**Nanostructured electrode materials for electrochemical energy storage and conversion**

Guoxiu Wang

Centre for Clean Energy Technology, University of Technology Sydney, NSW 2007, Australia

In this talk, I will report the development of advanced rechargeable batteries based on materials architecture design. Lithium-air battery is one of the most promising systems for meeting today’s stringent requirements as the power source for electric vehicles. Porous graphene with different pore size architectures were synthesized as cathode catalysts for lithium-air batteries. Porous graphene exhibited significantly higher discharge capacities than that of non-porous graphene. The Ru nanocrystal decorated porous graphene exhibited an excellent catalytic activity with a high reversible capacity, low charge/discharge over-potential, and long cycle life. [1, 2]

I will report a recent development on an ionic liquid bearing the redox active 2,2,6,6-tetramethyl-1-piperidinyloxy moiety, which serves multiple functions as redox mediator, oxygen shuttle, lithium anode protector, as well as electrolyte solvent. The additive contributes a 33-fold increase of the discharge capacity in comparison to a pure ether-based electrolyte and lowers the over potential to an exceptionally low value of 0.9 V. Meanwhile, its molecule facilitates smooth lithium plating/stripping, and promotes the formation of a stable solid electrolyte interface to suppress side reactions. In particular, it enables an outstanding electrochemical performance when operated in air. [3] Furthermore, sodium-air batteries were also investigated. [4]

Sodium-ion batteries and potassium-ion batteries are being considered as a promising system for stationary energy storage and conversion, owing to natural abundance of sodium and potassium. Several electrode materials were synthesized as either cathode materials or anode materials for sodium-ion batteries, potassium-ion batteries and sodium-sulfur batteries. [5-7]

Single-atom catalysts offer a pathway to cost-efficient catalysis with the minimal amount of precious metal used but creating them and keeping them stable during operation is a challenge. We have fabricated double transition-metal MXene nanosheets, Mo2TiC2Tx, with abundant exposed basal planes and Mo vacancies in the outer layers by electrochemical exfoliation. The developed catalyst exhibits an outstanding catalytic ability with a low overpotential and a mass activity about 40 times greater than the commercial platinum-on-carbon catalyst. The strong covalent interactions between positively charged Pt single atoms and MXene contribute to the exceptional catalytic performance and stability. [8]

**References**

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