

## Electric Supplementary Information

### Sustainable Water-Activated Metal-Air Paper Batteries Based on Waste Biomass-Based Electrocatalysts

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#### Appendix

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## S1. Effect of mixing ratios of BM powders and CNFs on ORR performances of NBCs

Figure S1 shows LSV curves of NBCs derived from different mixing ratios of BM powders and CNFs and  $\text{MnO}_2/\text{Vulcan}$  in 1M NaCl aq. at the ring-disc electrode rotating speed of 1,600 rpm. The onset potentials of NBCs were higher than that of  $\text{MnO}_2/\text{Vulcan}$ , however, there are some variations in NBCs. In terms of onset potential, which is one of the important factors of ORR activity, and conductivity, the NBC derived from BM powders:CNFs=5:5 had the highest performance. When the content of BM powders was low and CNF content was high, the number of catalytic sites decreased because heteroatom content became lower. In contrast, the conductivity decreased with increasing BM powders and decreasing CNF contents. The best balance of BM powders and CNFs is required to achieve both high ORR catalytic property and high conductivity.

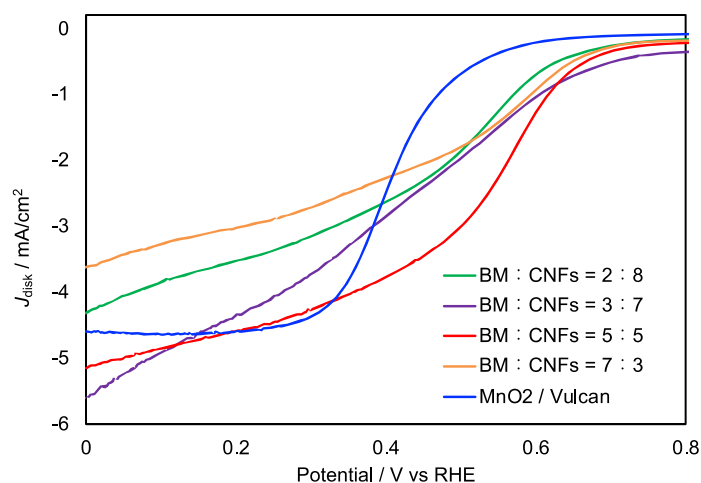


Figure S1. LSV curves of NBCs derived from different mixing ratios of BM powders and CNFs and  $\text{MnO}_2/\text{Vulcan}$  in 1M NaCl aq. at the ring-disc electrode rotating speed of 1,600 rpm.

## S2. Rotating speed dependence of LSV curves and K-L plot of MnO<sub>2</sub>/Vulcan

Rotating speed dependence of LSV curves (a) and K-L plot (b) of MnO<sub>2</sub>/Vulcan were shown in Figure S2. From Figure S2(a), the onset potential at each rotating speed was identical, and the electron numbers of reaction was almost identical (3.23-3.32) from the K-L plot.

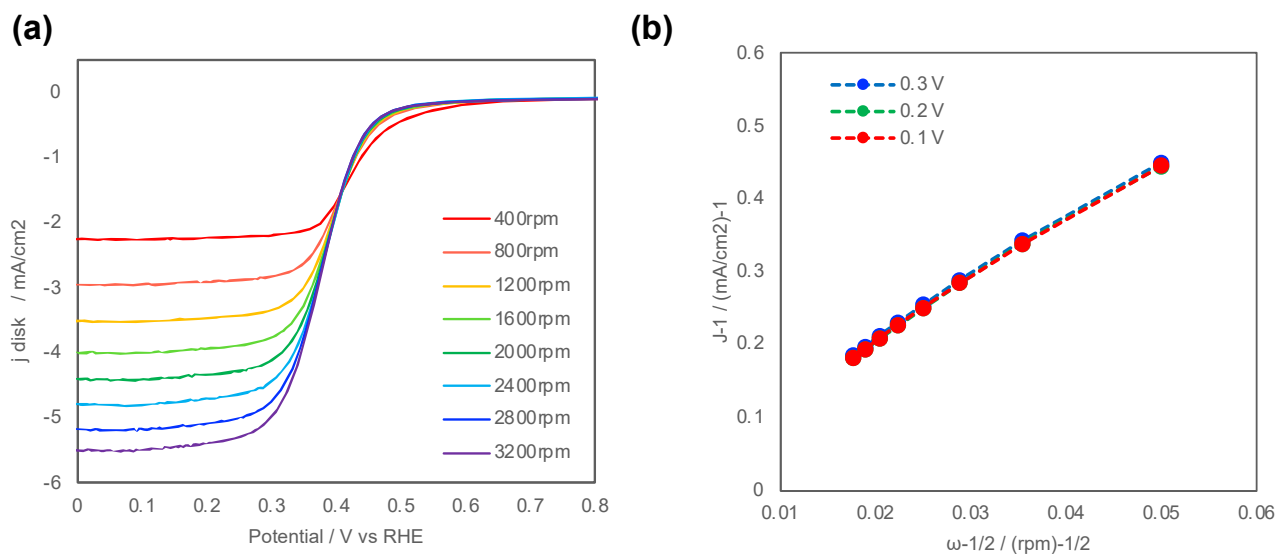


Figure S2. Rotating speed dependence of LSV curves (a) and K-L plot (b) of MnO<sub>2</sub>/Vulcan.

### S3. Charge-discharge cycle test of the Mg-air paper battery cell

Figure S3 shows a charge-discharge polarization curve of a Mg-air paper battery cell with using NBC as a cathode catalyst at 10 mA/cm<sup>2</sup>.

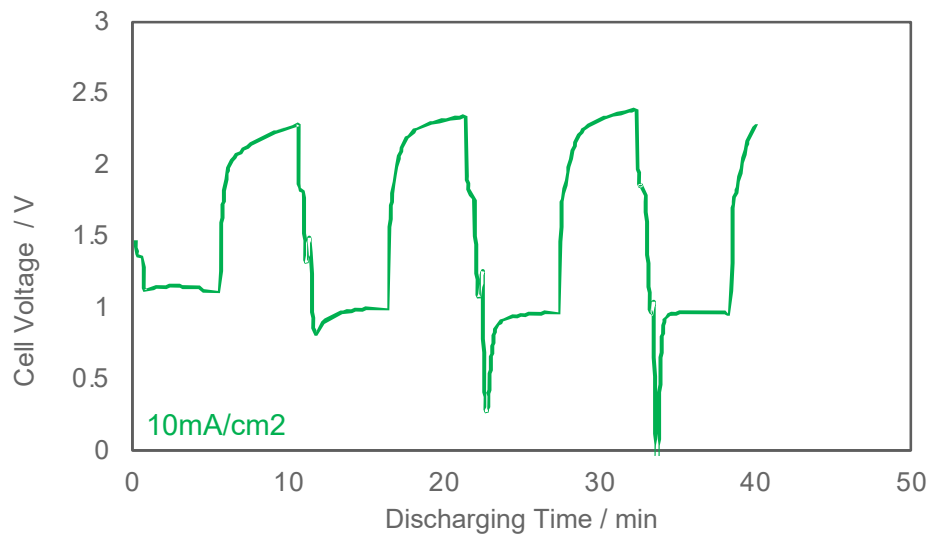


Figure S3. Charge-discharge polarization curve of a Mg-air paper battery cell with using NBC as a cathode catalyst at 10 mA/cm<sup>2</sup>.