

Electronic Supplementary Information

Enhanced capacitive properties of all-metal-oxide-nanoparticles-based asymmetric supercapacitors

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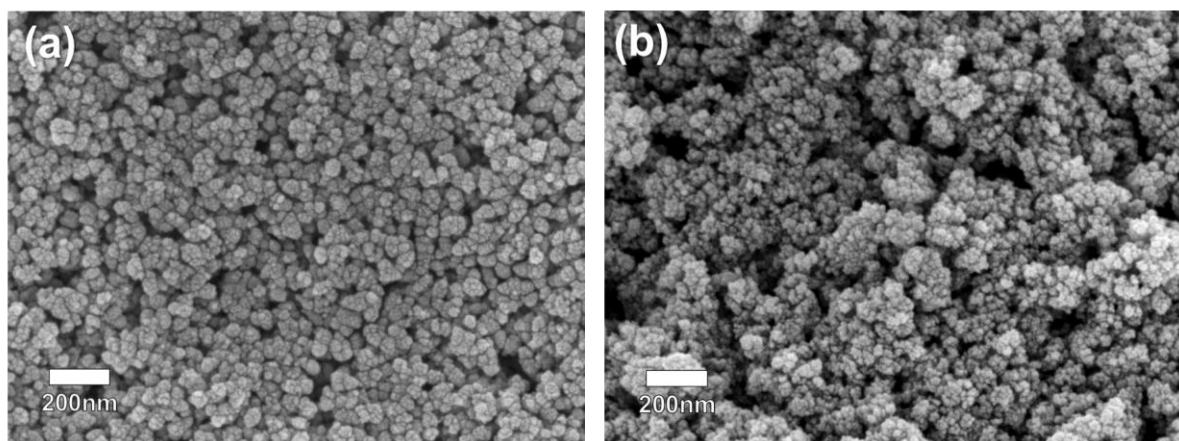


Fig. S1. FE-SEM images of TiO₂-free (a) Fe₂O₃ and (b) MnO₂ electrodes.

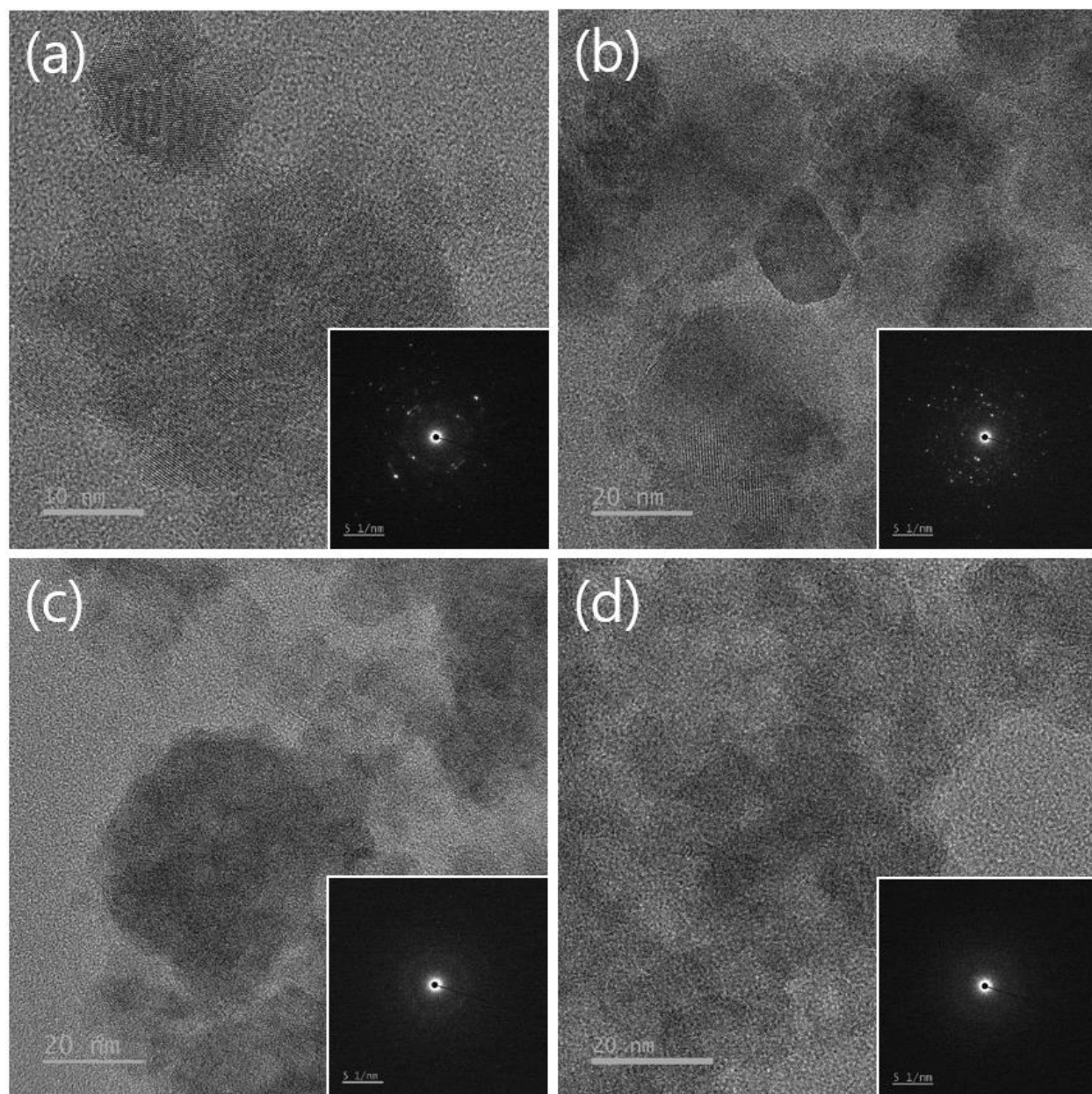


Fig. S2. TEM images and SAED patterns (inset) of the (a) Fe_2O_3 , (b) $\text{TiO}_2\text{-Fe}_2\text{O}_3$, (c) MnO_2 and (d) $\text{TiO}_2\text{-MnO}_2$ NPs

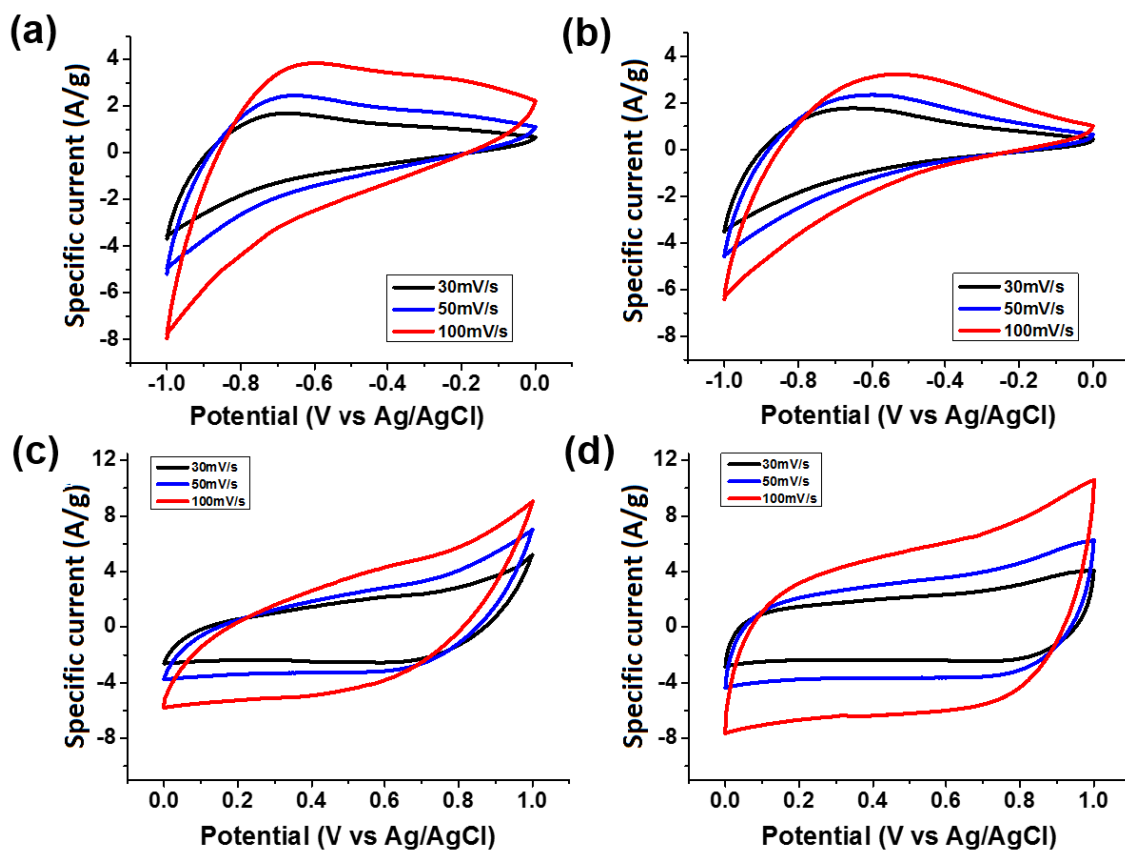


Fig. S3. Cyclic voltammograms of (a) TiO₂-free-Fe₂O₃, (b) TiO₂-Fe₂O₃, (c) TiO₂-free-MnO₂ and (d) TiO₂-MnO₂ half-cell electrodes at various scan rates..

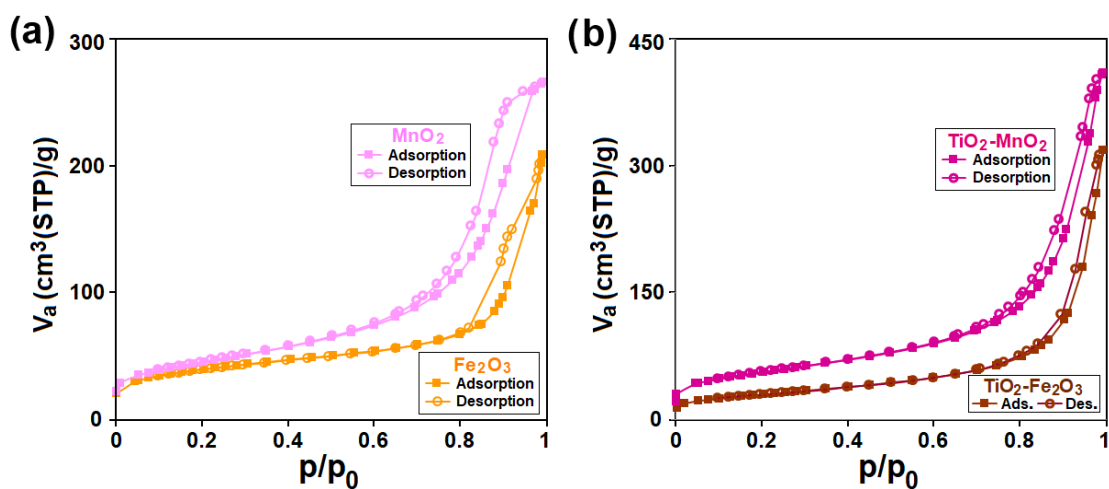


Fig. S4. BET N₂ adsorption-desorption isotherm plots of (a) MnO₂ and Fe₂O₃ and (b) TiO₂-MnO₂ and TiO₂-Fe₂O₃ NPs.

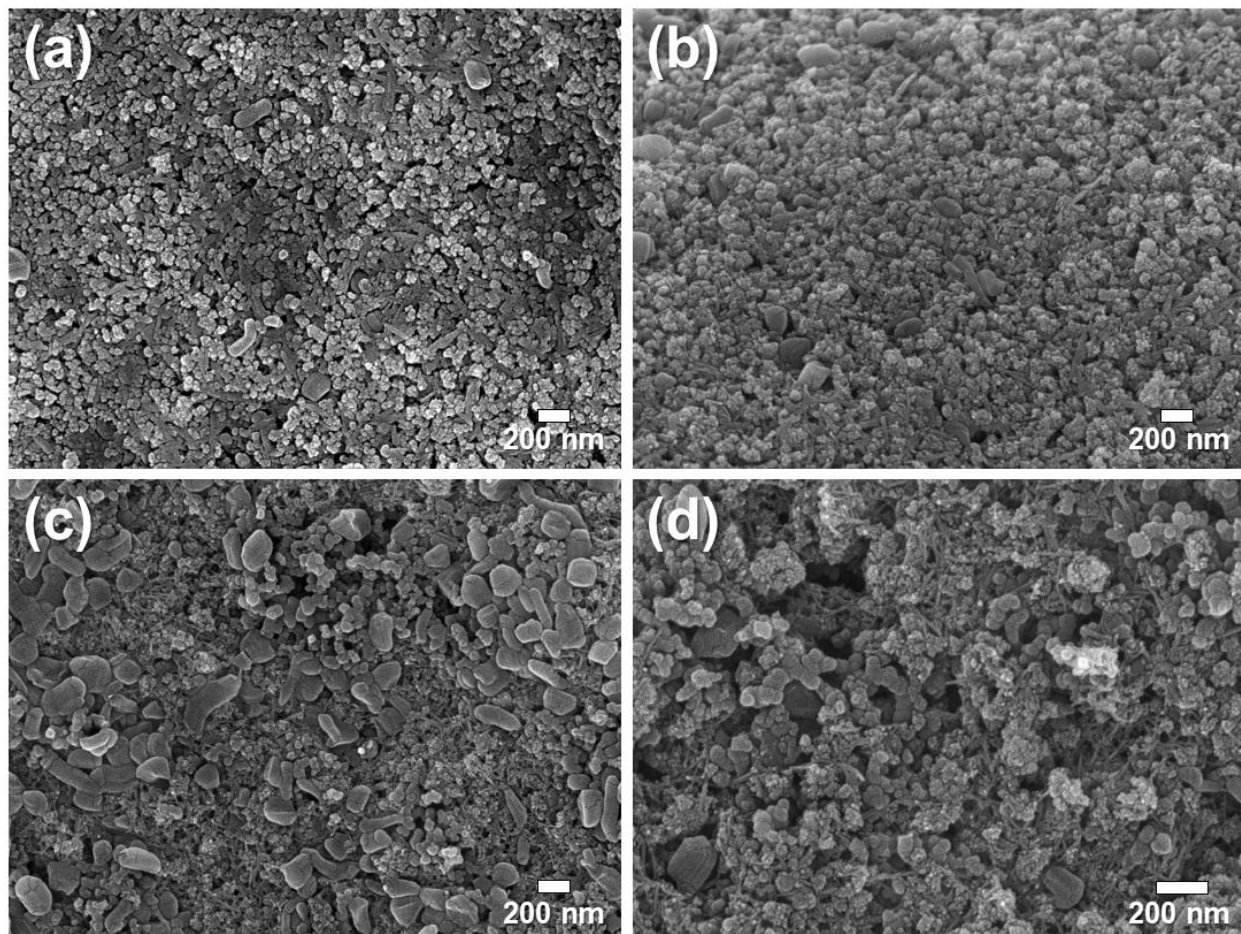


Fig. S5. FE-SEM images of (a, b) $\text{TiO}_2\text{-Fe}_2\text{O}_3$ and (c, d) $\text{TiO}_2\text{-MnO}_2$ half-cell electrodes in the $\text{TiO}_2\text{-Fe}_2\text{O}_3//\text{TiO}_2\text{-MnO}_2$ ASC. The images (a) and (c) were taken before the GCD cycle test, and the images (b) and (d) were taken after 2000 GCD cycles.

Scan rate (mV s^{-1})	TiO ₂ -free-Fe ₂ O ₃		TiO ₂ -Fe ₂ O ₃	
	Surface element (%)	Insertion element (%)	Surface element (%)	Insertion element (%)
30	41.9	58.1	22.0	78.0
50	46.7	53.4	27.9	72.1
100	57.6	42.4	40.7	59.3

Table S1. Summary of the contribution of each capacitive element calculated by deconvolution analyses for the Fe₂O₃-NPs-based single electrodes with and without incorporation of TiO₂ NPs.

Scan rate (mV s^{-1})	TiO ₂ -free-MnO ₂		TiO ₂ -MnO ₂	
	Surface element (%)	Insertion element (%)	Surface element (%)	Insertion element (%)
30	31.1	68.9	49.3	50.7
50	39.7	60.3	55.0	45.0
100	59.4	40.6	67.6	32.4

Table S2. Summary of the contribution of each capacitive element calculated by deconvolution analyses for the MnO₂-NPs-based single electrodes with and without incorporation of TiO₂ NPs.

Scan rate (mV s ⁻¹)	Specific capacitance (F g ⁻¹)		
	TiO ₂ -Fe ₂ O ₃ // TiO ₂ -Fe ₂ O ₃ symmetric	TiO ₂ -MnO ₂ // TiO ₂ -MnO ₂ symmetric	TiO ₂ -Fe ₂ O ₃ // TiO ₂ -MnO ₂ asymmetric
10	46.9	73.7	72.7
30	35.5	61.4	58.5
50	29.9	54.9	52.8
100	24.3	45.8	45.6

Table S3. The C_{sp} values obtained from CV analyses for the TiO₂-Fe₂O₃- and TiO₂-MnO₂-NPs-based symmetric and asymmetric devices at various scan rates.

Specific current (A/g)	Specific capacitance (F/g)		
	TiO ₂ -Fe ₂ O ₃ // TiO ₂ -Fe ₂ O ₃ symmetric	TiO ₂ -MnO ₂ // TiO ₂ -MnO ₂ symmetric	TiO ₂ -Fe ₂ O ₃ // TiO ₂ -MnO ₂ asymmetric
1	12.8	53.5	87.5
2	10.3	43.2	77.7
3	3.5		
5		31.6	60.6

Table S4. The C_{sp} values obtained from GCD analyses for the TiO₂-Fe₂O₃- and TiO₂-MnO₂-NPs-based symmetric and asymmetric devices at various current densities.