NANO MICRO small

Supporting Information for:

Magnetic Luminescent Porous Silicon Microparticles for Localized Delivery of Molecular Drug Payloads

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Supplementary Figures:

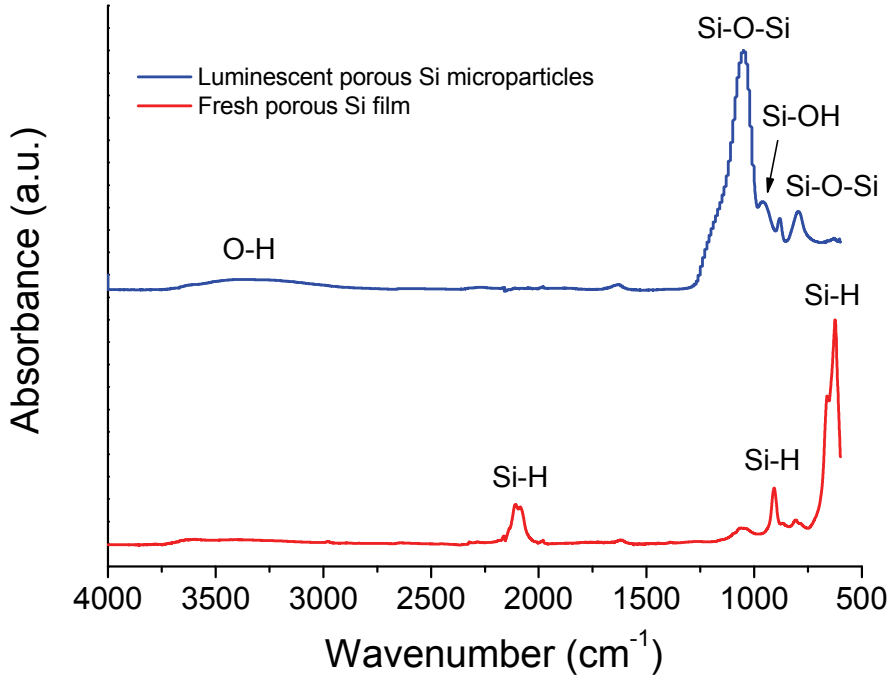

Figure S1. FTIR spectra of porous silicon film and luminescent porous silicon microparticles, prior to loading of magnetite nanoparticles. Oxidation of the porous Si film during microparticle production removes the surface Si-H species and generates a surface oxide.

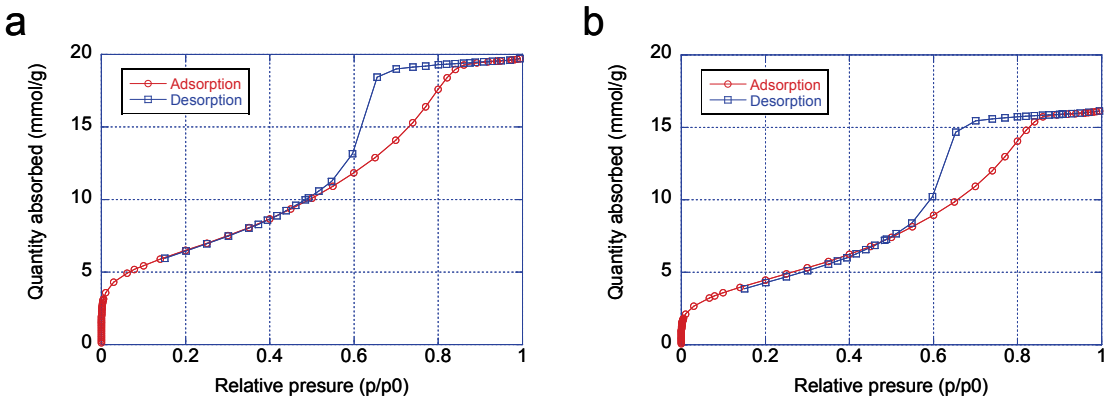

Figure S2. N_2 adsorption/desorption isotherms of porous Si microparticles before (a) and after (b) loading of magnetite nanoparticles. The adsorption/desorption measurements reveal a type IV isotherm with a pronounced hysteresis loop, indicating the nanostructure of the microparticles is mesoporous (pore diameters 2-50 nm). The specific surface area (BET method) and pore volume (BJH method) are 520 m^2/g and 0.712 cm^3/g, respectively for the material before loading of magnetite. After loading of magnetite, the specific surface area (373 m^2/g) and pore volume (0.577 cm^3/g) are decreased. Based on the BJH model, the average pore size of the luminescent porous Si microparticles does not change significantly upon loading of iron oxide nanoparticles: calculated diameters before and after loading are 4.67 and 4.95 nm, respectively. Note: the calculated pore sizes are different from the SEM results because the BJH model includes the branched pores inside the microparticles and it may not be an ideal fitting for this material.

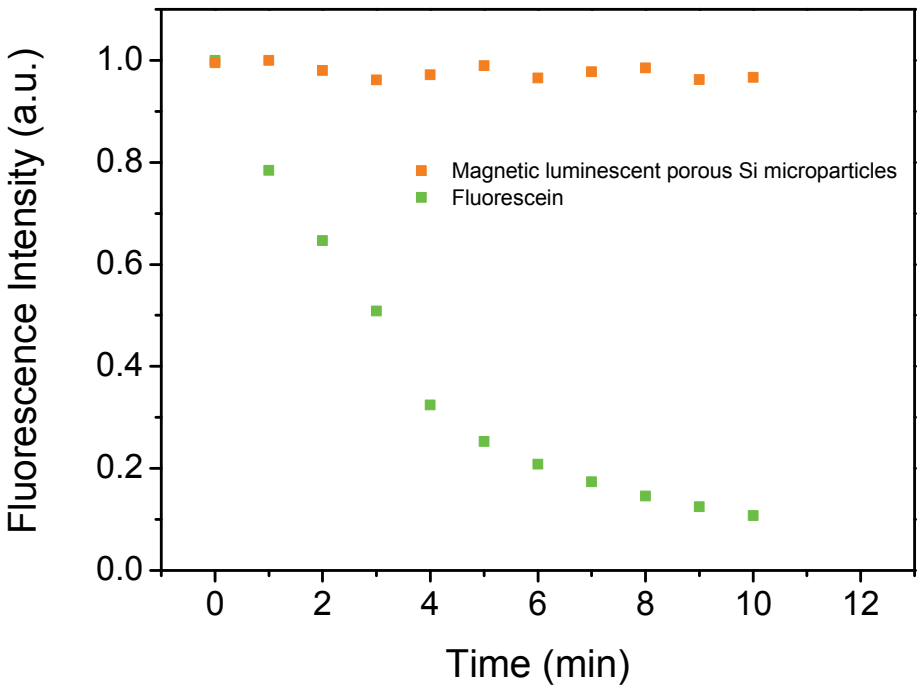

Figure S3. Intensity of fluorescence as a function of time for magnetic, luminescent porous Si microparticles compared with the organic dye fluorescein absorbed on silica microbeads. Both samples were dispersed on glass slides and exposed to a 100 W mercury lamp for the duration of the experiment. The significant decrease of fluorescence intensity of the fluorescein sample is attributed to photobleaching induced by oxygen and oxygen-induced free radicals.[1]

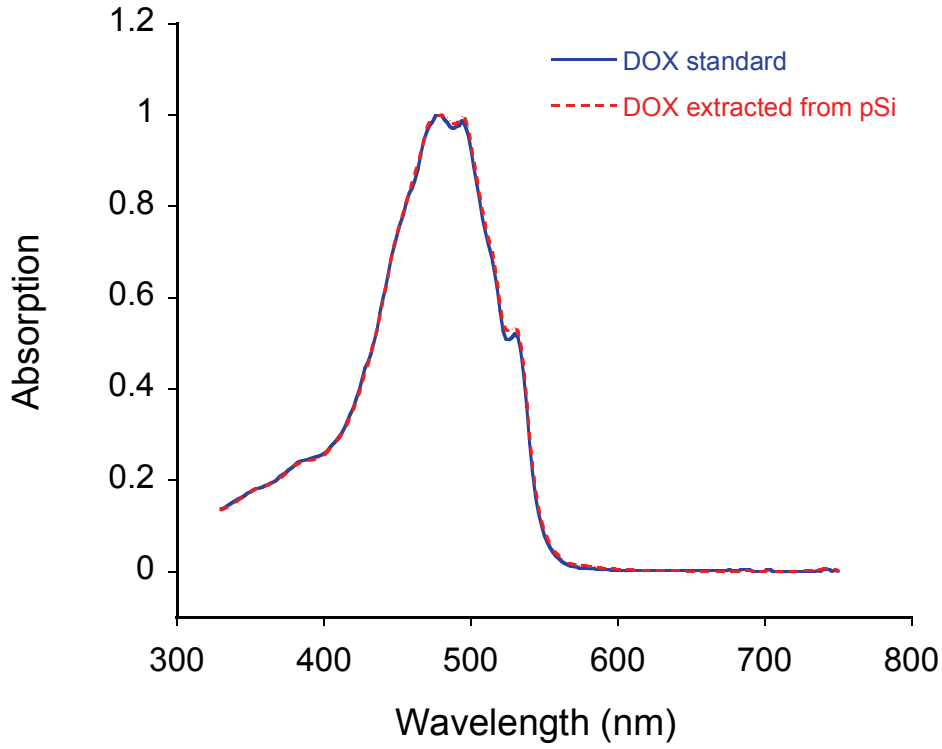

Figure S4. UV-Vis absorption spectra of DOX standard in ethanol and DOX extracted from DOX loaded magnetic luminescent porous Si microparticles in ethanol. The spectra are normalized for comparison.

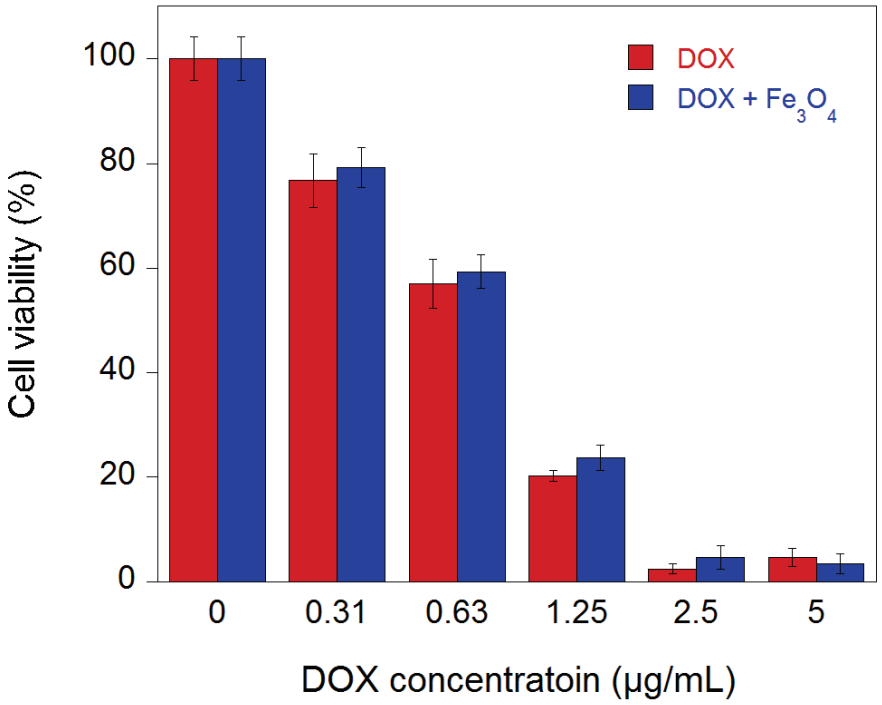

Figure S5. In vitro cytotoxicity of doxorubicin (DOX) alone compared to DOX plus iron oxide nanoparticles (the mass ratio of DOX to Fe_3O_4 is 98:8, which is the same as that loaded in the porous Si particles) towards HeLa cells, determined by MTS assay.

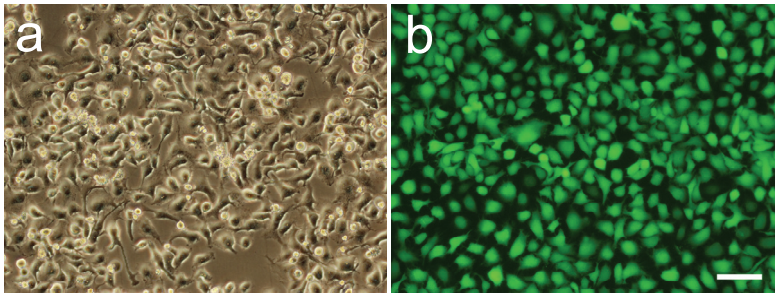

Figure S6. (a) Phase contrast and (b) fluorescence microscope images of a control dish of HeLa cells (24 h incubation with 1 μg/mL free DOX). The image is representative of the entire dish, which shows no significant variation in cell morphology or fluorescence intensity as a function of position. Scale bar for all images is 100 μm.

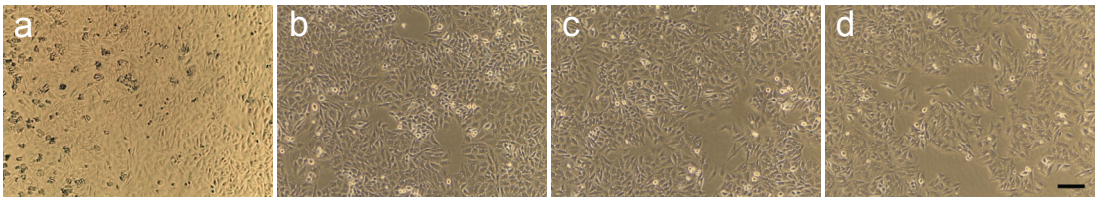

Figure S7. Phase contrast microscope images of HeLa cells after 24 h incubation with drug-free magnetic, luminescent porous Si microparticles. The particles were accumulated at the edge of the Petri dish under the influence of a magnet, similar to the experiment represented by Figure 4. Images (a-d) were obtained at the same locations of the Petri dish as illustrated in Figure 4i. Scale bar is 100 μm.

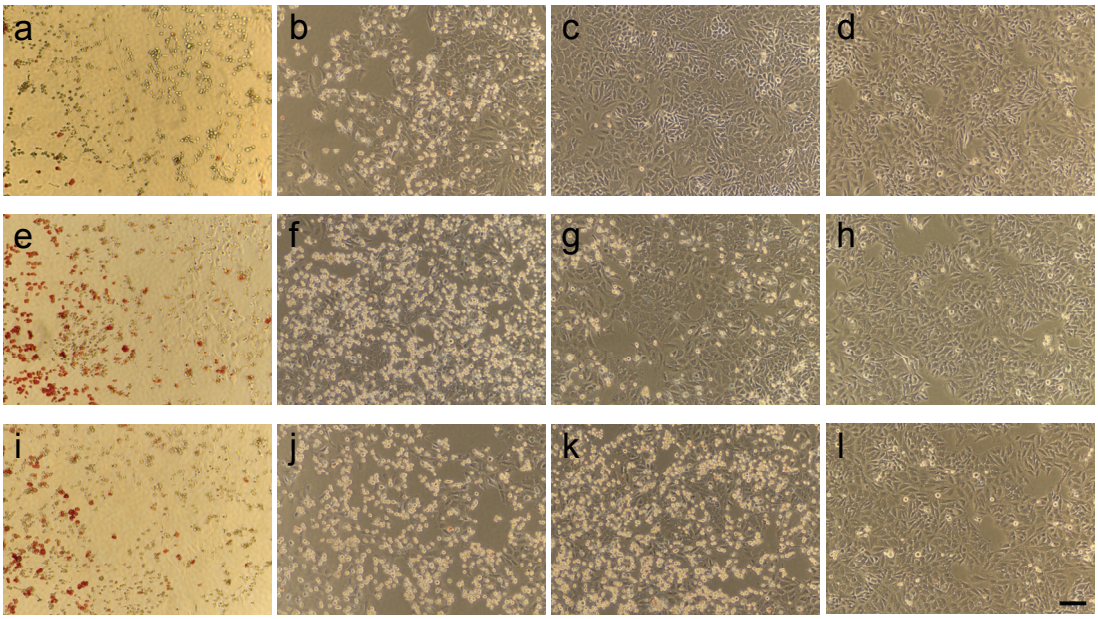

Figure S8. Phase contrast microscope images of HeLa cells after 8 h incubation with different quantities of DOX-loaded magnetic, luminescent porous Si microparticles. (a-d): 0.1 mg particles; (e-h): 0.2 mg; (i-l): 0.4 mg. The microparticles, visible as reddish flakes on the left hand side of images (a), (e), and (i), were attracted with a magnet to an edge of the Petri dish during incubation. Images (a-d) were obtained at different locations of the Petri dish as illustrated in Figure 4i. Images (e-h) and (i-l) were obtained at locations corresponding to (a-d), respectively. Scale bar is 100 μm.

Supplementary methods:

Characterization: The Fourier-transform infrared (FTIR) spectra of as-etched porous silicon films and luminescent porous Si microparticles were obtained in absorption mode using a Thermo Scientific Nicolet 6700 FTIR spectrometer equipped with a diamond attenuated total reflectance (ATR) accessory. N_2 adsorption isotherms (interpreted with the BET and BJH models) were measured on a Micromeritics ASAP2020 analyzer. The photostability of magnetic, luminescent porous Si microparticles was evaluated relative to the organic fluorophore fluorescein absorbed on silica microbeads. Both samples were dispersed on glass slides and were illuminated with a 100 W mercury lamp, and fluorescence intensities were monitored periodically (1 m intervals) during the experiment using a fluorescence microscope (Eclipse LV150, Nikon) equipped with a thermoelectrically cooled CCD camera (CoolSNAP HQ2, Photometrics). Excitation (355 ± 25 nm for magnetic, luminescent porous Si microparticles, 480 ± 20 nm for fluorescein) and emission (435 nm long pass for magnetic, luminescent porous Si microparticles, 535 ± 25 nm for fluorescein) filters were used for these experiments.

In vitro cytotoxicity of DOX and DOX with magnetite: HeLa cells were incubated with different concentrations of free DOX or a mixture of DOX and iron oxide nanoparticles for 48 h. Cytotoxicity was evaluated using MTS assay (Promega). The mass ratio of DOX to iron oxide was fixed at 98:8, which is the same as in the loaded porous Si microparticles.

Localized delivery of DOX to HeLa cells: HeLa cells were seeded into 60-mm Petri dishes with 4 mL of cell media and cultured for 2 days (the cell confluency was ~ 90%). The magnetic luminescent porous Si microparticles (DOX-loaded or drug-free, 0.1 mg to 0.4 mg, depending on the experiment) were then added and attracted to an edge of the Petri dish with a rare-earth permanent magnet. The Petri dish was agitated

for 1 min with the magnet attached and then incubated at 37 °C for 8 or 24 hours without any agitation. Cell viability was examined by observing morphology of the cells using a phase contrast microscope (TE 300, Nikon) and by a fluorescent viability stain assay (Calcein AM, Invitrogen, inc.).

References:

[1] H. Giloh, J. W. Sedat, *Science* **1982**, *217*, 1252.