Electronic Supplementary Material (ESI) for Faraday Discussions.

Supporting materials

Feasibility of Achieving Two-Electron K-O_2 Batteries

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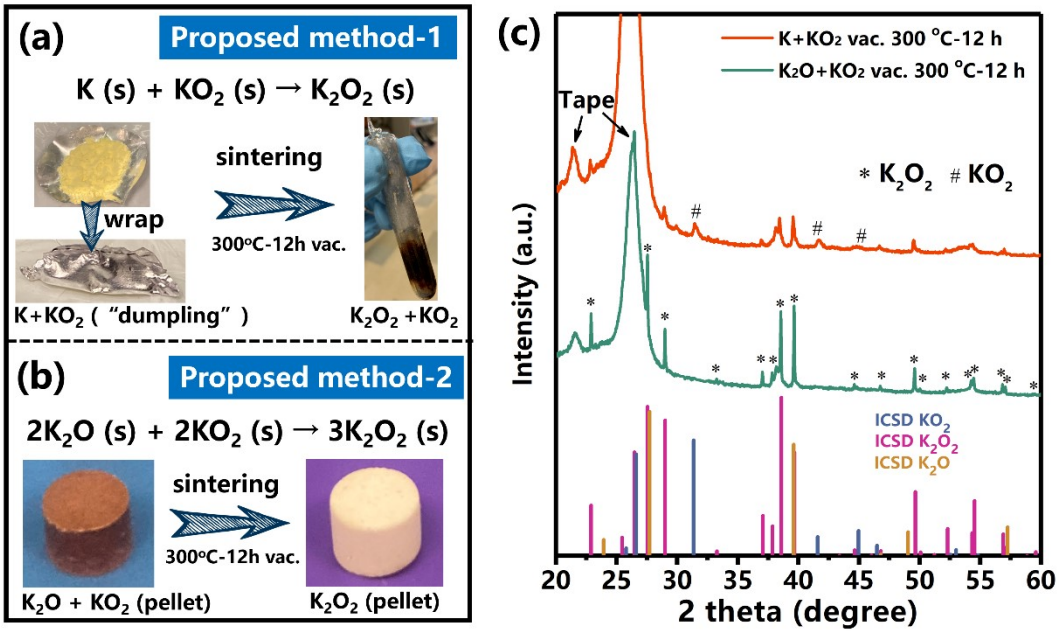

Figure S1. Proposed two methods to synthesize K_2O_2. (a) Rolling the K chunks with the pasta machine and wrapping the commercial KO_2 powder with the obtained K foil, followed by heating treatment at 300 °C for 12 hours under vacuum. (b) Cold-pressing the KO_2 and K_2O powder mixture into a cylindrical pellet, followed by sintering at 300 °C for 12 hours under vacuum. (c) XRD patterns of the as-synthesized products via two proposed methods. Details can be found in the **Experimental Section**.

For the K_2O_2 synthesis route 1, it is proposed that the K solid would first melt at the evaluated temperature (above 64 °C) and become a liquid with high surface tension, which may result in poor contact between the liquified K and KO_2 solid. In addition, the K may also evaporate during heating under vacuum, further leading to K loss for reaction.

In comparison, the solid-solid reaction in the synthesis route 2 could ensure tight contact between the reactants, which is proposed to circumvent the issue associated with the usage of metallic K.

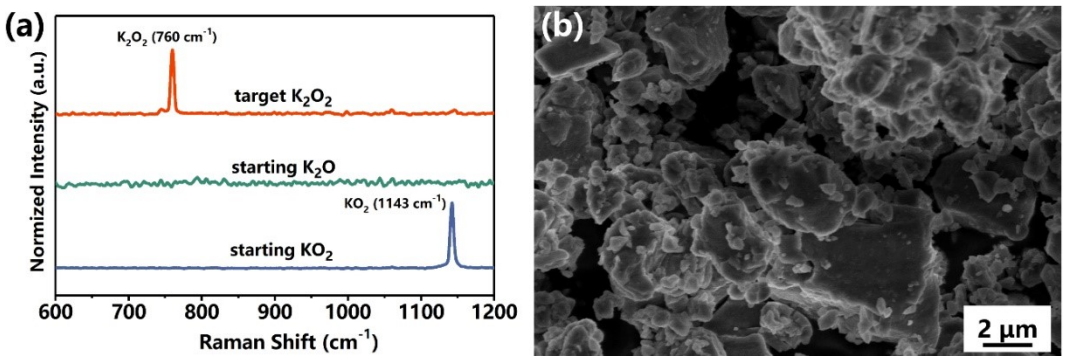

Figure S2. Characterization on the as-synthesized K_2O_2. (a) Raman spectra of the K_2O_2 and the corresponding starting materials of K_2O and KO_2. (b) Typical SEM image of the as-obtained K_2O_2.