Na-Air Batteries: Understanding of Mechanisms and Rechargeability

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Alkali metal-oxygen (Li-O_2, Na-O_2) batteries have attracted a great deal of attention recently due to their high theoretical energy densities, which is comparable to gasoline, making them attractive candidates for use in electrical vehicles. However, the limited cycling life and low energy efficiency (high charging overpotential) of these cells hinder their commercialization [1,2]. Li-O_2 battery system has been extensively studied in this regard during the past decade. Compared to the numerous reports of Li-O_2 batteries, the research on Na-O_2 batteries is still in its infancy. Although Na-O_2 batteries show a number of attractive properties such as low charging overpotential and high round-trip energy efficiency, their cycling life is currently limited to a few tens of cycles. Lithium and sodium elements share similar chemical properties, however, the chemistry and electrochemistry of Li- and Na-O_2 batteries are not the same. While the discharge product of Li-O_2 cells is well-recognized to be lithium peroxide (Li_2O_2), both sodium peroxide (Na_2O_2) and superoxide (NaO_2) have been detected as the discharge product of Na-O_2 cells in a number of different studies. Therefore, understanding the chemistry behind Na-O_2 cells is critical towards enhancing their performance and advancing their development.

Our group applied nanostructured carbon materials as cathodes to investigate various effects including surface area of porous carbon black [3], current density on CNTs [4] and functional groups on graphene [5], 3D electrodes [6] and humidity on rechargeability [7]. Furthermore, the determining kinetics factors for controlling the chemical composition of the discharge products in Na-O_2 cells will be discussed and the potential research directions toward improving Na-O_2 cells are proposed. The perspectives will also be discussed.

References:

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