ПИ
p93/2w

ELSEVIER

VOL 66 | OCTOBER 2014

Progress in Materials Science

An International Review Journal

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CONTENTS:

Rechargeable magnesium battery: Current status and key challenges for the future
P. Saha, M.K. Datta, O.I. Velikokhatnyi, A. Manivannan, D. Alman and P.N. Kumta
Piezoelectric single crystal ultrasonic transducers for biomedical applications
Q. Zhou, K.H. Lam, H. Zheng, W. Qiu and K.K. Shung
SnO_2: A comprehensive review on structures and gas sensors
S. Das and V. Jayaraman

VOL 66 | OCTOBER 2014

ISSN:0079-6425

tion/insertion/conversion type cathodes; metallic magnesium and their alloys/intermetallic/composites as anodes; and electronically conductive but chemically and electrochemically inert current collectors for magnesium battery. The limited electrochemical oxidative stability of current generation of electrolytes with inherently slow magnesium-ion diffusion in to electrodes as well as the inability of Mg^{2+} to reversibly cycle in all but a few materials systems impede the growth of high power and high energy density magnesium cells, analogous to Li-ion systems. Before the successful fabrication of a prototype magnesium battery, optimization of electrolyte performance, the realization of suitable intercalation/insertion cathodes and the identification of alternative alloys, intermetallics, composites and compounds as anodes are highly critical. Exploration of the compatibility of various battery parts including metallic current collectors with currently used organochloro electrolytes sheds light on the electrochemical corrosion of metals such as Cu, Al, stainless steel (SS) toward chlorinated Grignard's salts warranting further investigation for identifying, electrically conducting and electrochemically inert current collectors. Results to date show the preferential selectivity of certain electronically conducting metallic and non-metallic current collectors for rechargeable magnesium batteries owing to its high anodic stability in the present electrolyte. Development of magnesium-ion battery therefore requires an interdisciplinary approach with a sound understanding of organometallic and inorganic chemistry, adequate knowledge of materials chemistry, materials science and engineering, as well as electrochemistry, and a comprehensive knowledge of metallic corrosion principles in basic/acidic electrolytic environments in order that a system with acceptable energy density (~150–200 W h/kg) and operational voltage ~2–3 V can be developed in the near future.

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Contents

1. Introduction 3
2. Various components of the magnesium battery system 6
    2.1. Non-aqueous liquid electrolytes for magnesium battery system 6
    2.2. Polymer based electrolytes for magnesium battery system 24
    2.3. Current collectors for magnesium based battery systems 32
    2.4. Currently used cathodes for Mg battery system 38
        2.4.1. Chevrel phase, CP (Mo_6T_8; $T = S$, Se, Te) cathodes 39
        2.4.2. Mixed Chevrel phases ($Mo_6S_{8-y}Se_y$; $y = 1,2$) and $Cu_xMo_6S_8$ ($x \sim 1$) 54
        2.4.3. V_2O_5 – Mg-ion insertion-type cathode 55
        2.4.4. Chemical insertion of Mg^{2+} ion into transition metal oxide/sulfide/boride hosts 57
        2.4.5. Molybdenum oxide (MoO_3) and uranium oxide (a-U_3O_8) – Mg^{2+} insertion-type cathodes 58
        2.4.6. NASICON-type materials as cathode 58
        2.4.7. Transition metal oxides (TMO) type intercalation cathodes 60
        2.4.8. Olivine compound $MgMSiO_4$ (M = Mn, Co, Fe) cathode 64
        2.4.9. MT_2 (M = metal, T = S, Se) type intercalation cathodes 68
        2.4.10. MoS_2 intercalation cathode 68
        2.4.11. Magnesium/sulfur conversion cathodes 71
    2.5. Currently used anodes for magnesium battery system 72
3. Limitations of current magnesium based battery system 76
4. Concluding remarks and future prospects 78

5. Indemnification 79
Acknowledgements 79
References 79

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1. Introduction

The projected doubling of world energy consumption within the next 50 years, coupled with the growing demand for low or even zero-emission sources of energy, has brought increasing awareness for sustainable pathways to meet the energy needs of future generations. Generation of electricity from efficient, clean and renewable energy sources, such as solar, wind, geothermal or hydropower without carbon dioxide production (green energy), an undesirable greenhouse pollutant, offers enormous potential for meeting the energy demands of the future [1–8]. However, the electricity generated from these intermittent renewable sources requires efficient sustainable stationary electrical energy storage (EES) devices to achieve an effective, and reliable transmission and distribution (T & D) of electrical energy (i.e., grid applications), power regulation, load leveling and distributed energy resources [6,8–11]. Stationary EES devices are therefore needed to realize the full potential of renewable energy sources as part of the electric distribution grid or smart grid application as shown in Fig. 1. In addition, there is a tremendous need for improved EES devices for transportation to transition from today's hybrid electric vehicular state enabling the realization of plug-in hybrids or the much desired all-electric vehicles (EVs) [6,9–11]. Realization of plug-in hybrids or all electric vehicles at affordable costs will pave the way for energy independence of the United States of America and reliance on foreign liquid fuel thus securing the energy future for several decades to come and even moving into the next millennium.

The primary outstanding technological challenge is to develop a cost effective solution for attaining efficient electrical energy storage. Current EES technologies based on batteries, fuel cells and redox-flow batteries are among the leading EES technologies that have been projected to offer a solution to the complex, multi-faceted problems facing the energy storage gridlock. Among these, rechargeable batteries have been proposed to offer a unique solution for EES primarily for transmission and distribution (T & D) [7,8]. In recent years, battery technology as EES devices have emerged as the major flagship technologies serving as the much desired panacea of hope to provide a meaningful solution to both stand-alone stationary power systems integrated into the electric grid as well as electric vehicles [6,9–13]. In most electricity storage technologies, lower-cost materials and synthesis methods are

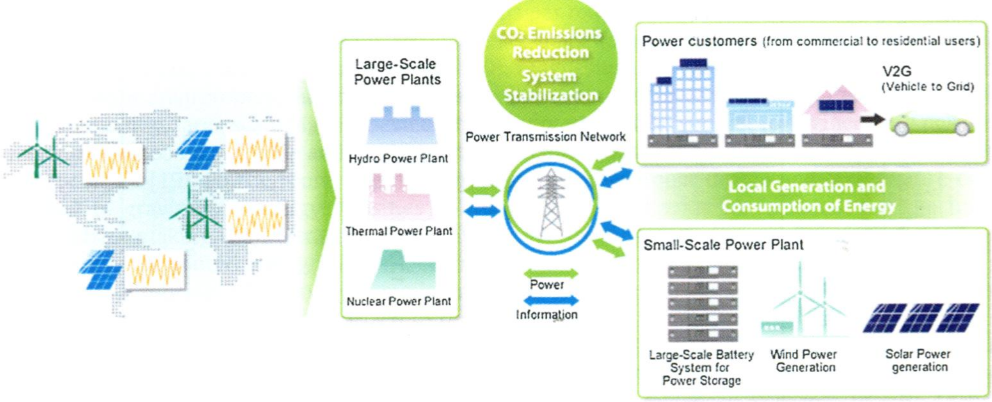

Fig. 1. Schematic diagrams of smart Electrical Energy Storage (EES) concept which will serve as energy storage need and play a critical role in the low-carbon society in future http://panasonic.net/energy/storage_battery/low-carbon/index.html.