

A versatile functionalized ionic liquid to boost the solution-mediated performances of lithium-oxygen batteries

Jinqiang Zhang¹, Bing Sun¹, Yufei Zhao^{1,2}, Anastasia Tkacheva¹, Zhenjie Liu³, Kang Yan¹, Xin Guo¹, Andrew M. McDonagh¹, Devaraj Shanmukaraj⁴, Chengyin Wang⁵, Teofilo Rojo⁴, Michel Armand⁴, Zhangquan Peng³ & Guoxiu Wang¹

¹Centre for Clean Energy Technology, University of Technology Sydney, Broadway, Sydney, NSW 2007, Australia. ²Department of Materials Science and Engineering, Dongguan University of Technology, Dongguan, Guangdong 523808, People's Republic of China. ³State Key Laboratory of Electroanalytical Chemistry, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun, Jilin 130022, China. ⁴CIC EnergiGUNE, Parque Tecnológico de Álava, 48, 01510 Miñano, Álava, Spain. ⁵College of Chemistry and Chemical Engineering, Yangzhou University, Jiangsu 225002, People's Republic of China. Correspondence and requests for materials should be addressed to M.A. (email: marmand@cicenergigune.com) or to Z.P. (email: zqpeng@ciac.ac.cn) or to G.W. (email: Guoxiu.Wang@uts.edu.au)

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Abstract

Due to the high theoretical specific energy, the lithium–oxygen battery has been heralded as a promising energy storage system for applications such as electric vehicles. However, its large over-potentials during discharge–charge cycling lead to the formation of side-products, and short cycle life. Herein, we report 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. Moreover, the proportion of ionic liquid in the electrolyte influences the reaction mechanism, and a high proportion leads to the formation of amorphous lithium peroxide and a long cycling life (> 200 cycles). In particular, it enables an outstanding electrochemical performance when operated in air.