Ordered Mesoporous TiN as a Promising Carbon-Free Cathode for Aprotic Li –O_2 Batteries

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Despite the extraordinary gravimetric energy densities, Li-O_2 batteries are still facing a technological challenge;[1] limited round trip efficiency leading to insufficient cycle life. Recently, carbonaceous electrode materials were found to be one of the primary origins of the limited cycle life,[2] as they produce irreversible side products during discharge. A few investigations based on noncarbonaceous materials have demonstrated largely suppressed accumulation of irreversible side products,[3] but such studies have focused mainly on the materials themselves rather than delicate morphology control. As such, here, we report the synthesis of mesoporous titanium nitride (m-TiN) with a 2D hexagonal structure and large pores (>30 nm), which was templated by a block copolymer with tunable chain lengths, and introduce it as a stable air-cathode backbone. Due to the well-aligned pore structure and decent electric conductivity of TiN, the battery reaction was quite reversible, resulting in robust cycling performance for over 100 cycles under a voltage cutoff condition. Furthermore, by protecting the Li metal with a poreless polyurethane separator[4] and engaging a lithium iodide redox mediator[3], the original capacity was retained for 280 cycles under a consistent capacity condition (430 mAh/g). This study reveals that when the appropriate structure and material choice of the air-cathode are coupled with an advanced separator and an effective solution-phase redox mediator, the cycle lives of Li-O_2 batteries can be enhanced dramatically.

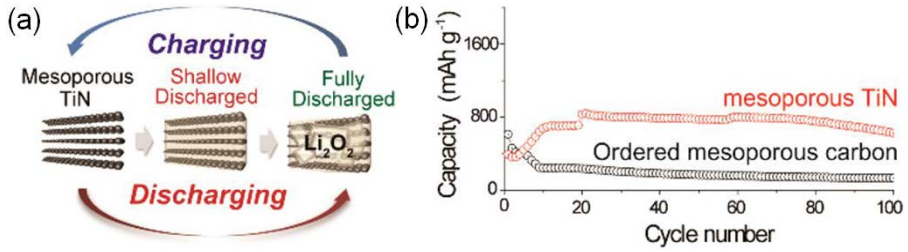

Figure 1. (a) Shematic illustration showing the m-TiN morphology change during discharge and charge. (b) The cycling performance of the m-TiN and ordered mesoporous carbon.

References:

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