# Superoxide stabilization and a universal $KO_2$ growth mechanism in potassium-oxygen batteries

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Rechargeable potassium–oxygen ($K–O_2$) batteries promise to provide higher round−trip efficiency and cycle life than other alkali–oxygen batteries with satisfactory gravimetric energy density (935 Wh $kg^{-1}$)[1-4]. In this study, we introduce a strategy that exploits a strong electron-donating-solvent, e.g. dimethyl sulfoxide (DMSO) to effectively stabilize the discharge product, potassium superoxide, results in significant improvement in electrode kinetics (up to four orders of magnitude) and improved chemical/electrochemical reversibility. We report the first DMSO-based $K–O_2$ battery, demonstrating a much higher energy efficiency and stability than the glyme-based electrolyte. We couple online electrochemical mass spectrometry (OEMS), rotating−ring disk electrode (RRDE), X−ray diffraction (XRD) and scanning electron microscope (SEM) to study the stability of the reactions and develop a universal crystal growth model of $KO_2$. We show that ideal solvent for $K–O_2$ batteries should strongly stabilize superoxide (strong donicity) to obtain high electrode kinetics and reversibility while providing fast oxygen diffusion to achieve high discharge capacity. Our work elucidates key electrolyte properties that control the efficiency and reversibility of $K−O_2$ batteries.

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