Biocompatible calcium ion-doped magnesium ferrite nanoparticles as a new family of photothermal therapeutic materials for cancer treatment

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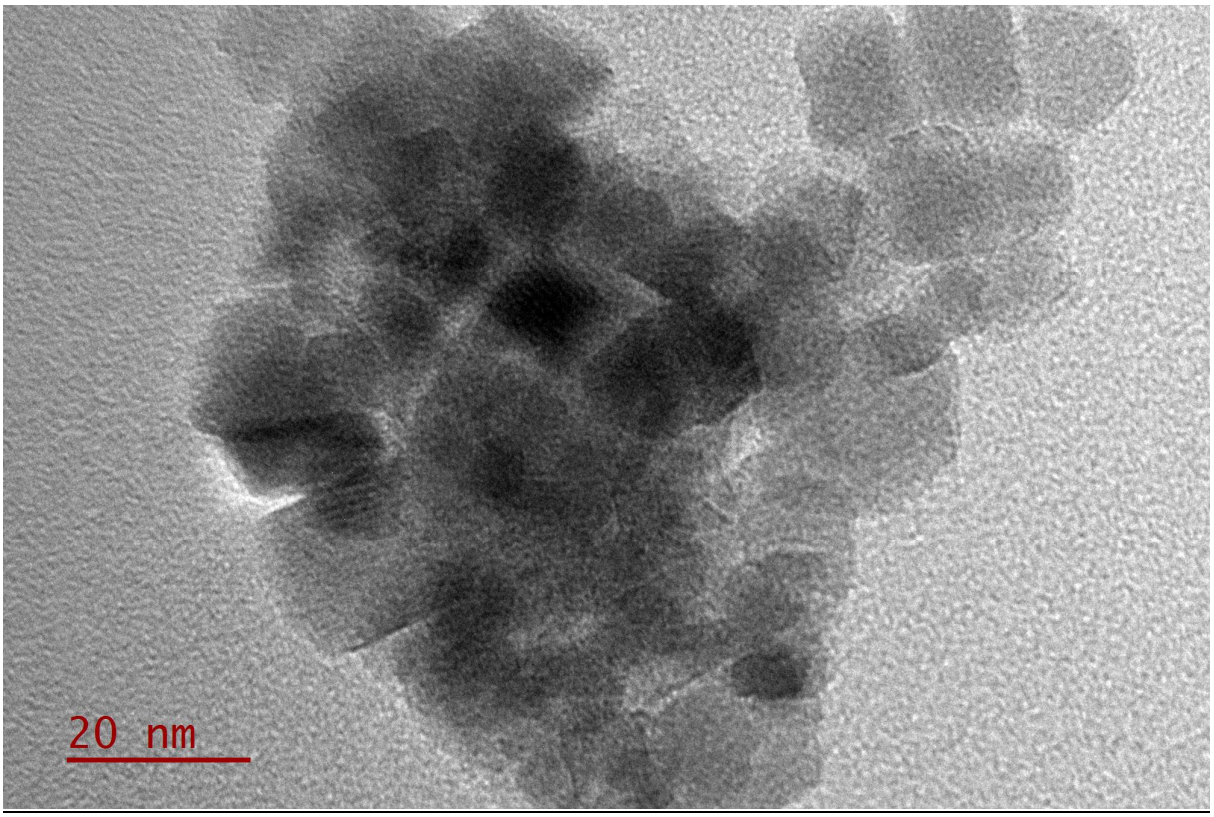

Figure S1. TEM image of Ca^{2+}-doped $MgFe_2O_4$ NPs.

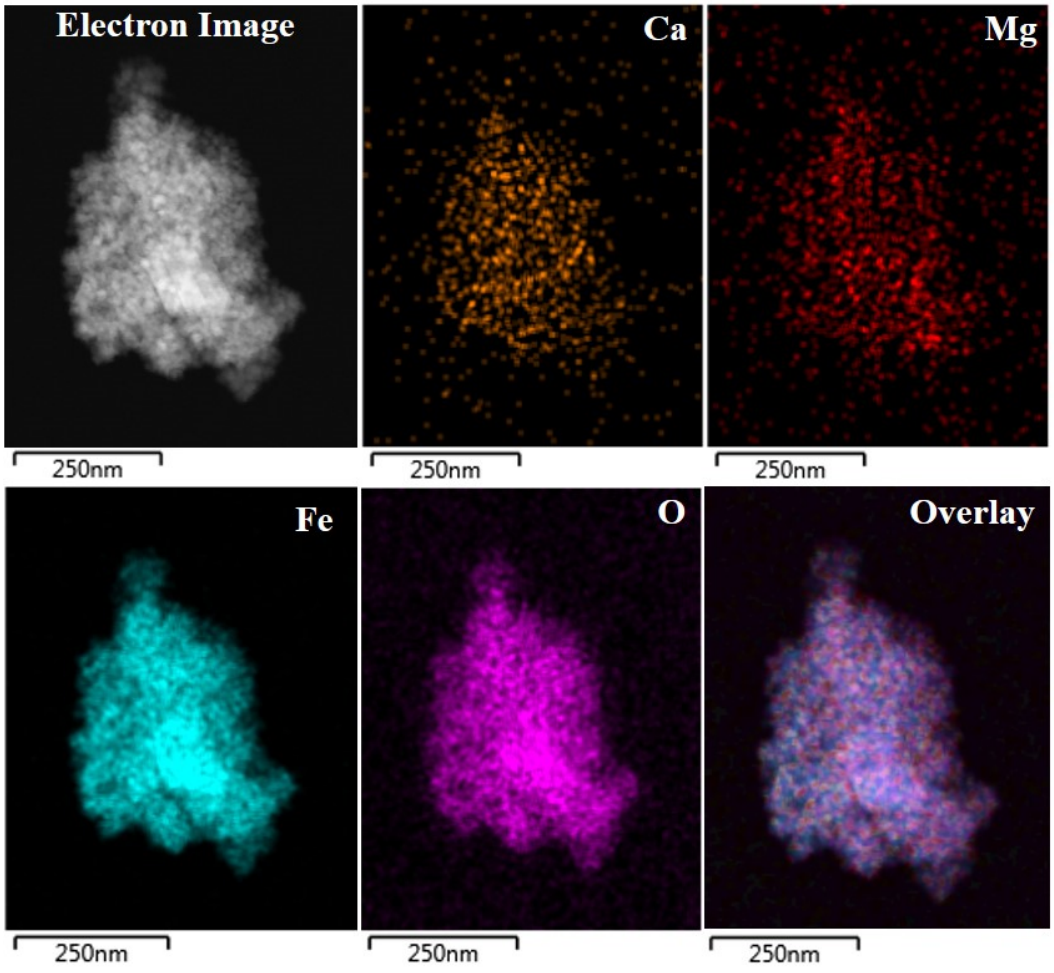

Figure S2. Cs-corrected FETEM with EDX mapping.

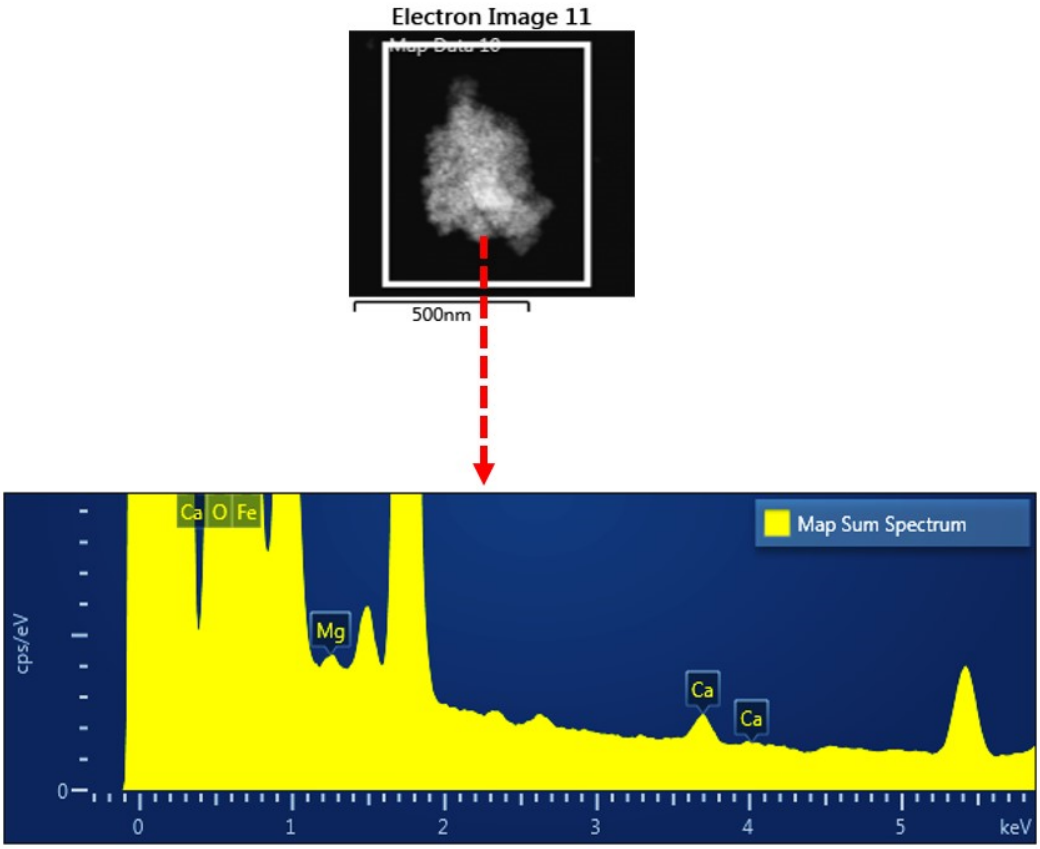

Figure S3. Cs-corrected FETEM with EDX spectroscopy.

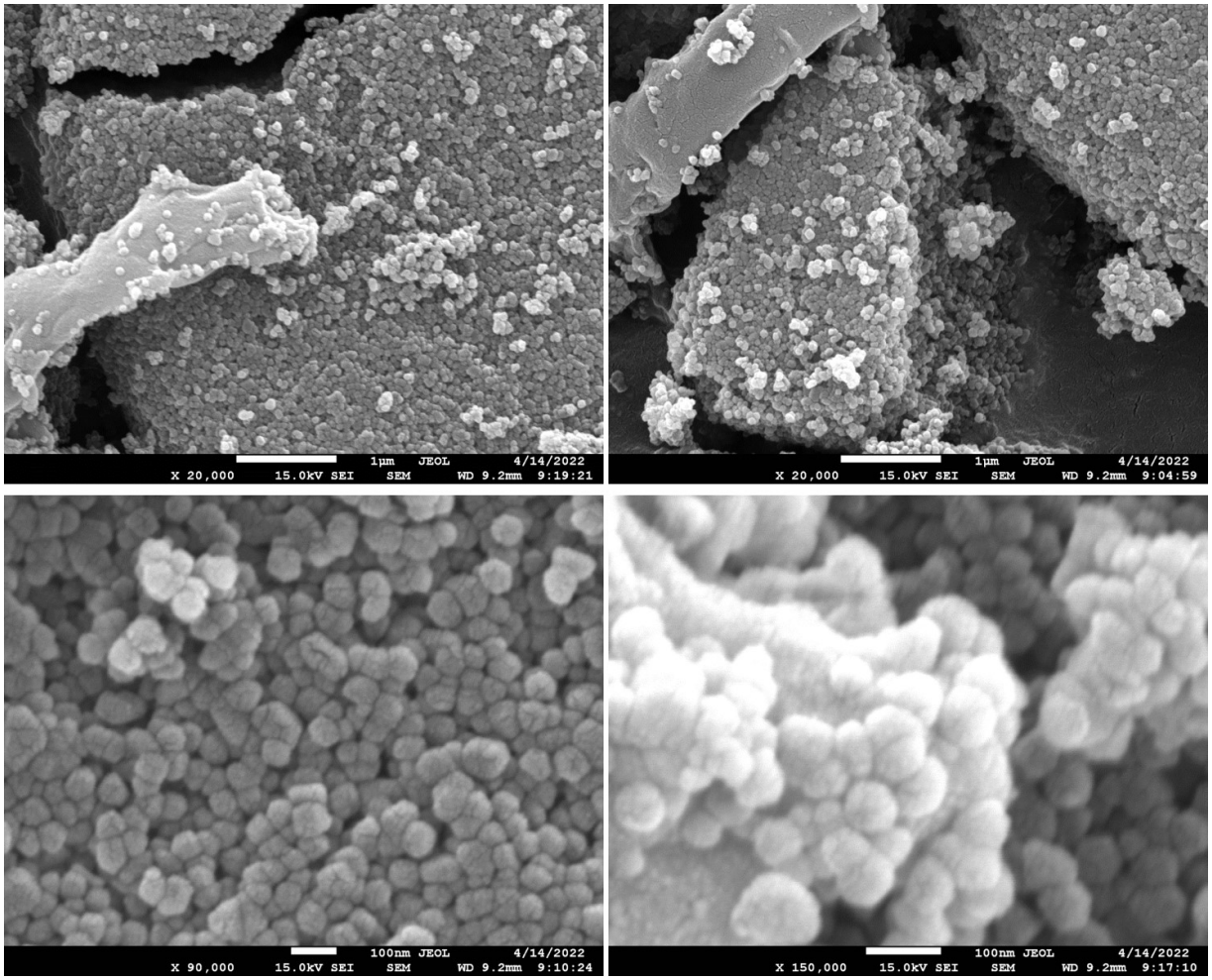

Figure S4. SEM images of Ca^{2+}-doped $MgFe_2O_4$ NPs.

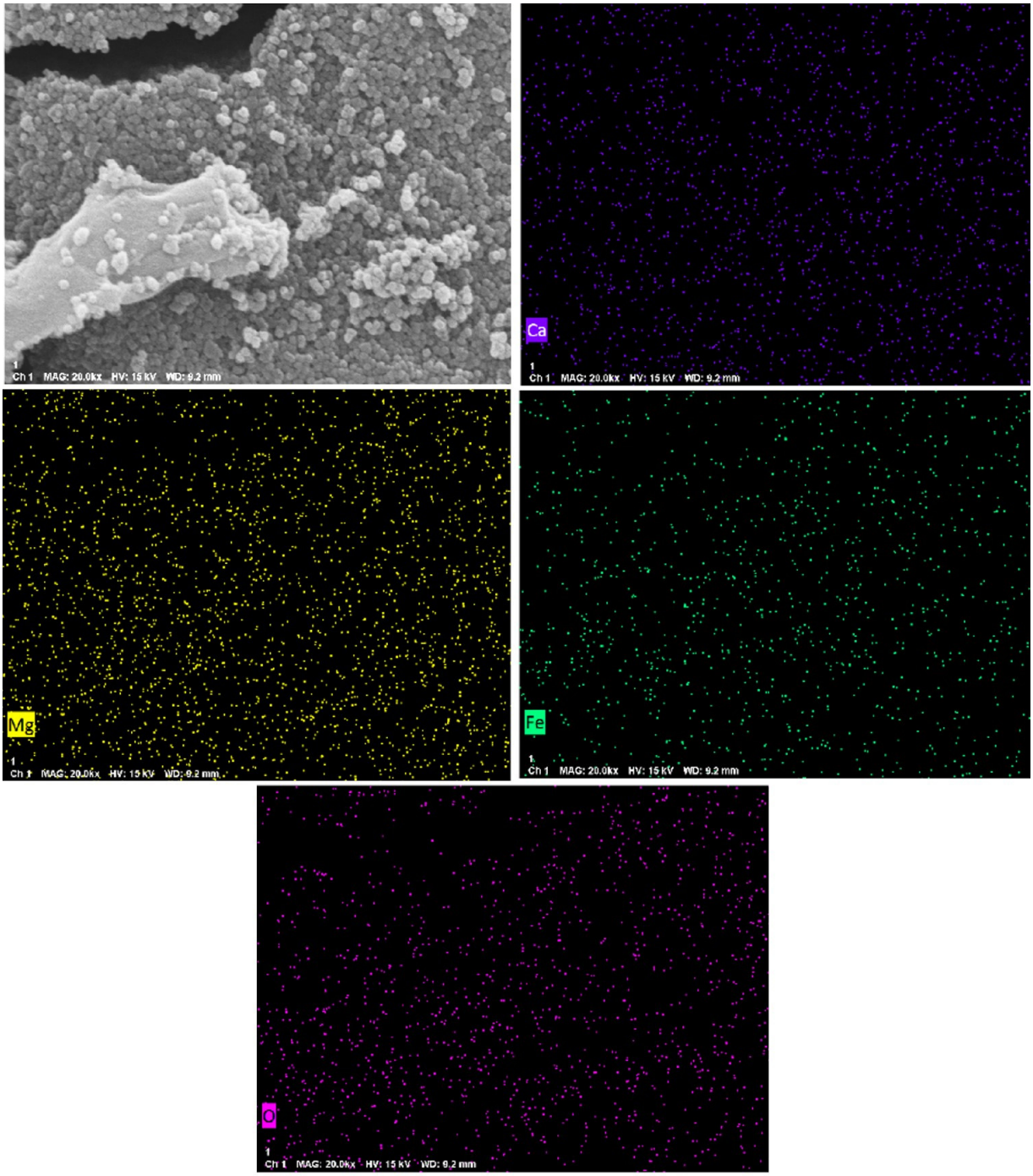

Figure S5. SEM with EDX mapping of Ca^{2+}-doped $MgFe_2O_4$ NPs.

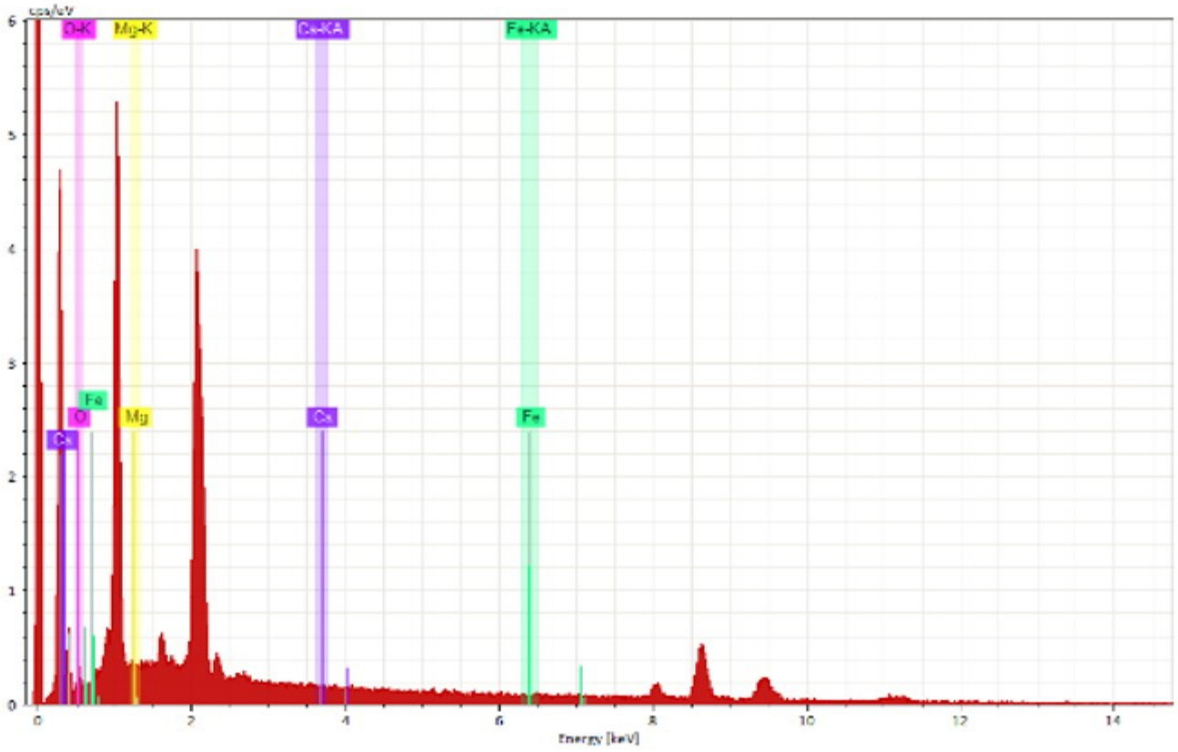

Figure S6. SEM-EDX spectra of Ca^{2+}-doped $MgFe_2O_4$ NPs.

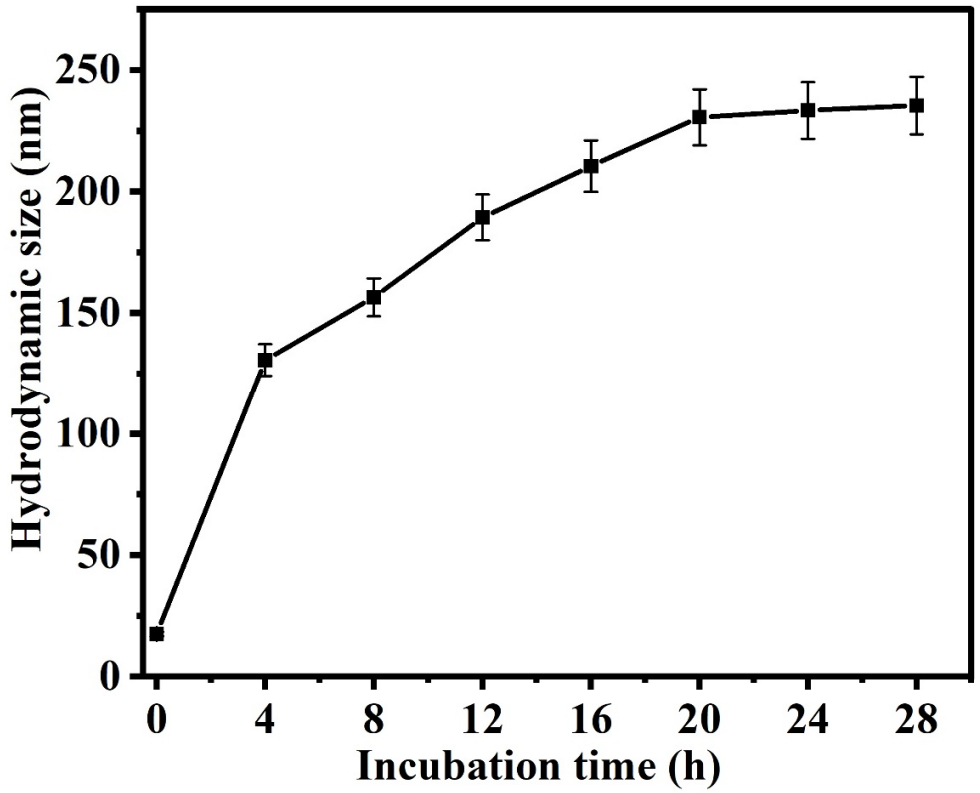

Figure S7. Hydrodynamic size of Ca^{2+}-doped $MgFe_2O_4$ NPs after incubation in RPMI medium supplemented with 10% FBS.

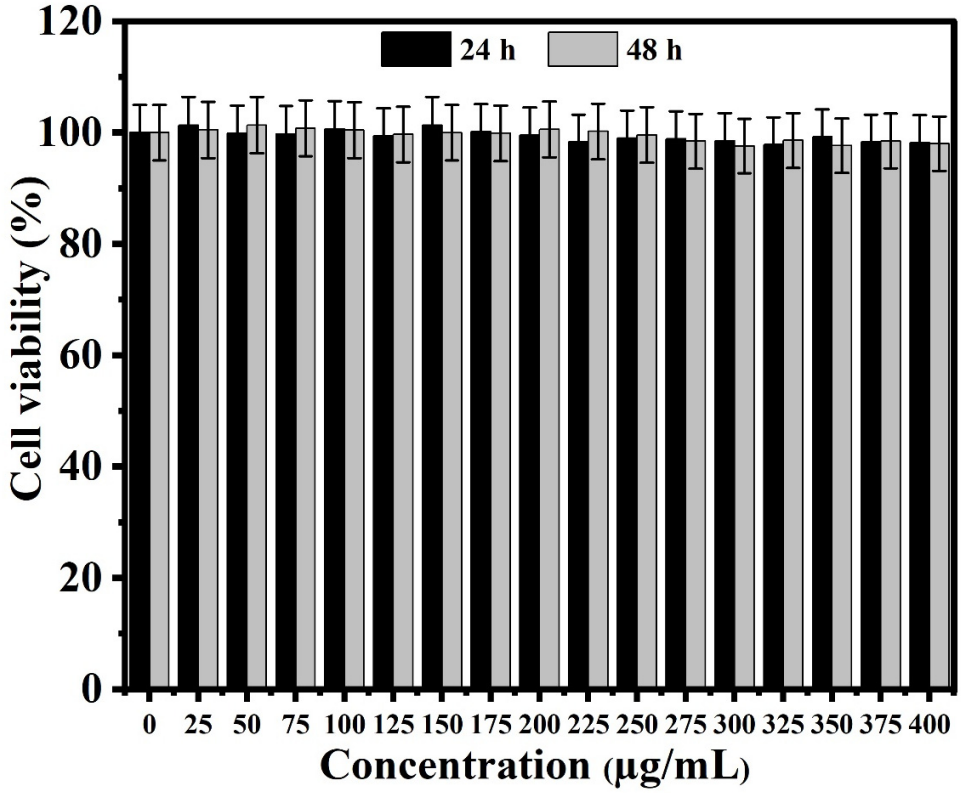

Figure S8. *In vitro* biocompatibility of Ca^{2+}-doped $MgFe_2O_4$ NPs at various concentrations on HDF cells after 24 h and 48 h.

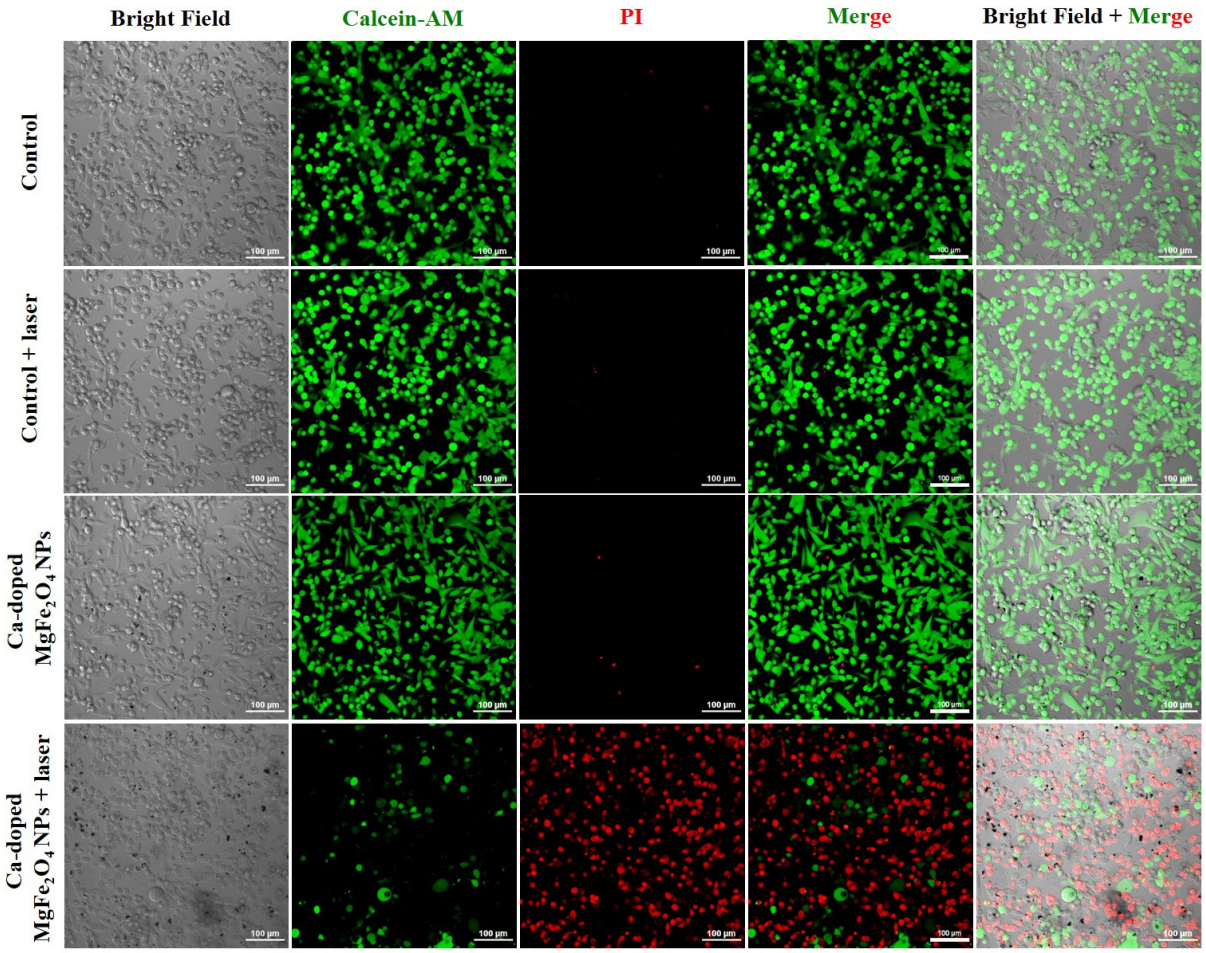

Figure S9. Confocal laser scanning microscope images of MDA-MB-231 cells treated with PBS only, PBS + laser irradiation, Ca^{2+}-doped $MgFe_2O_4$ NPs only, and Ca^{2+}-doped $MgFe_2O_4$ NPs + laser irradiation. Calcein-AM (green) and PI (red) were used to distinguish between live and dead cells (20 × magnification; scale bar: 100 µm).

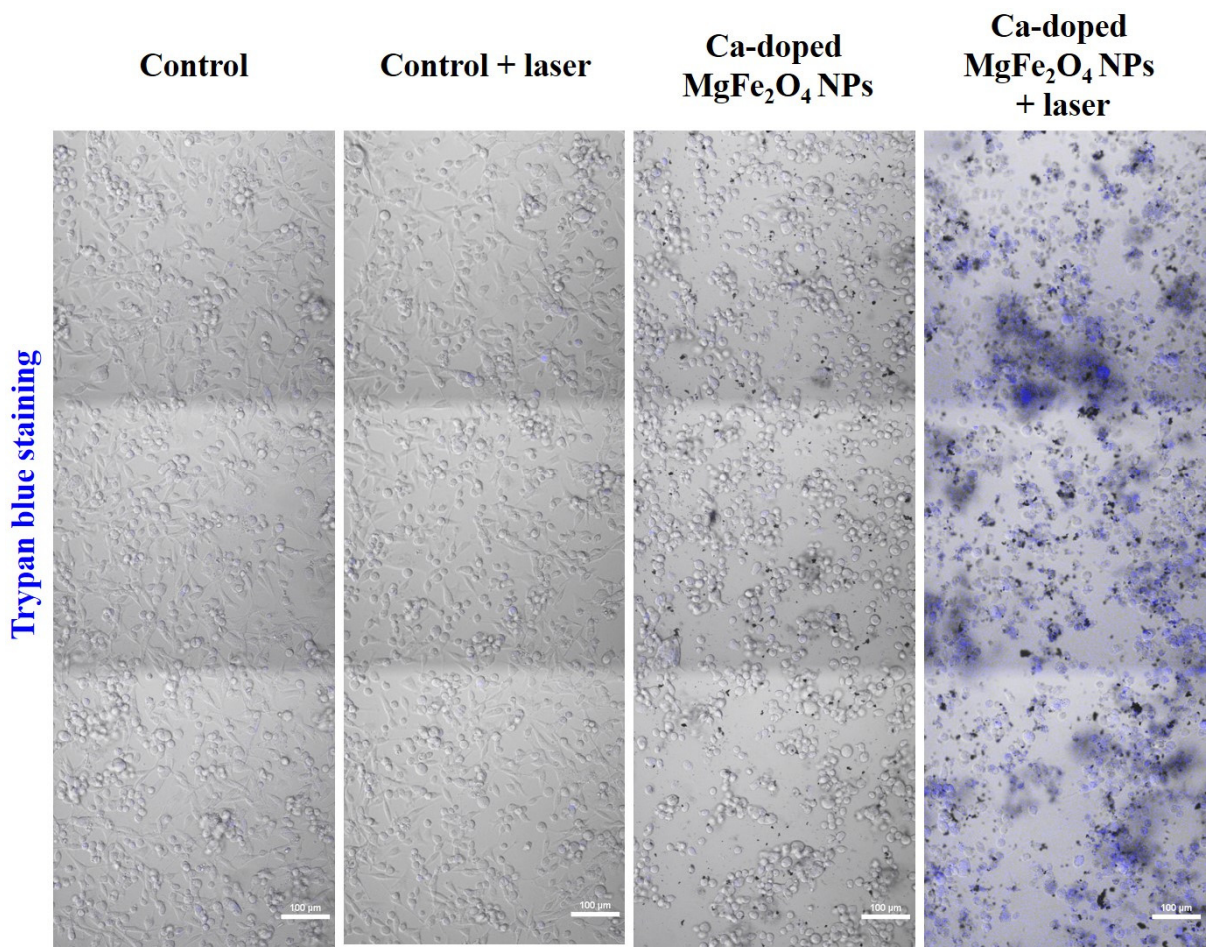

Figure S10. Optical images of trypan blue stained MDA-MB-231 cells treated with PBS only, PBS + laser irradiation, Ca^{2+}-doped $MgFe_2O_4$ NPs only, and Ca^{2+}-doped $MgFe_2O_4$ NPs + laser irradiation (20 × magnification; scale bar: 100 μm).

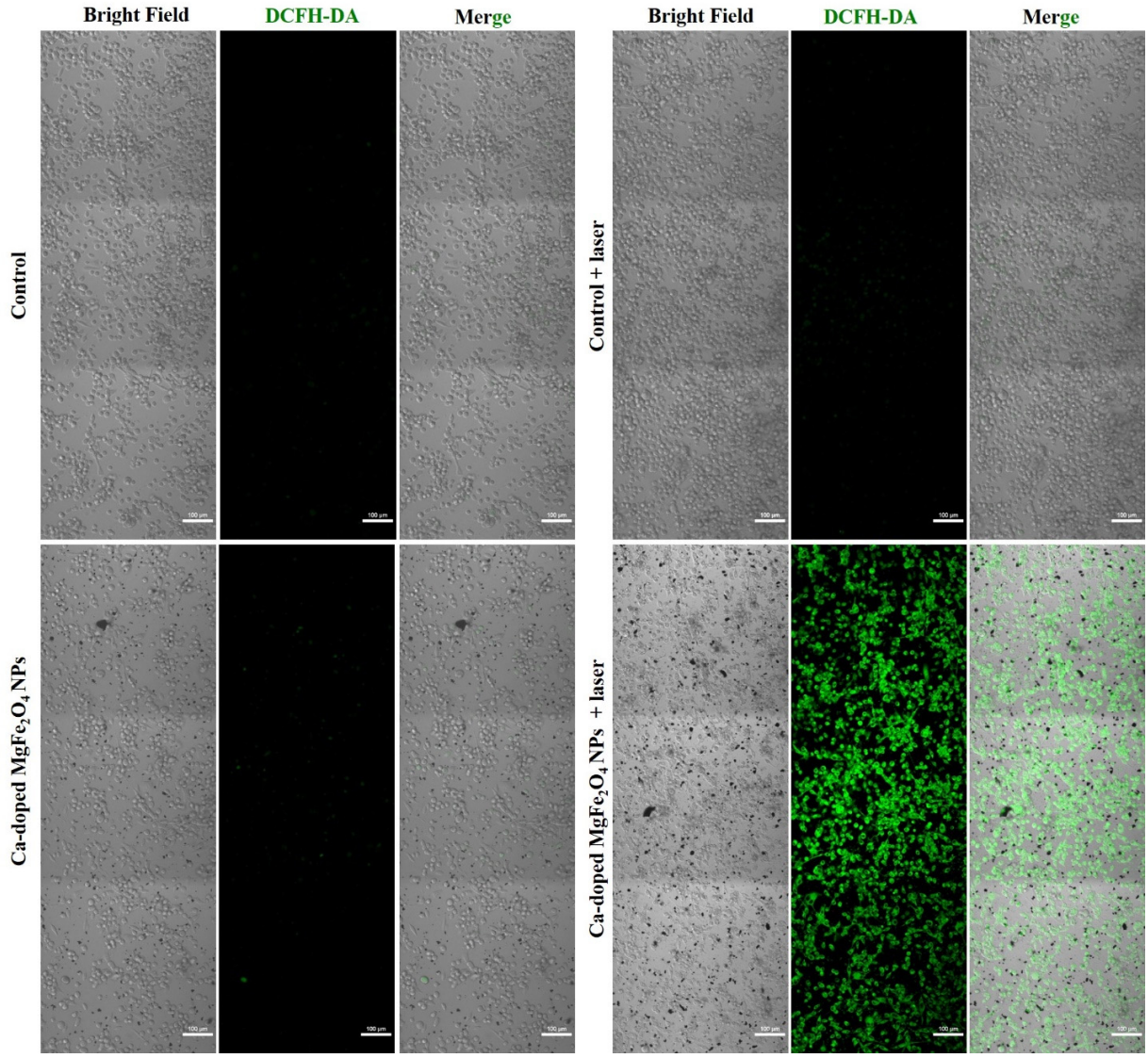

Figure S11. Confocal laser scanning microscopy images of DCFH-DA-stained MDA-MB-231 cells treated with PBS only, PBS + laser irradiation, Ca^{2+}-doped $MgFe_2O_4$ NPs only, and Ca^{2+}-doped $MgFe_2O_4$ NPs + laser irradiation, for determining the intracellular ROS level (20 × magnification; scale bar: 100 μm).

Table S1. Comparative study of the photothermal effect of Ca^{2+}-doped $MgFe_2O_4$ NPs and various ferrite NPs.

NPs	Cell line	*In vitro* biocompatibility test (%)	Laser	Temp (°C)	Photothermal conversion efficiency (η)	*In vitro* PTT (%)	References
Ca^{2+}-doped $MgFe_2O_4$ NPs	MDA-MB-231 cells	94.5%	785 nm, 0.8 W/cm², 5 min	51.7 °C	30.12%	32.37%	
Comparison of various ferrite NPs							
$ZnFe_2O_4$ NPs	A549 cells	> 80%	808 nm, 2.0 W/cm², 10 min	69.0 °C	37.7%	26.9%	[1]
GO/$MnFe_2O_4$ NPs	HeLa cells	> 92%	808 nm, 0.5 W/cm², 10 min	43 °C	-	32.1%	[2]
Bismuth ferrite NPs (BFO NPs)	HepG2 cells	> 90%	808 nm, 1.0 W/cm², 10 min	52.4 °C	51.4%	32.3%	[3]
$MgFe_2O_4$ NPs	HePG2 cells	> 90%	808 nm, 1.0 W/cm², 4 min	45.7 °C	-	12.0%	[4]

References

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