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DATE: July 16, 2021
TIME: 14:00 PM – 15:30 PM
LOC: Zoom Meeting

GUEST SPEAKER:
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TITLE:

Aqueous battery for large-scale energy storage: towards both high energy density and superior safety

ABSTRACT:
Development of energy storage system in the past year focus on improvement of energy density. While the progress is remarkable, safety problems of lithium ion batteries (LIB) have been intensively exposed. On one hand, LIB is not intrinsically safe with very active anode, flammable electrolyte and oxygen-releasing cathode; on the other hand, many application scenarios actually don't require very high energy density.
We work on aqueous electrolyte batteries to achieve both high energy density and superior safety performance. we show how to activate the desired reversible I^0/I^+ redox at a potential of 0.99 V *vs. SHE* by electrolyte tailoring *via* F^-, Cl^- ions-containing salts. The electronegative F^- and Cl^- ions can stabilize the I^+ during charging. In an aqueous Zn ion battery based on an optimized $ZnCl_2$ + KCl electrolyte with abundant Cl^-, I-terminated halogenated $Ti_3C_2I_2$ MXene cathode delivers two well-defined discharge plateaus at 1.65 V and 1.30 V, superior to all reported aqueous I_2-metal (Zn, Fe, Cu) counterparts. Together with the 108% capacity enhancement, the high voltage output results in a significant 231% energy density enhancement.
In addition, we also develop various approaches to stabilize the Zn anode. We accurately quantifying the hydrogen evolution in Zn metal battery by *in-situ* battery-gas chromatography-mass analysis. Then, we propose an vapor-solid method for an highly electronically insulating (0.11 $mS{\cdot}cm^{-1}$) but high Zn^{2+} ion conductive (80.2 $mS{\cdot}cm^{-1}$) ZnF_2 solid ion conductor with high Zn^{2+} transfer number (0.65) to isolate Zn metal from liquid electrolyte, which can not only prohibit over 99.2 % parasitic hydrogen evolution reaction during cycling but also guide uniform Zn electrodeposition. Meanwhile, $Zn@ZnF_2//Zn@ZnF_2$ symmetric cell exhibits excellent stability over 2500 h (over 6250 cycles) with 1 $mAh{\cdot}cm^{-2}$ of Zn reversibly cycled at 5 $mA{\cdot}cm^{-2}$, and stable cycling under ultrahigh current density and areal capacity (10 $mA{\cdot}cm^{-2}$, 10 $mAh{\cdot}cm^{-2}$) over 590 h (285 cycles), which far outperforms all reported Zn metal anode in aqueous system. In light of the superior $Zn@ZnF_2$ anode, the practical-level aqueous $Zn@ZnF_2//MnO_2$ batteries (~3.2 $mAh{\cdot}cm^{-2}$) shows remarkable cycling stability over 1000 cycles with 93.63 % capacity retained at ~100 % coulombic efficiency.

BIOGRAPHY:

Chunyi ZHI obtained B.S. degree in Physics from Shandong University and Ph.D. degree in condensed matter physics from Institute of Physics, Chinese Academy of Sciences. After two years' postdoc in National Institute for Materials Science (NIMS) in Japan, he was promoted to be ICYS researcher, researcher (faculty) and senior researcher (permanent position) in NIMS. Dr. Zhi is now a professor in MSE, CityU.

Dr. Zhi has extensive experiences in flexible energy storage, aqueous electrolyte batteries, zinc ion batteries and highly thermally conducting insulating polymer composites. He has published more than 350 papers, including Nature Review Mater.; Nature Commun.; Energy Environ. Sci.; Adv. Mater.; J. Am. Chem. Soc.; Angew Chem. In. Ed. etc., with 40 ESI highly cited papers (by Jan, 2021), an H-index of 95 and other-citation of 32000. He has been granted more than 80 patents. He founded a spin-off company named AmaZinc Energy Ltd. to commercialize flexible batteries developed in his group.

Dr. Zhi is a recipient of the outstand research award and President Award of CityU, NML award, IAAM medal and Beijing Science and Technology Award (first class). He is Clarivate Analytics Global highly cited researcher (2019, 2020, Materials Science), RSC fellow and member of The Hong Kong Young Academy of Sciences.