## **Supplementary Information**

## 1. Simulation of contrast signal enhancement

Given that r1 and r2 values of each agent can be experimentally obtained. One could simulate relative contrast enhancement performance of the agent using a standard signal equation for spin-echo pulse sequence;

$$S = k \rho (1-exp(-TR/T1)) exp(-TE/T2)$$
 (1)

Where S represents signal intensity, k is proportionality constant that reflects sensitivity of signal detection circuitry of on the scanner,  $\rho$  represents proton density. In the presence of contrast agent, the relative contrast signal exerted by the agent can be derived from an equation (1) as;

T1 or T2 changes that are caused contrast agent can be expressed in the following relationship;

$$1/T1constrast = 1/T1tissue + r1[Magent]$$
 (3)

Where r1 and IM<sub>agent</sub>] represent longitudinal relaxivity and concentration of the agent, respectively

Finally, the equation (2) can be reduced into following equation;

 $S_{contrast}/S_{tissue} = \{(1-exp(-TR(1/T1_{tissue} + r1[M_{agent}]))\}exp(-TE*r2[M_{agent}]) / [1-exp(-TR/T1_{tissue})]$ (4)

For known values of r1, r2, and concentration of the agents at given TE = 6.6 ms and TR = 400 ms that were used for phantom imaging (RARE sequence), simulated plot of contrast signal as function of agent concentration can be obtained.



Figure 1. Plot contrast signal enhancement factors obtained from experimental measurements and theoretical simulation as function of Mn concentration at 7T.

## 2. Plasma Mn<sup>2+</sup> concentrations

Blood samples were taken at different time intervals from 4 different mice (for each agent). The plasma was separated from whole blood by centrifuging at 1,500 g for 10 min. Mn concentrations in plasma were measured by ICP. Fig. 2 shows the time course of decay in Mn after tail vein infusion. Each point in Fig. 2 represents one sample and the time course was generated from all 4 mice. The results show that the blood half-life of MnCl<sub>2</sub> and iMnBCs particles was  $\sim$ 7 min and  $\sim$  12 min, respectively, at the concentration of 1.1 mg Mn infusion per kilogram body weight.



Figure 2. Measurement of  $Mn^{2+}$  plasma concentration after administration of  $MnCl_2$  and iMnBCs showing half-life time of MnCl2 and iMnBCs, respectively.





Figure 3. Hydrodynamic sizes of nanocomplexes in three different media A) DMEM cell culture media B) PBS, and C) DI water. No noticeable change in size after 4 hours of incubation. All measurements were done at 25 °C.