A Two-step Ligand Exchange Reaction Generates Highly Water-dispersed Magnetic Nanoparticles for Biomedical Applications

Mamoru Hatakeyama[†‡], *Hiroshi Kishi*[#‡], *Yoshinori Kita*[#], *Kensuke Imai*[#], *Kosuke Nishio*[#], *Satoki Karasawa*[#], *Yuka Masaike*[†], *Satoshi Sakamoto*[#], *Adarsh Sandhu*[†,§], *Akihiro Tanimoto*[⊥], *Tatsuya Gomi*[‖], *Eiichi Kohda*[‖], *Masanori Abe*[†,], *and Hiroshi Handa*[†,#*]

[†]Solutions Research Laboratories, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori-ku, Yokohama 226-8503, Japan

[#] Department of Biological Information, Graduate School of Bioscience and Biotechnology, Tokyo Institute of Technology, 4259 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8501, Japan

[‡]Quantum Nanoelectronics Research Center, Department of Electrical and Electronic Engineering, Tokyo Institute of Technology, 2-12-1 O-okayama, Meguro-ku, Tokyo 152-8550, Japan

[§]Department of Electrical and Electronic Engineering, Graduate School of Science and Engineering, Tokyo Institute of Technology, 2-12-1 O-okayama, Meguro-ku, Tokyo, 152-8550, Japan

[⊥] School of Medicine, Keio University, 35 Shinano-machi, Shinjuku-ku, Tokyo 160-8582, Japan

[‖]Oohashi Medical Center, Toho University, 2-17-6 Oohashi, Meguro-ku, Tokyo 153-8515, Japan

‡These authors contributed equally to this work.

[*]To whom correspondence should be addressed.

Phone: +81-45-924-5872, Fax:+81-45-924-5145, email: hhanda@bio.titech.ac.jp

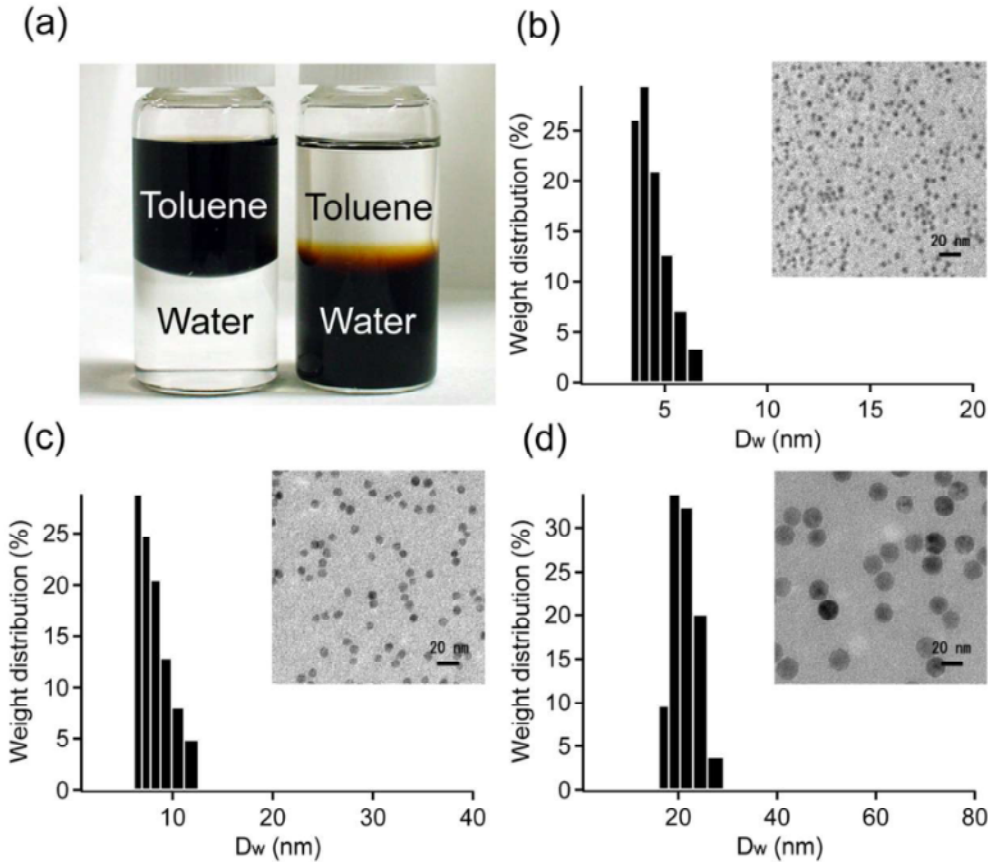

Figure S1. (a)Photographs of two-phase mixtures with oleate-MNPs dispersed in toluene (left) and citrate-MNPs dispersed in water (right). Hydrodynamic size distributions along with TEM images of citrate-MNPs; (b) 4 nm MNPs; (c) 8 nm MNPs; (d) 20 nm MNPs.

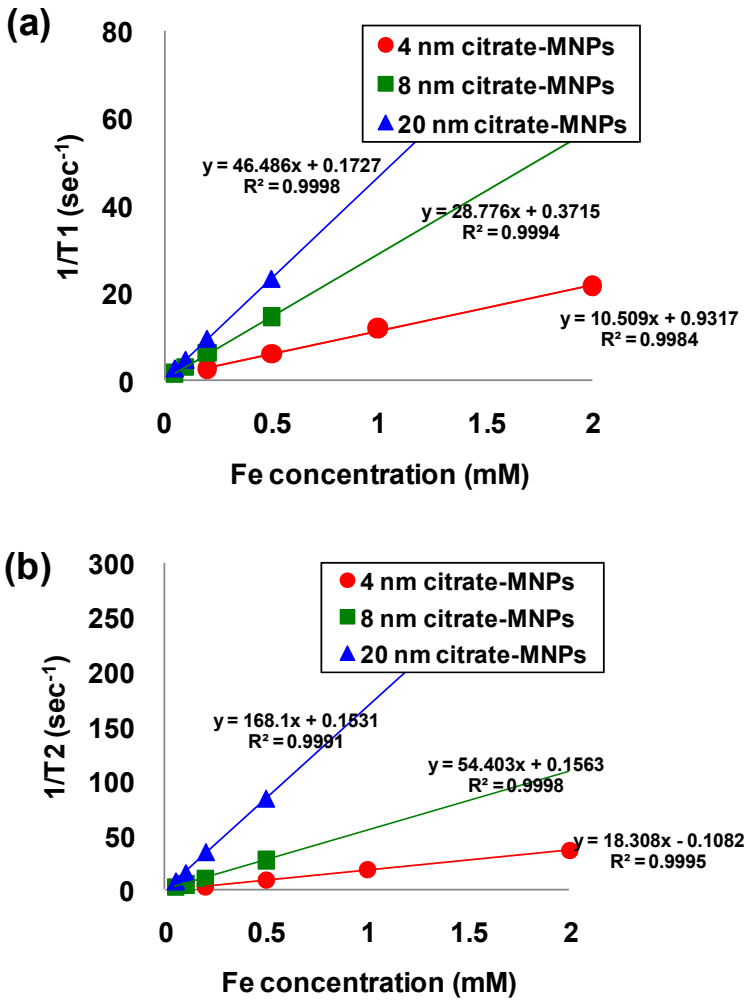

Figure S2. Inverse longitudinal and transverse relaxation times (a) 1/T1 and (b) 1/T2 for 4nm (red, circle), 8 nm (green, square) and 20 nm (blue, triangle) citrate-MPs as a function of the Fe concentration.