Electronic Supplementary Material (ESI) for Biomaterials Science.

Ultra-small manganese dioxide nanoparticles with high T_1 relaxivity for magnetic resonance angiography

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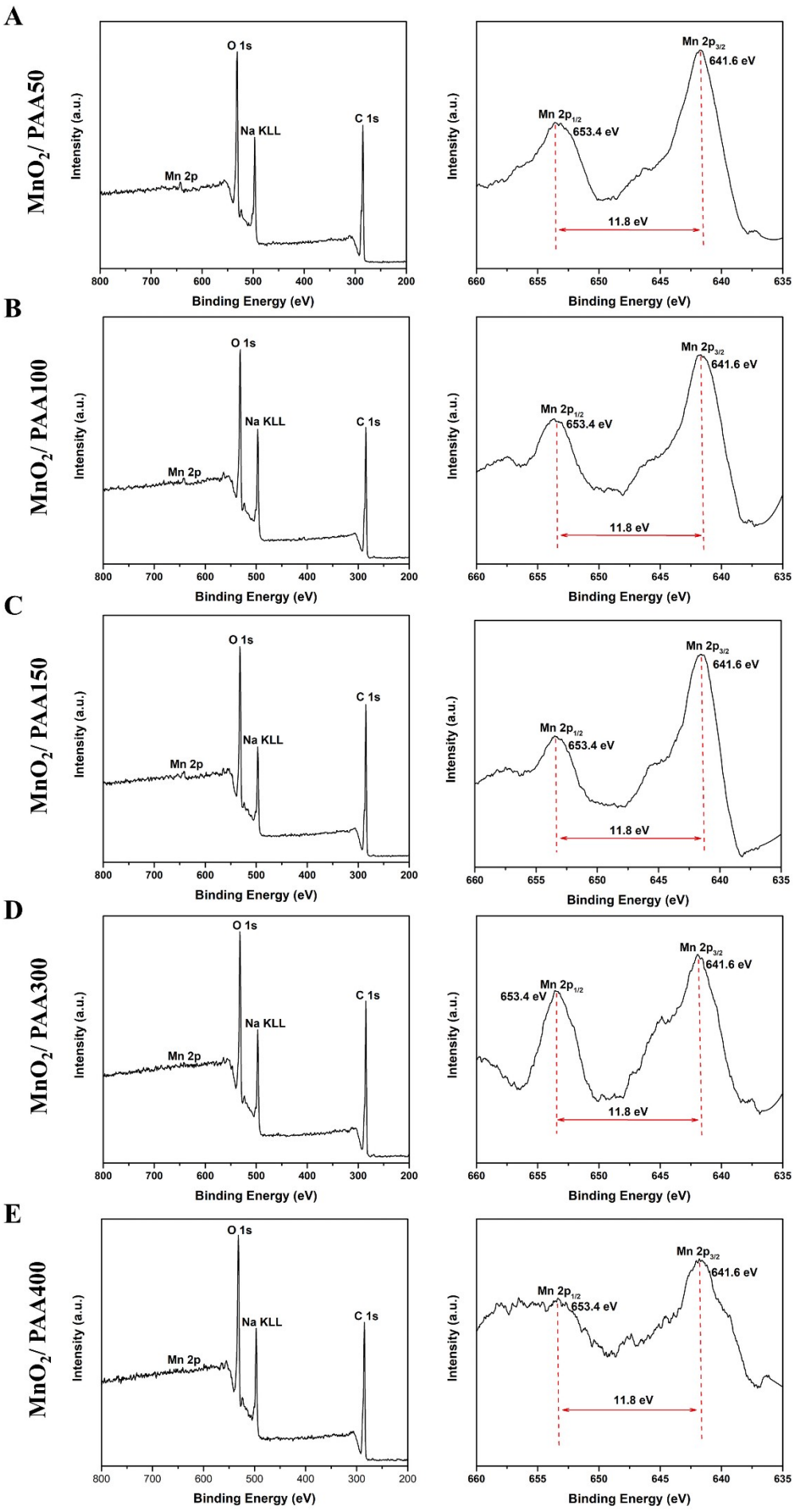
A
MnO2/ PAA50
O 1s
Na KLL
C 1s
Mn 2p
Intensity (a.u.)
Binding Energy (eV)
Mn 2p3/2
641.6 eV
Mn 2p1/2
653.4 eV
11.8 eV
B
MnO2/ PAA100
C
MnO2/ PAA150
D
MnO2/ PAA300
E
MnO2/ PAA400

Figure S1. XPS spectra of MnO_2/PAA50 NPs and Mn 2p (A), MnO_2/PAA100 NPs and Mn 2p (B), MnO_2/PAA150 NPs and Mn 2p (C), MnO_2/PAA300 NPs and Mn 2p (D), MnO_2/PAA400 NPs and Mn 2p (E).

Table S1. TGA results for MnO_2/PAA NPs.

Sample	Weight loss of PAA (%)
MnO_2/PAA50	25.6
MnO_2/PAA100	25.8
MnO_2/PAA150	30.3
MnO_2/PAA200	31.1
MnO_2/PAA300	31.4
MnO_2/PAA400	31.5

Table S2. The r_1, r_2 and r_2/r_1 values of MnO_2/PAA NPs under a 0.5 T NMR Analyzing system at 32°C.

Sample	r_1 ($mM^{-1}s^{-1}$)	r_2 ($mM^{-1}s^{-1}$)	r_2/r_1
MnO_2/PAA50	7.6	10.0	1.3
MnO_2/PAA100	9.9	14.8	1.5
MnO_2/PAA150	23.1	33.6	1.4
MnO_2/PAA200	29.8	40.6	1.3
MnO_2/PAA300	28.9	39.5	1.3
MnO_2/PAA400	28.5	41.2	1.4

Table S3. The r_1, r_2 and r_2/r_1 values of MnO_2/PAA NPs under a 1.5 T MRI scanner at 25℃.

Sample	r_1 ($mM^{-1}s^{-1}$)	r_2 ($mM^{-1}s^{-1}$)	r_2/r_1
MnO_2/PAA50	6.7	11.9	1.8
MnO_2/PAA100	9.6	17.2	1.8
MnO_2/PAA150	23.3	42.1	1.8
MnO_2/PAA200	29.0	53.3	1.8
MnO_2/PAA300	27.9	51.9	1.9
MnO_2/PAA400	27.4	51.1	1.9

Table S4. The r_1, r_2 and r_2/r_1 values of MnO_2/PAA NPs under a 3.0 T MRI scanner at 25℃.

Sample	r_1 ($mM^{-1}s^{-1}$)	r_2 ($mM^{-1}s^{-1}$)	r_2/r_1
MnO_2/PAA50	4.7	11.5	2.4
MnO_2/PAA100	6.0	16.5	2.7
MnO_2/PAA150	13.9	40.2	2.9
MnO_2/PAA200	16.7	51.4	3.1
MnO_2/PAA300	16.0	50.2	3.1
MnO_2/PAA400	15.6	49.1	3.1

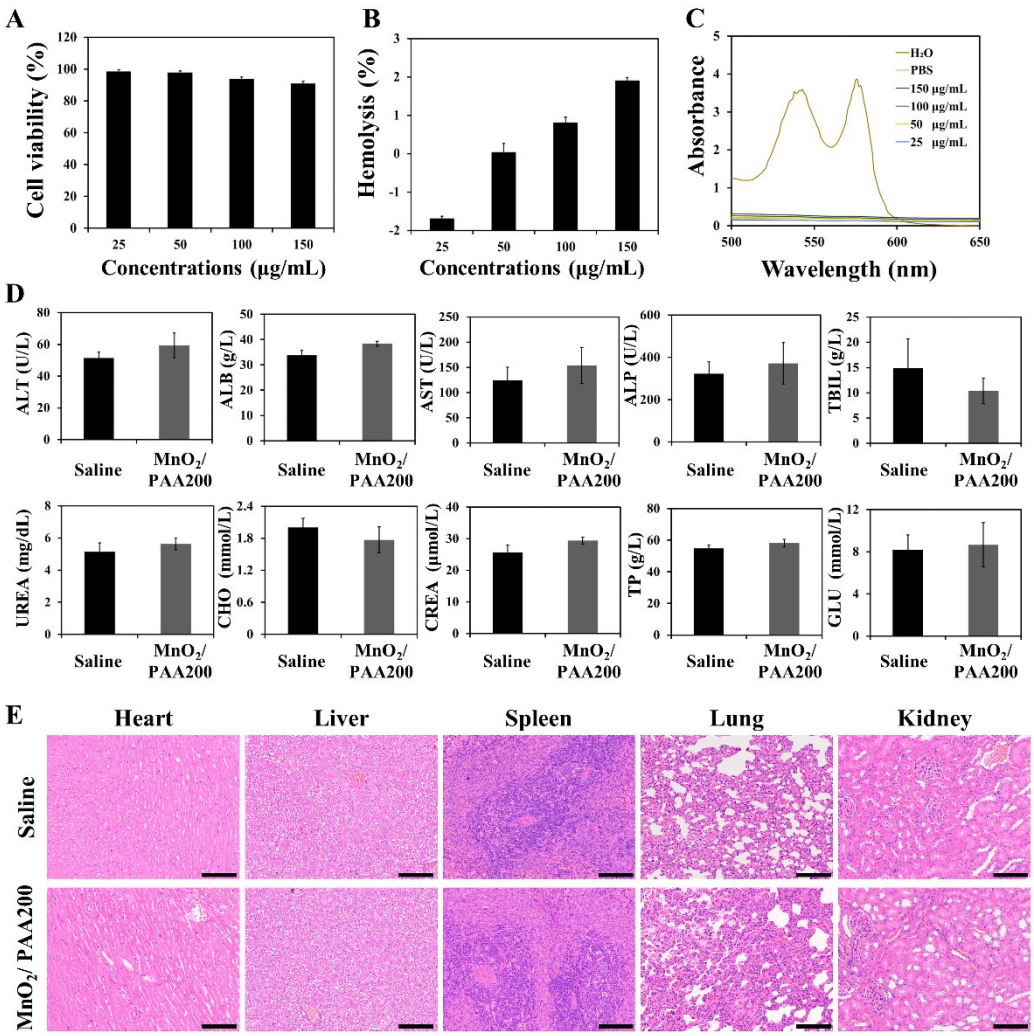

Figure S2. (A) Cell viabilities of Raw264.7 incubated with different concentrations of MnO_2/PAA200 NPs for 24 h; (B) The hemolysis percentage of MnO_2/PAA200 NPs; (C) The UV absorption spectra of blood incubated with deionized water, PBS and MnO_2/PAA200 NPs at different concentrations for 2 h. (D) Biochemical indicators and (E) H&E staining of main issues from SD rats 24 h after administration (0.05 mmol Mn kg/BW). Scale bar: 100 μm.

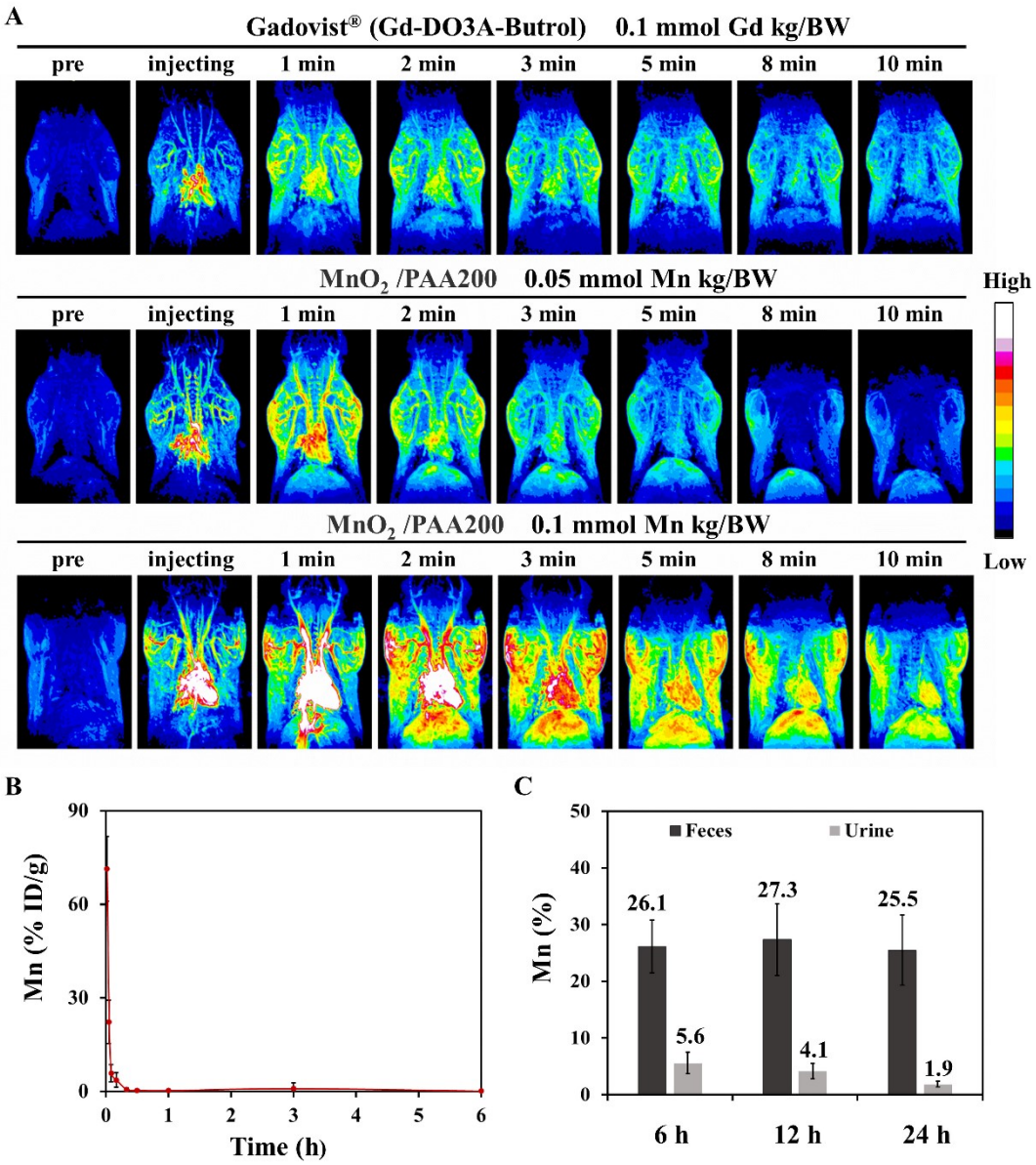

Figure S3. (A) Pseudocolor MR images of heart and neck of SD rats after injection of Gadovist® (Gd-DO3A-Butrol, dosage: 0.1 mmol Gd kg/BW) and MnO_2/PAA200 NPs (dosage: 0.05 or 0.1 mmol Mn kg/BW), respectively at different time points; (B) Percentage-injected dosage per gram of manganese (% ID/g) in blood at different time points with the dosage of 0.05 mmol Mn kg/BW; (C) Percentage-injected dosage of manganese in the feces and urine of SD rats at different time (6 h, 12 h and 24 h) after injection of MnO_2/PAA200 NPs (0.05 mmol Mn kg/BW).