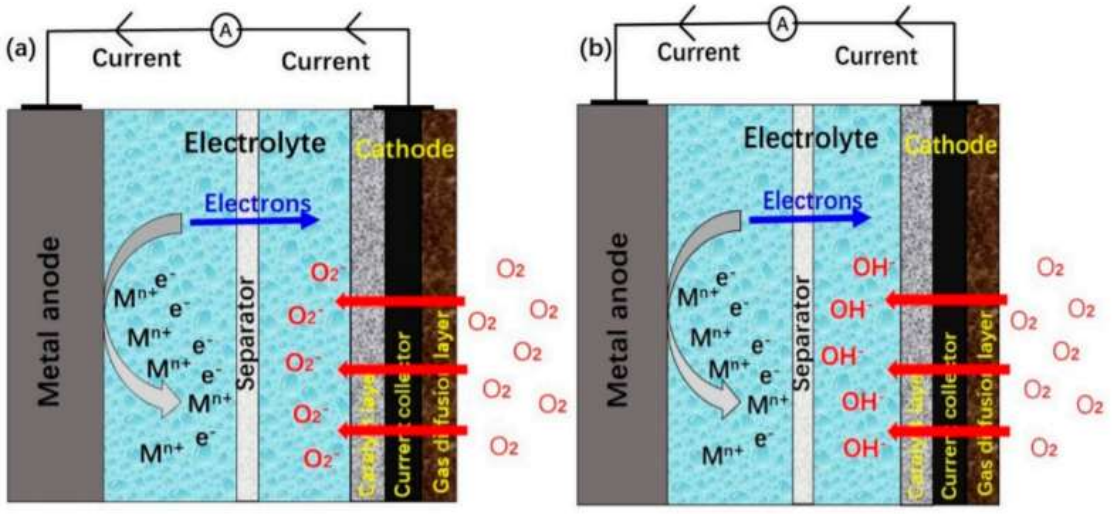
Metal Air Battery is made up of Metal Anode and air breathing cathode. Due to the Air breathing cathode the required oxygen is supplied from the atmosphere air and the charge density is very high.

The chemical activity of the metal anode determines the discharge capacity .Anode is made up of a metal. Generally used metals are Aluminium, Manganese, Copper, Magnesium and Iron. Generally pure metals are used . E.g.: 99.99% pure aluminium metal is used for construction of anode.

ORR and OER reactions take place on cathode. Cathode is composed of a catalyst layer, gas diffusion layer and current collector. Current collector can be made of metals and also non-metals. Generally used catalysts are platinum, ruthenium, iridium oxides. Gas diffusion layer provides oxygen diffusion channels between air and catalyst layer. Thin, light and highly porous Types of Electrolytes here we used to perform the reaction for metal air batteries is to Conduct is Aqueous, Hybrid, Ionic, Solid State Electrolytes.

WORKING PRINCIPLE

The working principle of MABs differs from that of traditional ionic batteries. The traditional ionic batteries involve the transformation of metallic ions from the anode to the cathode. In MABs, metals or alloys transform to metallic ions at anode and oxygen transforms to hydroxide ions at the cathode. Figure 3 shows the operation of a MAB in aqueous or non-aqueous electrolyte medium. In an aqueous electrolyte system, oxygen diffuses into batteries through the gas diffusion layer and transforms into receiving electrons forming oxygen anions. In a non-aqueous electrolyte system, oxygen receives electrons and transforms into oxygen anion. Metals release electrons, transform to metallic ions and dissolve into electrolytes. These processes will be reversible during a charging procedure of a rechargeable MAB.



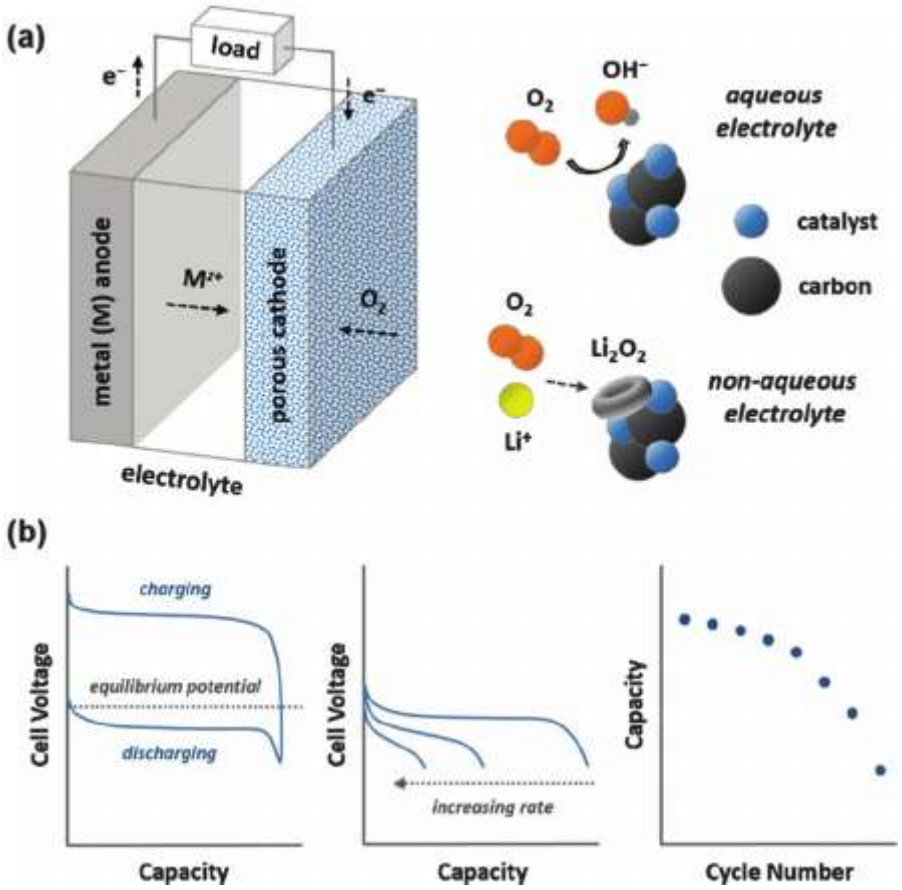
Advanced Manufacturing of MABs

Advanced manufacturing techniques for electrodes and batteries are composed of printing and laser processing. Printing technology has various advantages in microstructure controlling and large batch low-cost fabrication. Printing includes screen printing, spray printing, direct ink writing processing, and roll-to-roll fabrication
Advanced manufacturing techniques for electrodes and batteries are composed of printing and laser processing. Printing technology has various advantages in microstructure controlling and large batch low-cost fabrication. Printing includes screen printing, spray printing, direct ink writing processing, and roll-to-roll fabricationnanomaterial's and nanostructures. Lasers can be applied for sintering various materials including metals, ceramics, and polymers. In recent years, laser processing has been employed in the fabrication of electrodes, super capacitors, even full batteries. Successful micro manufacturing includes laser-drilling of micromoles in LiFePO4 cathode for Li-ion batteries and laser carbonization anode (grapheme) for an interdigital film battery. Li reported femtosecond laser-reduced Nano joined grapheme oxide/Au conductive network as micro-super capacitors electrodes. Poll reported femtosecond-laser structuring of LiMn2O4 composite cathodes for Li-ion micro-batteries. Yu reported laser sintering of printed anodes for AABs. Results indicated that laser sintering can remove the organic solvent from the printed Al nanoparticle slurry and increase the conductivity of the printed anode. Electrochemical characterization demonstrated laser power of 10 W for sintering for better performance, and 3-layer printed anode with a bigger discharge capacity. A 3-layer battery cell can yield a 239 mAh g−1 discharge capacity at an operation voltage of 0.95 V.

3D Printing

Traditional thin film 2D batteries have suffered from limited energy capacity. 3D printing of flexible micro-batteries with nanostructures can overcome this weakness. Currently, the printed parts of batteries can be electrodes, current collector, solid-state separator, and catalyst in metal–air batteries. Zhou reviewed 3D printing energy storage devices with a sandwich-type and in-plane architecture and demonstrated that the electrochemical energy storage systems can be greatly promoted with 3D printing. Lewis et al. Reported 3D fully printed electrodes for Li-ion batteries. Li4Ti5O12 (LTO) and LiFePO4 (LFP) were separately employed as anode and cathode materials. Electrode material inks were printed onto the substrate, forming multilayer electrodes and an anode and cathode in an interdigitated structure. The results showed that the charge and discharge of 8-layer full cell delivered Appl. Sci. 2019, 9, 2787 17 of 22 1.2 mAh cm−2 at a rate of 0.5 C. EIS test revealed the thicker electrode had higher resistance. Meanwhile, CV testing showed the thin wall displayed broader redox peaks. Furthermore, both thin and thick electrodes exhibit excellent Columbic efficiencies. 3D printed LIBs had 4.45 mAh cm−2 at 0.14 mA cm−2, corresponding a full cell delivering 14.5 mAh cm−2 at 0.2 mA cm−2. The same printed technology can also be employed for MABs. For MABs, screen printing has been used in catalysts. A remarkable shortcoming is the narrow choice of suitable materials for printing. In addition, expensive equipment also limits application. However, 3D printing is the destructive technology in MAB manufacturing due to unprecedented designing freedom, high precision, and cost-effective processing.

RESULT



From the research I have studied that the due to the Metal anode the anode is pose be corrosion and also due to the loss of metal ion on the anode material the metal air battery is unable to recharge. Here in the metal air battery there is a cause of metal anode oxidation
And this can be reduced by a proper electrolyte and proper catalyst

CONCLUSION

In summary, this paper briefly reviewed the recent advances in the studies of the metal–air batteries. Better batteries should be an excellent combination of cathode, anode, and electrolyte. however, there are still some problems to be solved, such as anode side reaction, impure gas CO2 release, electrolyte instability, and so on. Essentially, improving ORR and OER are quite important to the cathode. Crystallographic structure, materials size, materials morphology, carbon-based materials-doped, and composites can influence different activities of catalyst, which is required to improve both ORR and OER in the cathode. Nanocomposites and doped-carbon materials are good choices for catalysts in ORR and OER. Research indicates that compared with traditional alloy as an anode, alloys with nanocomposites can reduce the side reaction and improve discharge capacity. While various electrolytes have different advantages more efficient solid-state electrolyte is required in rechargeable metal–air batteries. Integration of advanced manufacturing, especially 3D printing and laser processing, opens new horizons for MABs. These manufacturing processes allow a better strategy for the systematic combination of the best performance of anodes, cathodes, and electrolyte for improved energy density, efficiency, and cycling stabilities. Although many issues still exist, the further development of MABs, as a compelling alternative to LIBs, holds great promise to address emergent needs of portable electronics , electrical vehicles, and IoTs.

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