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Editorial

Conversion reaction lithium metal batteries

Liping Wang[1] (✉), Peng Gao[2] (✉), Chunmei Li[3] (✉), and Hong Li[4] (✉)

[1] *School of Materials and Energy, University of Electronic Science and Technology of China, Chengdu 611731, China*
[2] *Electron Microscopy Laboratory and International Center for Quantum Materials, School of Physics, Peking University, Beijing 100871, China*
[3] *Centre for Cooperative Research on Alternative Energies (CIC energiGUNE), Basque Research and Technology Alliance (BRTA), 01510 Vitoria-Gasteiz, Spain*
[4] *Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China*

Since its commercialization in 1991, lithium-ion batteries have had wide applications. High energy density and low cost are leading goals for lithium batteries. Compared with the traditional intercalation-type lithium-ion battery, conversion-type lithium metal battery undergoes multi-electron reactions, offering a much higher capacity and 2–5 times higher energy density (Fig. 1). Moreover, their cathodes can have sustainable and environment-friendly transition elements such as Fe and Cu. As the cathodes are normally "Li-free", they are coupled with "Li-containing" anodes, such as Li metal and Li-alloy. Owning to these advantages, conversion-based lithium metal batteries are regarded as "long-term targets".

Different from the intercalation cathodes, where the structure frameworks keep stable during Li ions insertion and desertion, the conversion cathodes MX_n (M = Fe, Co, Ni, Cu, Ti, Mn, etc; X = F, S, O, P, Cl, etc) suffer from structure conversion and reforming. In this case, the conversion cathodes have difficulty in completely recovering, which brings in a fast capacity decay. Meanwhile, the lithium metal anode has a high chemical activity leading to low Coulombic efficiency. This special issue collects some of the latest studies on nanoscience and technology for conversion reaction lithium metal batteries.

This special issue has collected 38 papers, including 5 topics: (i) conversion-type cathodes, including O_2, S, CuS, sulfurized polyacrylonitrile, and FeF_3; (ii) Li-containing anodes, including Li metal, Li/C composites, Li-Zn or Li-Mg or Li-Sn alloy; (iii) electrolytes including electrolyte additives, solid-state electrolyte, and ionic liquids; (iv) separators; (v) current collectors. Overall, the collection of this issue represents the frontier of material development, interface studies, characterization techniques, and cell configuration designs, which are expected to have a significant impact on both academic and industrial research communities.

It is our honor to be invited to organize this special issue for *Nano Research*. We would like to thank the authors for their contributions, the reviewers for improving the quality of these papers, and the editors for their support.

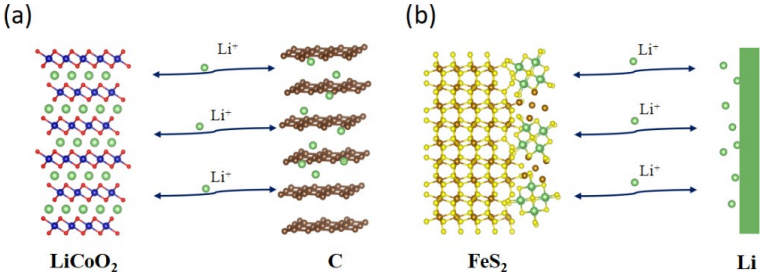
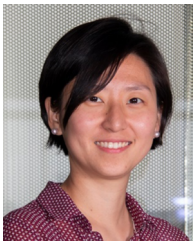


Figure 1 Two different types of lithium batteries. (a) Traditional intercalation-type lithium-ion battery. (b) Conversion-type lithium metal battery.

Liping Wang is a full professor at the University of Electronic Science and Technology of China. She received her Ph.D. degrees (2011) in Institute of Physics, Chinese Academy of Sciences and Laboratoire de réactivité et chimie des solides (LRCS), Université de Picardie Jules Verne, France. She worked as a post-doctoral fellow at the Max Planck Institute of Colloids and Interfaces, Germany (2012) and Research Associate at Brookhaven National Lab, United States (2013–2014). Her current research interests are high energy density Li batteries. She has published over 100 papers in related research fields and obtained nearly 20 authorized Patents. She serves as the Young Editorial Board Member in *eScience* and *Energy Material Advances*. She has been admitted as a Fellow of the Royal Society of Chemistry (FRSC).

Address correspondence to Liping Wang, lipingwang@uestc.edu.cn; Peng Gao, p-gao@pku.edu.cn; Chunmei Li, cli@cicenergigune.com; Hong Li, hli@iphy.ac.cn

Peng Gao is a Boya Distinguished professor in the International Center for Quantum Materials, and Electron Microscopy Laboratory, in School of Physics of Peking University. He received his Bachelor of Physics from University of Science and Technology of China and Ph.D. in Physics from the Institute of Physics, Chinese Academy of Sciences. He was a Research Fellow at University of Michigan from 2010 to 2013, a Research Associate at Brookhaven National Laboratory in USA from 2013 to 2014, and Japan Society for the Promotion of Science (JSPS) foreign researcher fellow in the University of Tokyo from 2014 to 2015, and tenure-track assistant and associated professor at Peking University from 2015 to 2021. He mainly engages in atomic-scale interface physics and electron microscopy/spectroscopy. He has co-authored more than 300 peer-reviewed scientific papers.



Chunmei Li was a research line leader in CIC energiGUNE, Spain. She obtained European joint Ph.D. in Material Science in 2014. The Ph.D. thesis was carried out between the University of St Andrews (UK) with Prof. Peter G. Bruce and the Université de Picardie Jules Verne (France) with Prof. Jean-Marie Tarascon. The research was related to the fundamental studies of non-aqueous Li-O_2 batteries, mainly the mechanism of O_2 reduction in aprotic solvents. She joined CIC energiGUNE in 2014 as a post-doc researcher and became research line leader in 2018. Her research interests focused on low-cost, sustainable, and safe solid-state Li-S cells.

Hong Li is currently a full professor in Institute of Physics, Chinese Academy of Sciences. He got the bachelor's degree from Lanzhou University in 1992, master's degree in CAS in 1995 and Ph.D. degree in the Institute of Physics, CAS in 1999. His research interest is high energy density lithium-ion batteries, solid lithium batteries, and failure analysis. He serves as the regional editor of *Solid State Ionics* and *Ionics*. He has published over 450 papers and obtained over 70 authorized Patents.