Ge-incorporation into 6-line ferrihydrite nanocrystals

(Electronic Supplementary Information)

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Experimental Procedures

The finally synthesized solution was flocculated by adding several drops of ammonia water and subsequently centrifuged. The supernatant was discarded and washed several times with deionized water and ethanol, and the flocculated sol was immediately dialyzed against deionized water for 3 days. A drop of the dialyzed sample solution was deposited on a Former-backed copper grid for transmission electron microscopy (TEM) and selected area electron diffraction (SAED). The rest of the solution was freeze-dried for characterization analyses.

TEM images and SAED patterns were obtained with an *omega-filter* equipped JEOL JEM-2200FS transmission electron microscope operated at 200KV. XRD and EXAFS experiments were performed at the 8C2 and 7C1 beamlines of the Pohang Accelerator Laboratory in Pohang, Korea. XRD patterns were collected using X-ray beam with λ = 1.5489(1)Å in the range from 8 to 128.5°(2θ) at a step of 0.02° and a measurement time of 4 second per each step. EXAFS spectra were collected in the transmission mode using the powdered samples at room temperature. Ionization chambers were used as detectors for measuring the incident and transmitted X-ray beam intensities. The EXAFS data were analyzed following the standard method of the UWXAFS software package.[1] Conventional X-ray diffraction (XRD) analysis was performed on freeze-dried samples using a MXP 18A RINT-2500 X-ray diffractometer (MAC science, Japan) with Cu-Kα radiation. TG-DTA data were collected in the range of 25~1000°C by the increasement rate of 10°C/min using TG-DTA 2000S (MAC science, Japan). FT-IR spectra were collected using a Perkin-Elmer Paragon 1000 FT-IR spectrometer in the transmission mode on pellets containing 1 mg of sample in 170 mg of a KBr matrix. Samples were heated by the rate of 10°C/min to target temperatures. Magnetization hysteresis loops, and zero-field-cooled (ZFC) and field-cooled (FC) magnetization data as a function of temperature were taken on a Quantum Design MPMS-5T SQUID magnetometer. ZFC magnetization curves were obtained by cooling in zero field from 300 K to 5 K and then by measuring the magnetization at stepwise increasing temperature 5 K to 300 K in a small applied field (100 Oe). The sample was cooled again in the same field, and FC magnetization curves were obtained by measuring at stepwise from 5 K to 300 K. Hysteresis loops were obtained by using maximum applied fields up to 50 KOe at 5 K and 300 K.

References

(1) Stern, E.A.; Newville, M.; Ravel, B.; Yacoby, Y.; Haskel, D. *Physica B* ***1995****, 209*, 117-120.

Results (1) –TEM images

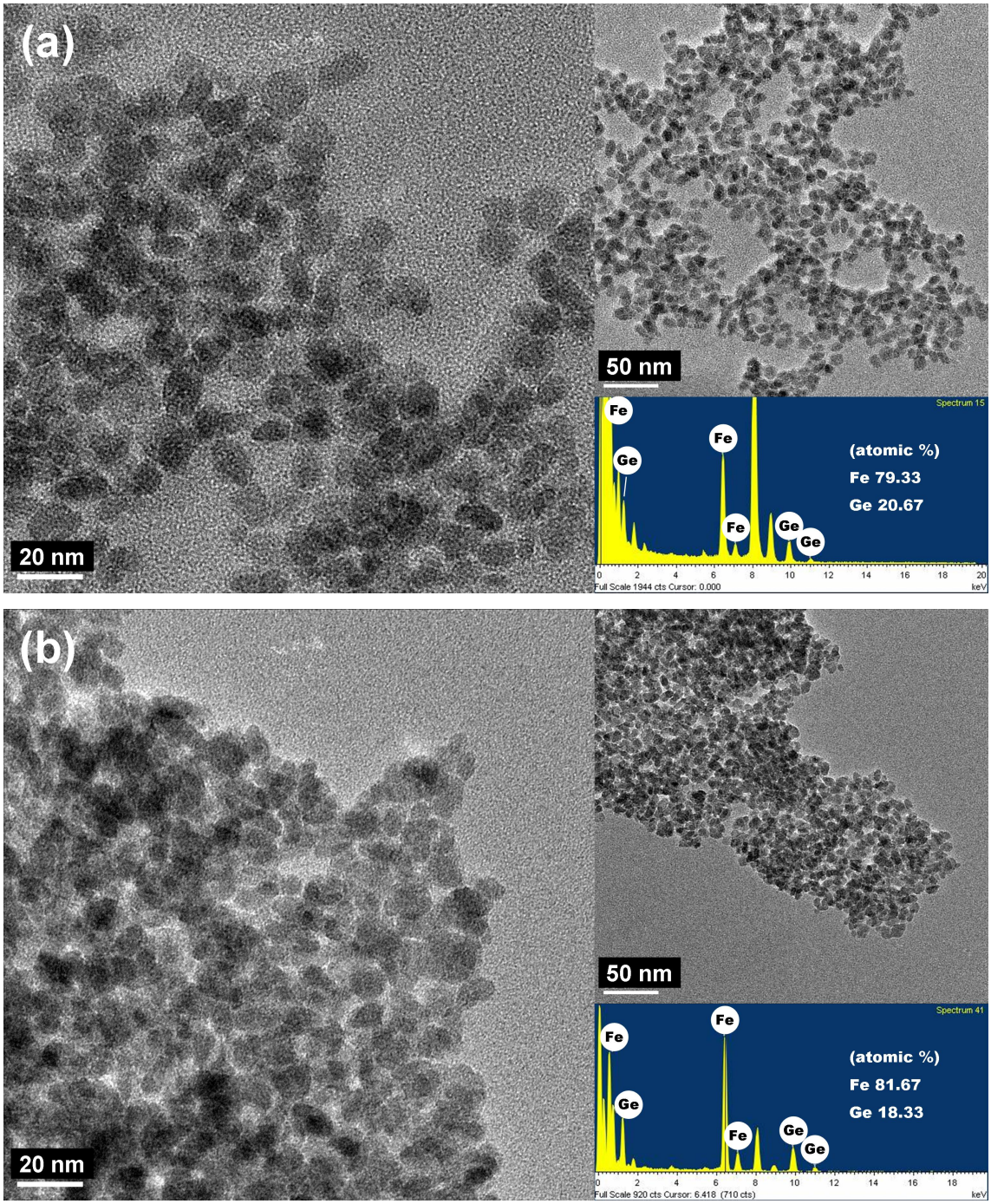

Figure S1. Transmission electron micrographs of Ge-incorporated, nanocrystalline ferrihydrites synthesized under the conditions of (a) Ge-Fh-2 and (b) Ge-Fh-4, with chemical analyses by using EDX.

Results (2) –XRD results

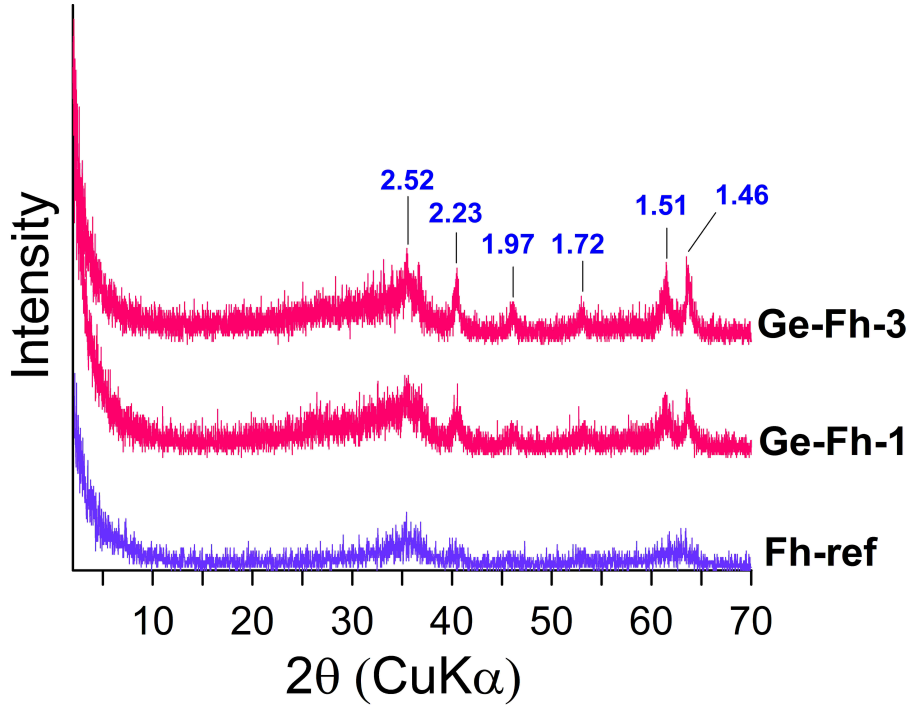

Figure S2. X-ray difraction patterns (Cu-Kα) of Ge-ferrihydrite (Ge-Fh-1 and 3) and reference ferrihydrite (Fh-ref).

Results (3) –EXAFS results

EXAFS result of Ge-Gh-1.

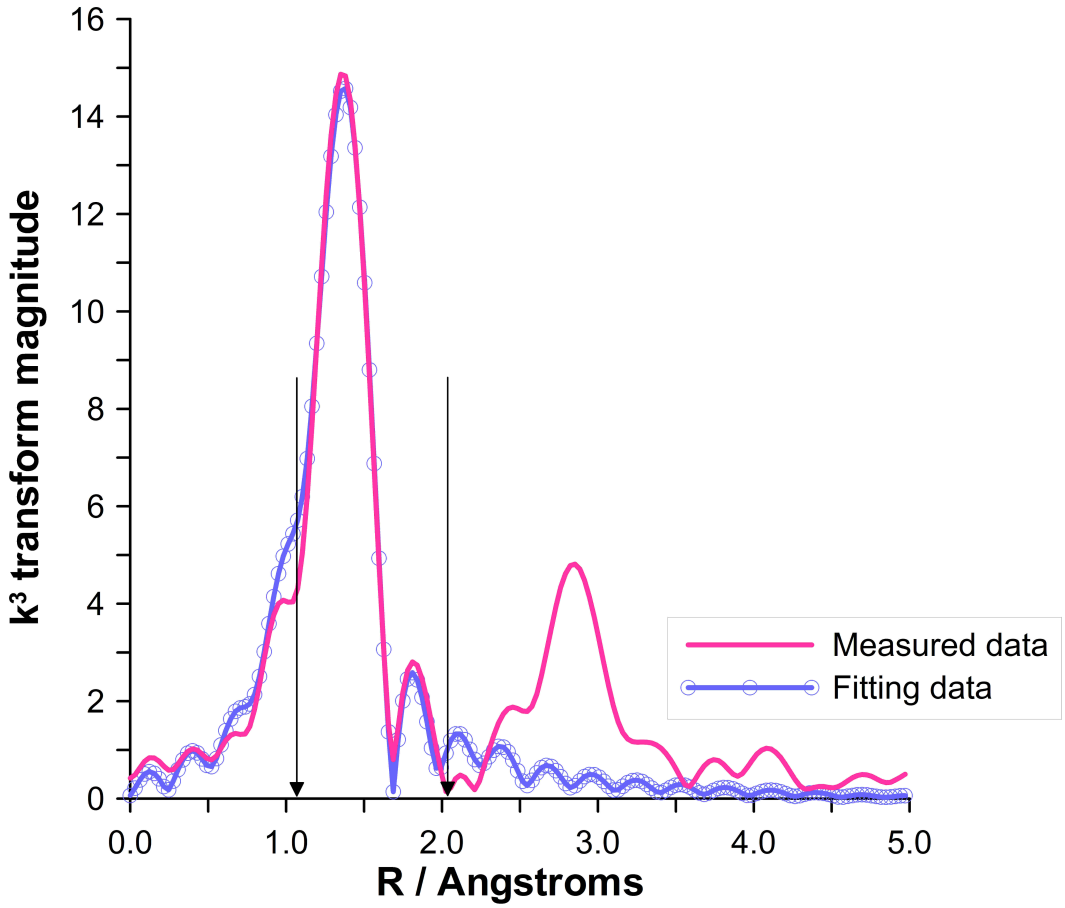

Figure S3. (a) Magnitudes of the Fourier transform of the k^3-weighted Ge K-edge EXAFS spectrum of Ge-ferrihydrite (Ge-Fh-1). The phase shifts were not corrected. The arrows indicate the r-range over which the fit was performed.

Results (4) –TG-DTA analyses

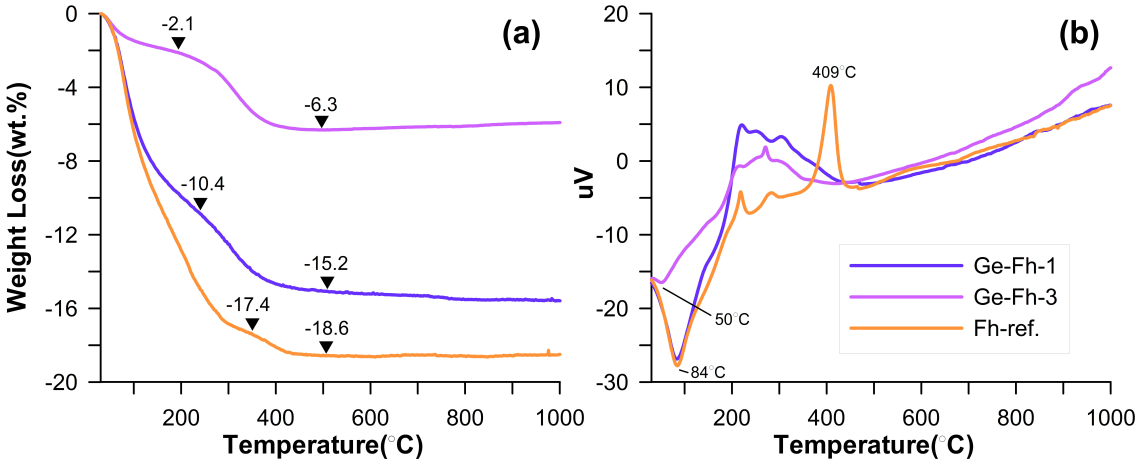

Figure S4. TG (a) and DTA (b) results for the samples synthesized under the conditions of Ge-Fh-1, Ge-Fh-3 and Fh-ref., showing percent weight loss and μV as a function of temperature.

Results (5) –FT-IR analyses

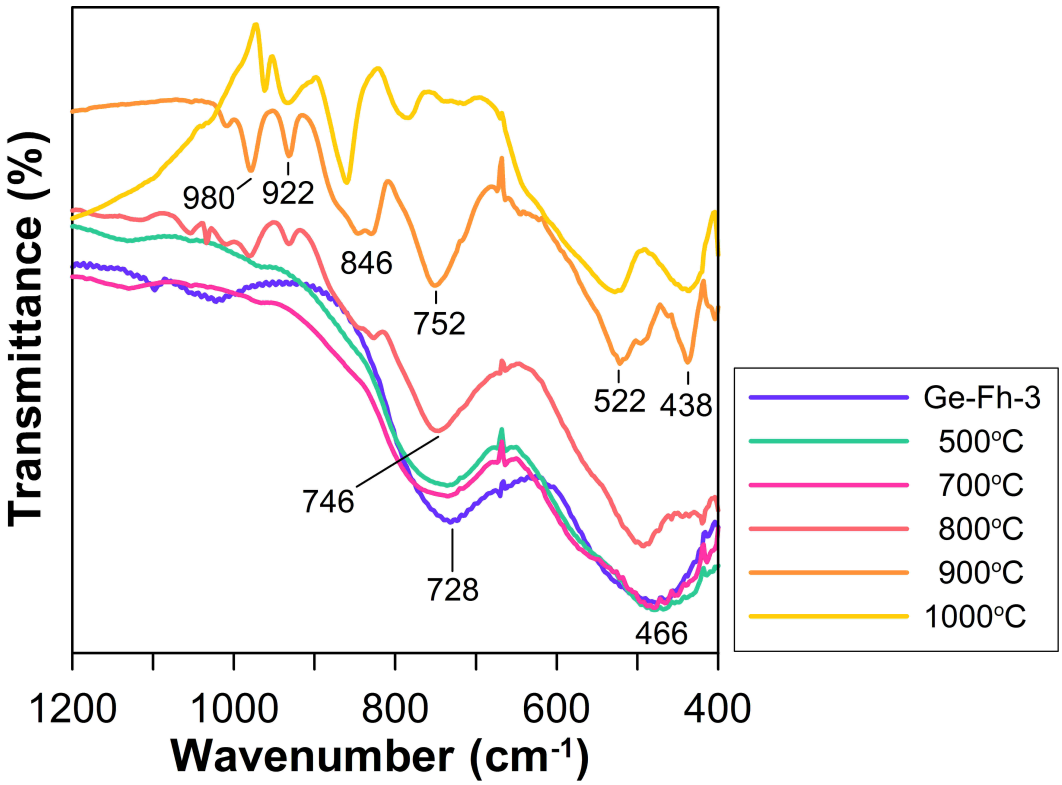

Figure S5. FT-IR spectra of the heat-treated Ge-ferrihydrites of Ge-Fh-3.

Results (6) –Magnetic Property Measurement; ZFC-FC Curves

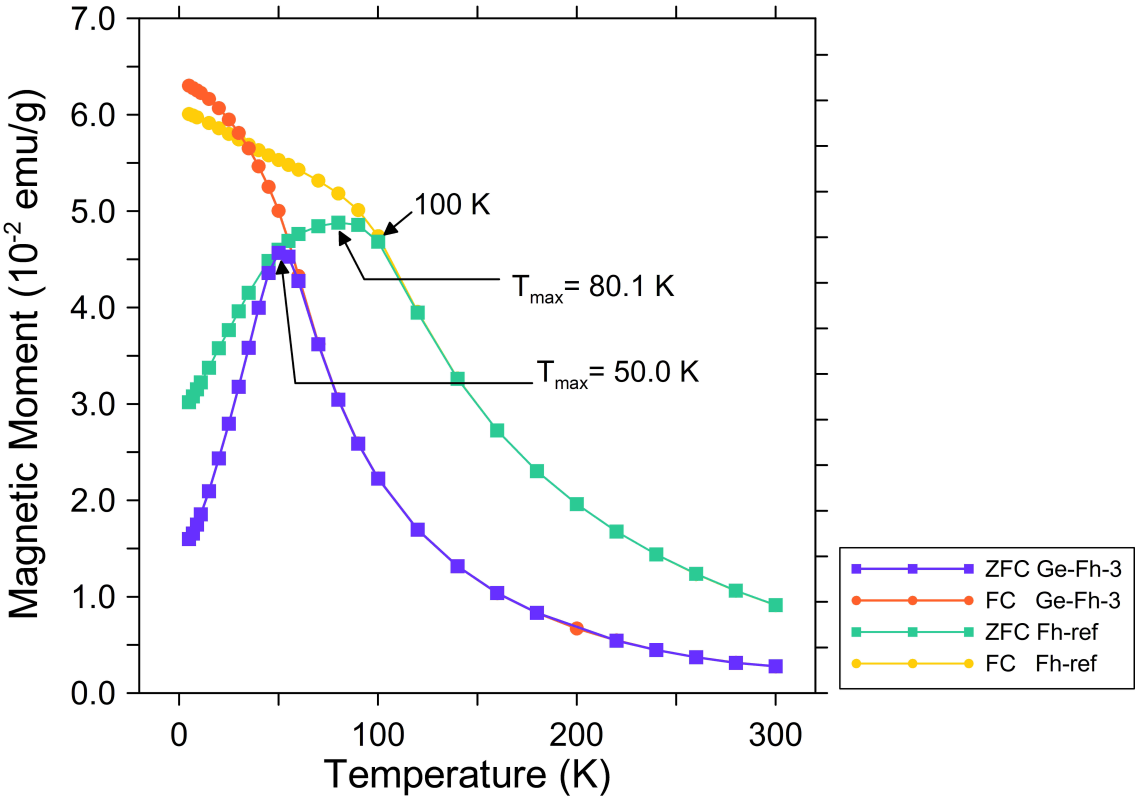

Figure S6. Zero-field-cooled (ZFC) and field-cooled (FC) measurements for Ge-ferrihydrite (Ge-Fh-3) and pure ferrihydrite (Fh-ref).

Results (7) –Magnetic Property Measurement; Hysteresis loops

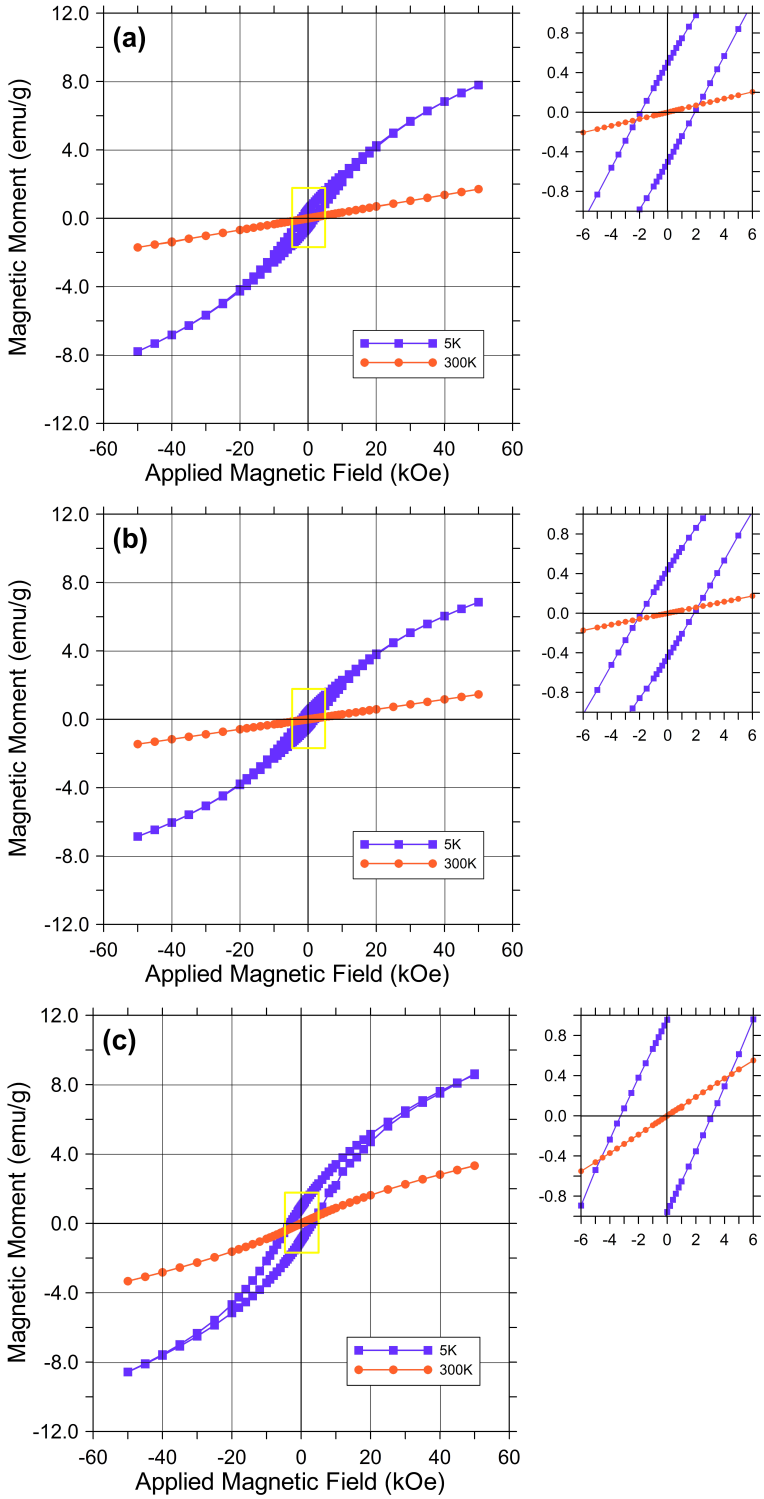

Figure S7. Hysteresis loops for Ge-Fh-1 (a), Ge-Fh-3 (b), and Fh-ref (c). Data were collected at 5 K and 300 K. Hysteresis loops were not reached to saturation at 50 kOe.