Evaluation of the composite Bi_2O_3/MoO_3 formation on the electrochemical properties of bismuth oxide for application in hybrid supercapacitors

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Due to the escalating demand for renewable energy sources and the impending scarcity of fossil fuels, developing new materials capable of efficiently converting energy is crucial for environmental preservation. Oxides are particularly noteworthy in this regard due to their ability to exhibit pseudocapacitive behavior, making them versatile in electrochemical energy storage systems with high energy and power density [1]. However, oxides suffer from inherent drawbacks such as low electronic conductivity and cycling stability. Among oxides, Bi_2O_3 stands out for its high theoretical specific capacity, cost-effectiveness, environmental friendliness, and low redox potential, making it suitable for applications in alkaline batteries, lithium batteries, hybrid supercapacitors, and other electrochemical devices. In alkaline environments, Bi_2O_3 undergoes a conversion mechanism to Bi_2O_2 and then to Bi^0, achieving a theoretical capacity of 345.1 mAh g^{-1}. Nevertheless, its low conductivity limits its performance at high current densities [2]. In this study, we explored the synthesis of Bi_2O_3 doped with 1% molybdenum oxide (MoO_3) via a solvothermal method. XRD analysis revealed that the doped material closely resembled β-Bi_2O_3, with additional minor peaks indicating the presence of MoO_3 **(Fig. 1a)**. Electrochemical tests were conducted using a three-electrode cell with 6 mol L^{-1} KOH as the electrolyte. Cyclic voltammetry **(Fig. 1b)** of the Bi_2O_3/MoO_3 composite exhibited well-defined peaks, with anodic processes occurring at lower potentials and cathodic processes at higher potentials, suggesting enhanced electronic conductivity compared to Bi_2O_3. Galvanostatic charge/discharge tests **(Fig. 1c)** showed that while Bi_2O_3 exhibited higher specific capacity at lower current densities, the Bi_2O_3/MoO_3 composite demonstrated superior performance at higher current densities. At 7 A g^{-1}, the composite delivered 150.73 C g^{-1}, a 13.83% increase compared to Bi_2O_3 (132.41 C g^{-1}), and at 10 A g^{-1}, the improvement was 57.13%, with 111.82 C g^{-1} for Bi_2O_3/MoO_3 and 71.16 C g^{-1} for Bi_2O_3. Furthermore, the rate capability of Bi_2O_3/MoO_3 was approximately 58%, significantly higher than the 24% observed for Bi_2O_3, showing once more the enhanced electronic conductivity of the composite.

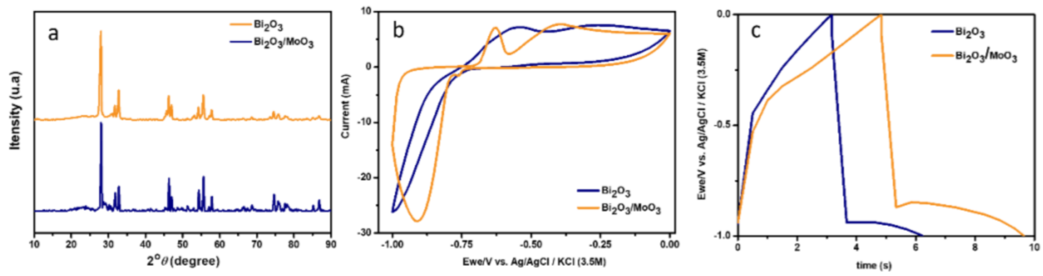

Figure 1. (a) XRD of the synthesized materials; (b) Cyclic voltammetry curves obtained at 20 mV s^{-1}; (c) Charge-discharge curves at 10 A g^{-1}

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References

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