Supporting Information

A pH/Redox-Dual Responsive, Nanoemulsion-Embedded Hydrogel for Efficient Oral Delivery and Controlled Intestinal Release of Magnesium Ions

Yu Huang[a,†], Zewei Wang[a,†], Guiju Zhang[a,b], Jie Ren[a], Li Yu[a], Xuhan Liu[a], Yuanxi Yang[a], Abirami Ravindran,[a] Chloe Wong,[a] and Rongjun Chen[a,*]

[a] Department of Chemical Engineering, Imperial College London, South Kensington Campus, London SW7 2AZ, United Kingdom

[b] School of Light Industry, Beijing Technology and Business University, 11 Fucheng Road, Haidian District, Beijing 100048, P. R. China

* Corresponding author: Dr Rongjun Chen.

Tel: +44 (0)20 75942070

Fax: +44 (0)20 75945638

E-mail: rongjun.chen@imperial.ac.uk

† These authors contributed equally to this work.

Table S1. The formulae of hydrogels with different polymer concentrations.

Hydrogel	PLP (mg)	CDE (mg)	EDC (mg)	NHS (mg)	PLP concentration (wt%)
Gel1	50	13	70	10	5
Gel2	75	19	104	17	7
Gel3	100	26	140	20	9
Gel4	150	38	208	34	13
Gel5	200	50	278	42	17

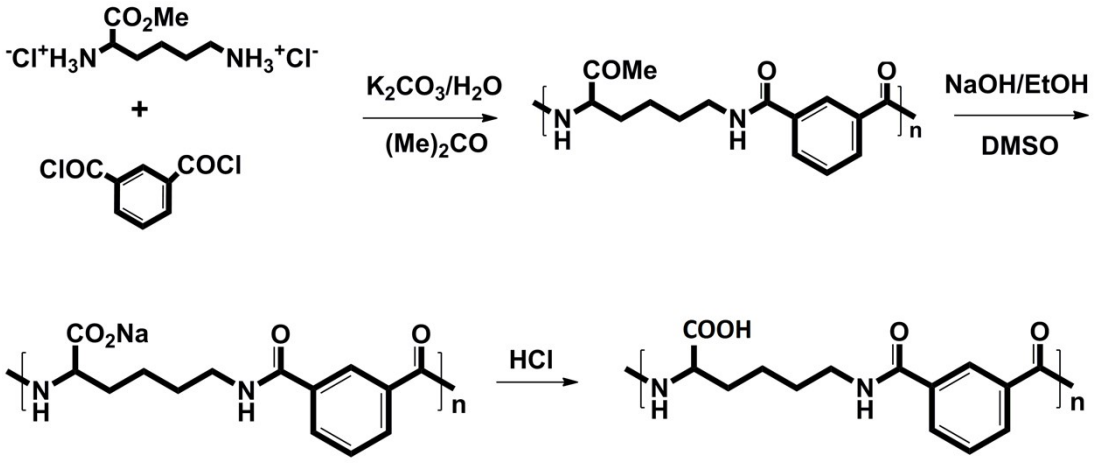

Figure S1. The synthesis route of poly($_L$-lysine isophthalamide) (PLP).

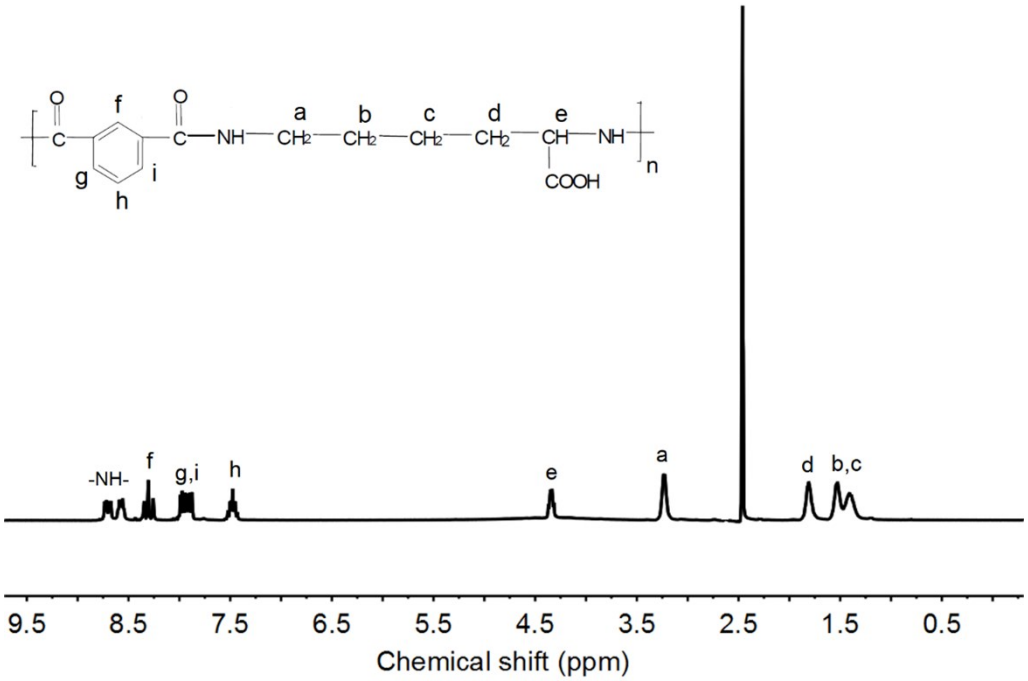

Figure S2. ^{1}H NMR spectrum of PLP (400 MHz, in DMSO-d_6, 298 K). The ^{1}H-NMR spectrum of its acid form in DMSO-d_6 consisted of various peaks as follows: δ (ppm) 1.28-1.64 (b: –CH_2– and c: –CH_2–), 1.76-1.97 (d: –CH_2–), 3.12-3.34 (a: –CH_2–), 4.25-4.43 (e: –CH–), 7.37-7.65 (h: complex multiplet aromatic –C–H); 7.85-8.17 (g and i: complex multiplet aromatic –C–H), 8.23-8.45 (f: complex multiplet aromatic –C–H), 8.53-8.96 (complex series of peaks amide –NH–).

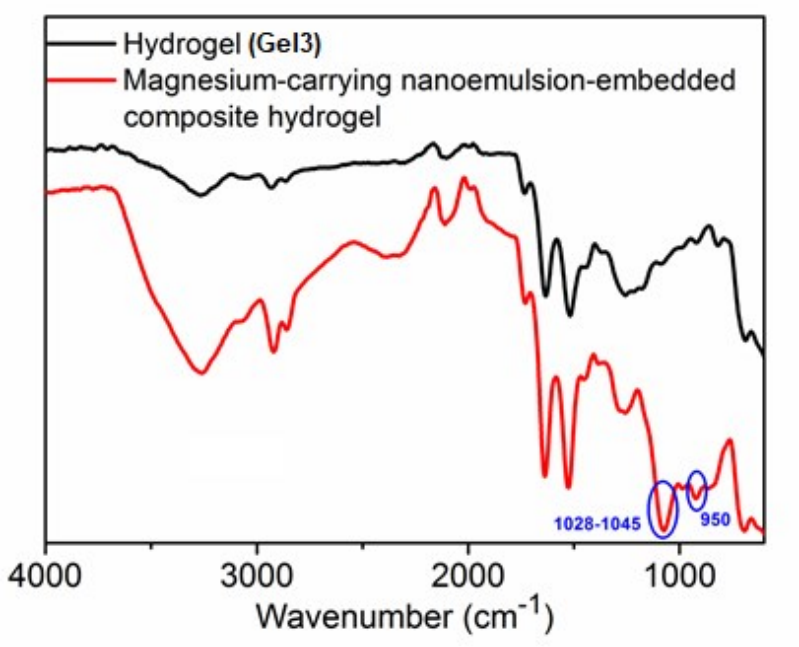

Figure S3. Typical FTIR spectra of the hydrogel Gel3 and the magnesium-carrying nanoemulsion-embedded hydrogel Gel3 (294.7 ± 4.8 mg of loaded magnesium).

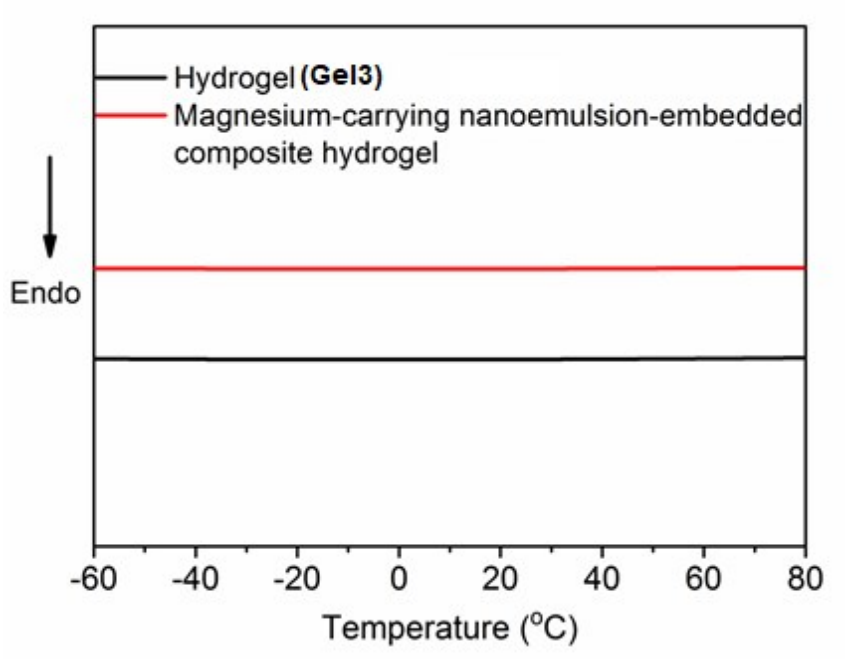

Figure S4. Typical DSC spectra of the lyophilized Gel3 and the lyophilized composite hydrogel Gel3 embedded with magnesium-carrying nanoemulsions (294.7 ± 4.8 mg of loaded magnesium).

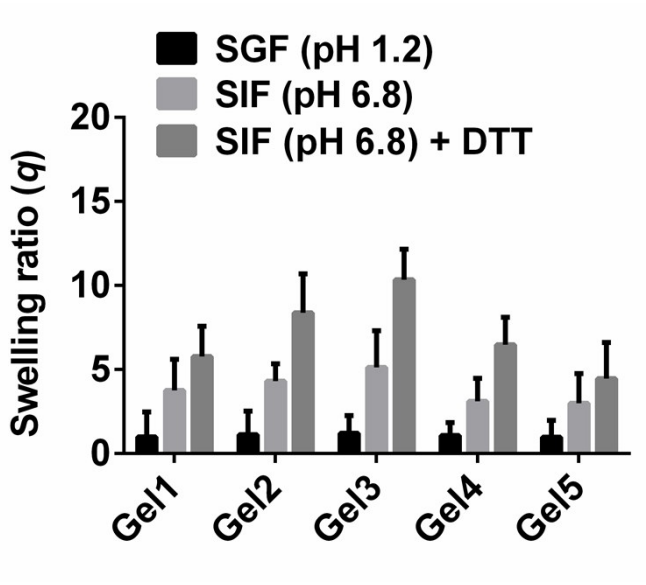

Figure S5. Swelling ratios *q* of different hydrogels with the PLP concentration at 5 wt% (Gel1), 7 wt% (Gel2), 9 wt% (Gel3), 13 wt% (Gel4) and 17 wt% (Gel5) after treatment with SGF (pH 1.2), SIF (pH 6.8) and SIF (pH 6.8) + 125 mM of DTT for 1 h, respectively.

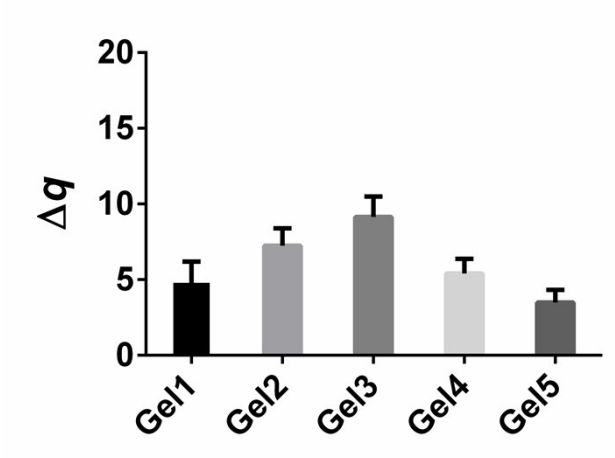

Figure S6. The differences in swelling ratio (Δq) of different hydrogels between treatments in SGF (pH 1.2) and SIF (pH 6.8) + 125 mM of DTT for 1 h.

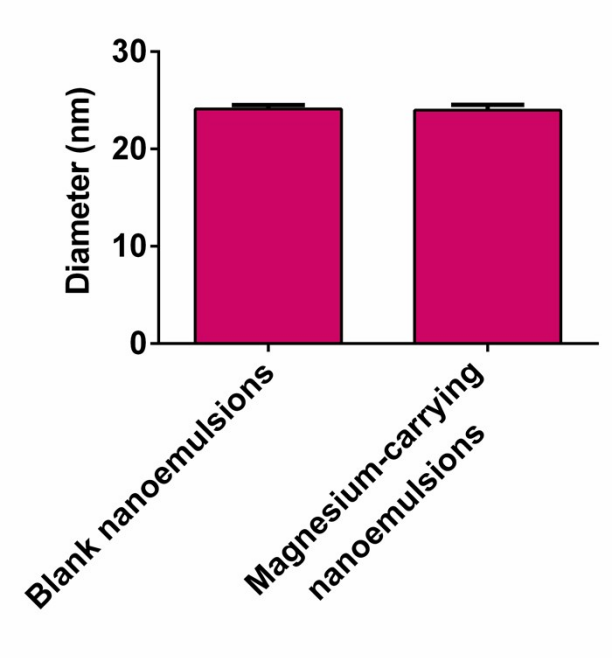

Figure S7. DLS size of blank nanoemulsions and magnesium-carrying nanoemulsions (294.7 ± 4.8 mg of loaded magnesium) in pH 7.4 PBS buffer.

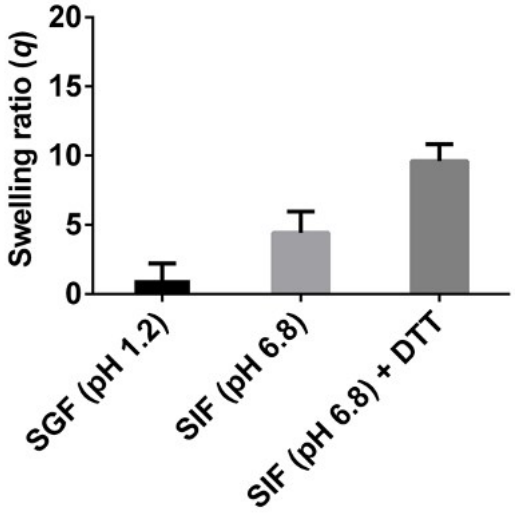

Figure S8. Swelling ratios *q* of the magnesium-loaded composite hydrogels after treatment of SGF (pH 1.2), SIF (pH 6.8) and SIF (pH 6.8) + 125 mM of DTT buffer for 1 h, respectively.

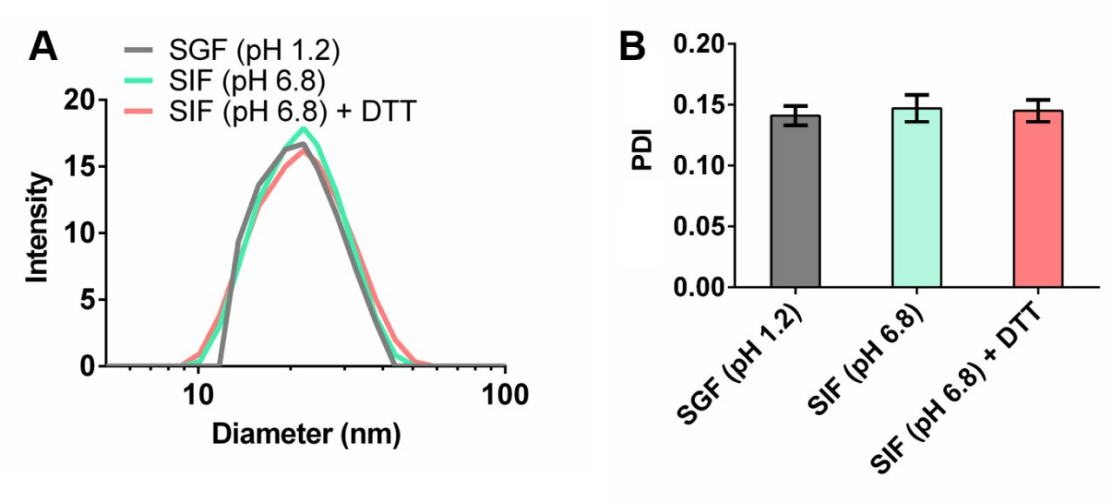

Figure S9. (A) Typical DLS size distribution and (B) PDI of the magnesium-carrying nanoemulsions post release from the composite hydrogels treated in SGF (pH 1.2), SIF (pH 6.8) and SIF (pH 6.8) + 125 mM of DTT, respectively for 6 h.