Electronic Supplementary Material (ESI) for Materials Horizons.

Supplementary Tables

Sample	cluster beam energy (eV)	Magnesium thickness (nm)	Curie temperature (K)	Sc K-edge position (eV)	Fe K-edge Position (eV)
$Fe_{90}Sc_{10}$-ribbon				4492	7112
Sc_2O_3				4507	-
$Fe_{80}Sc_{20}$	500	200	232	4489.7	7111.8
$Fe_{80}Sc_{20}$	200	200	206	4489.7	-
$Fe_{80}Sc_{20}$	100	200	177	4489.6	7111.8
$Fe_{80}Sc_{20}$	50	200	172	4489.8	7111.8
$Fe_{80}Sc_{20}$	50	10	-	4504.1	-

Table 1: Sc and Fe K-edge position related to the ion beam energy, magnesium layer thickness, and Curie temperature from the ZFC/FC curves.

sample	Fit range (Å)	Path	R (Å) (± 0.1 Å)	N (±1)	σ^2 ($Å^2$)
Sc K-edge					
Ribbon	1.57 – 4.8	Sc - O	2.19	3	0.034
		Sc - Fe_1	2.85	6	0.011
		Sc - Sc	2.74	4	0.007
		Sc - Fe_2	3.67	2	0.012
500 eV	1.48 – 3.7	Sc - Fe_1	2.82	8	0.022
		Sc – Sc_1	3.17	5	0.029
		Sc - Fe_2	3.89	2	0.017
100 eV	1.6 – 3.7	Sc - Fe_1	2.71	4	0.016
		Sc - Sc	3.53	4	0.034
		Sc - Fe_2	3.75	2	0.017
50 eV	1.95 – 3.6	Sc - Fe_1	2.76	3	0.012
		Sc - Sc	3.59	1	0.017
		Sc - Fe_2	3.66	-	-
Fe K-edge					
500 eV	1.35 – 4	Fe - Fe_1	2.43	5	0.0133
		Fe - Sc_1	2.83	4	0.049
		Fe - Sc_2	3.41	4	0.032
100 eV	1.39 – 3.7	Fe - Fe_1	2.41	4	0.0115
		Fe - Sc_1	2.83	-	-
		Fe - Sc_2	3.41	4	0.030
50 eV	1.47 – 3.39	Fe - Fe_1	2.40	3	0.0084
		Fe - Sc_1	2.83	-	-
		Fe - Sc_2	3.38	3	0.025

Table 2: Data range and metric parameters obtained by EXAFS least-squares fit. The amplitude reduction factor was fixed at 0.6 and 0.7 for all samples at the Sc and Fe K-edge, respectively. The fit range, the single scattering paths, the interatomic distance (R), the coordination numbers (N), and the mean squared atomic displacement/Debye-Waller factors (σ^2) are included in the table.

Supplementary Figures

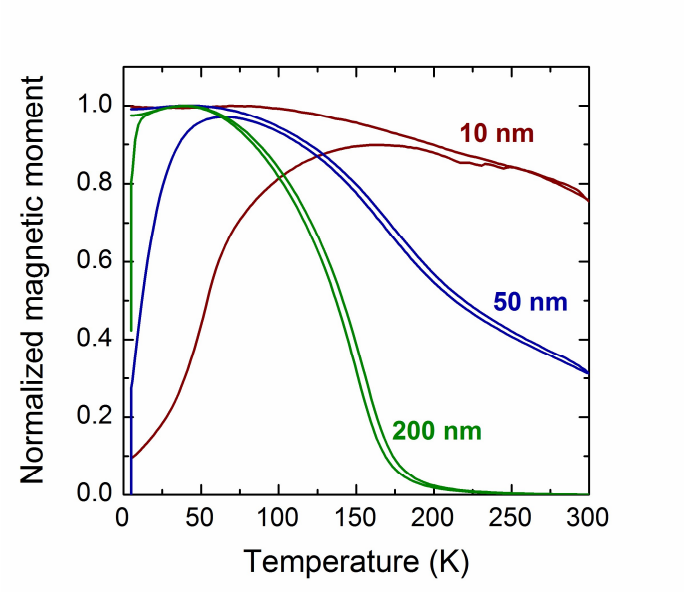

Figure 1: ZFC/FC measurements showing the influence of the protective Mg layer thickness on the magnetic properties of the cluster-assembled $Fe_{80}Sc_{20}$ films. The deposition of the $Fe_{80}Sc_{20}$ films was identical for all three samples with impact energy of 50 eV per cluster.

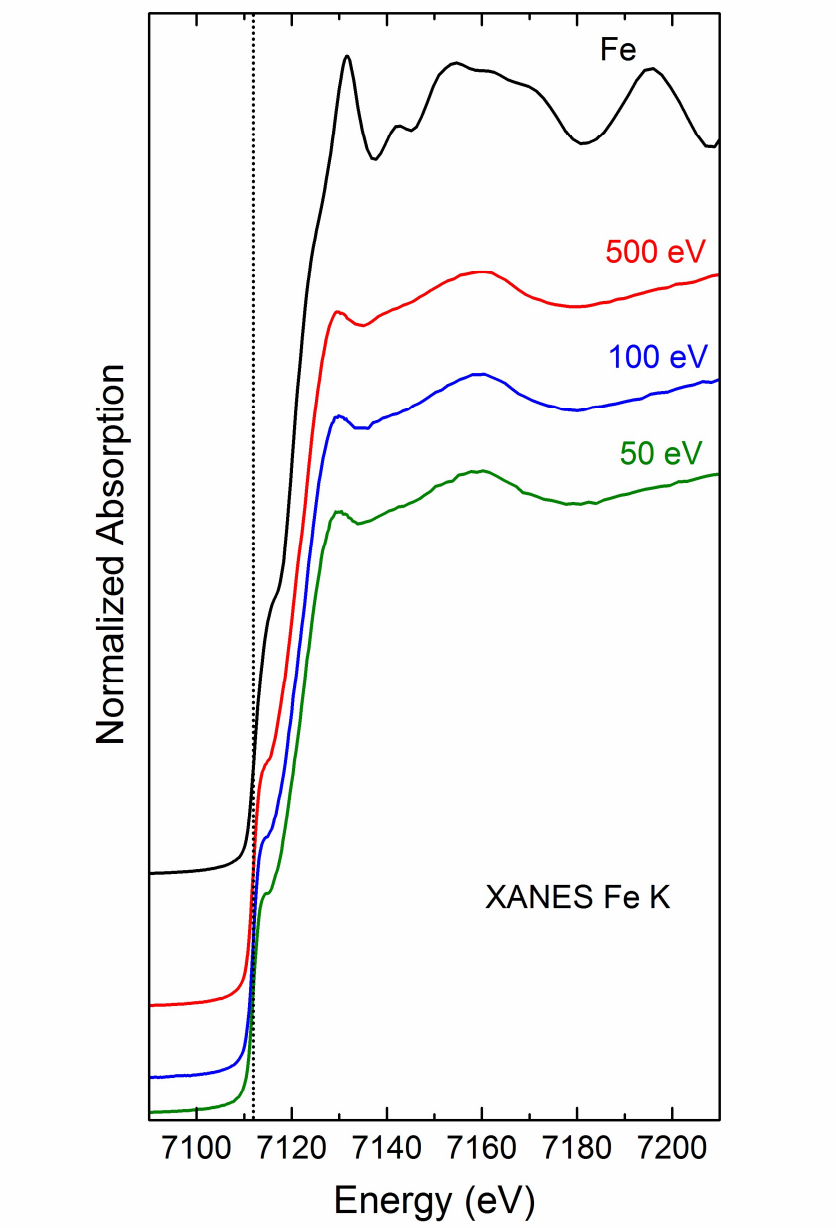

Figure 2: Normalized XANES region of the Fe *K*-edge XAS spectra of the samples deposited with energy of 500, 100, and 50 eV per cluster together with the spectra of Fe foil. The vertical dashed line at 7112 eV corresponds to the first inflection point in the Fe *K*-edge XANES spectrum of the pure metal.

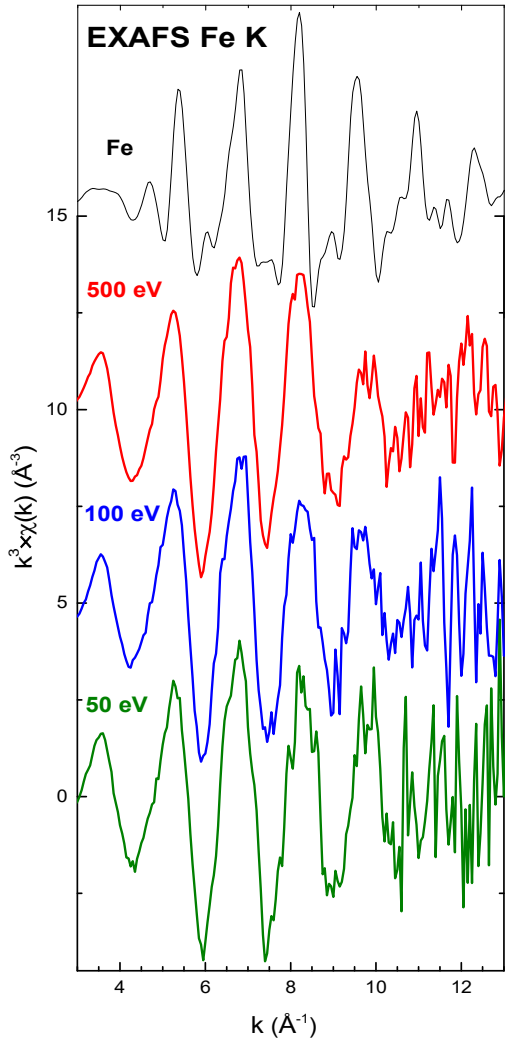

Figure 3: $k^3 \times \chi(k)$ EXAFS spectra at the Fe K-edge of the cluster-assembled metallic glasses deposited with an energy of 50, 100, and 500 eV per cluster. The Fe metal is shown for comparison.

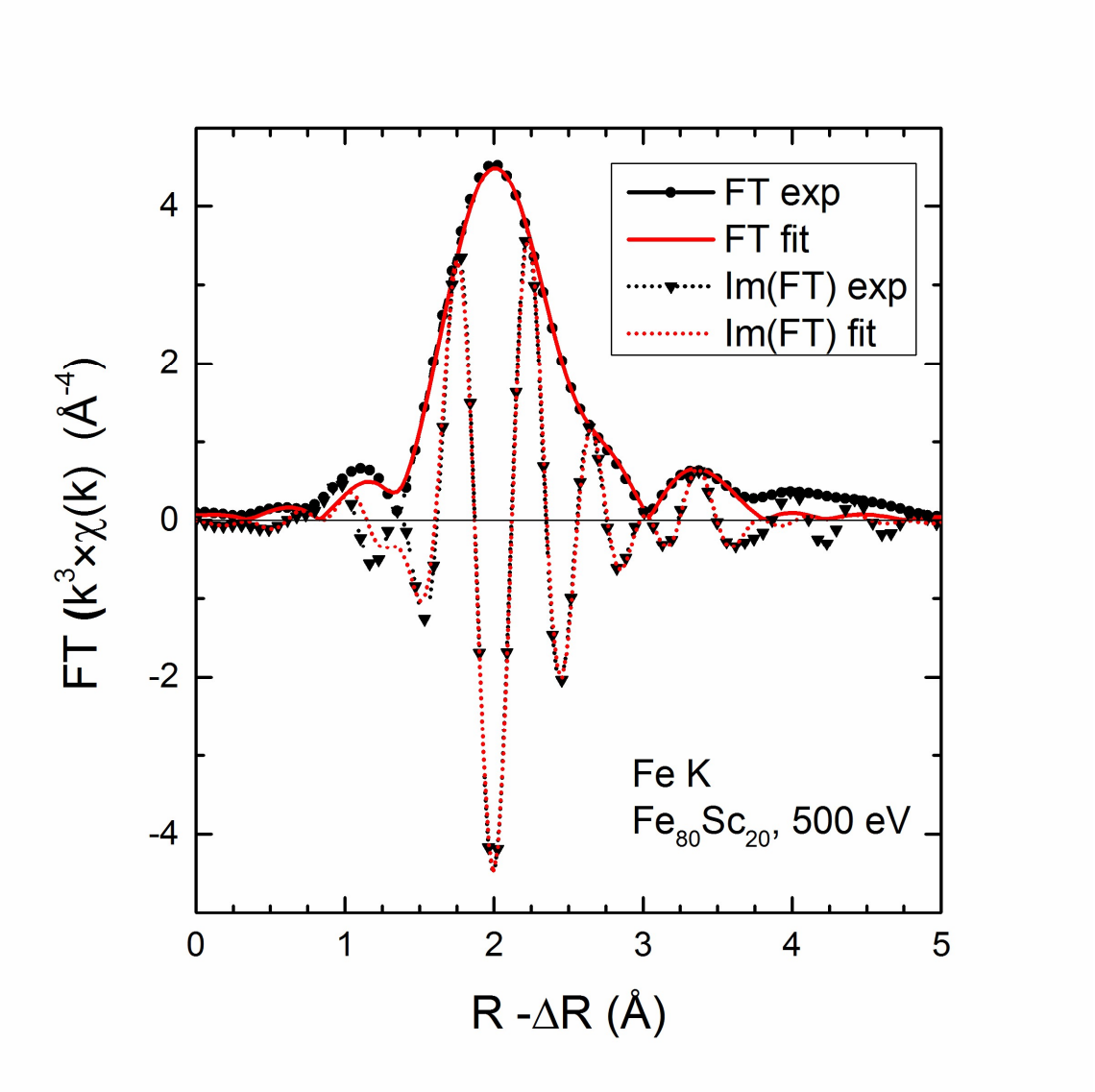

Figure 4: Magnitude and imaginary part of the Fourier transform of the k^3-weighted EXAFS at Fe K-edge and corresponding fit data of the 500 eV deposited cluster-assembled sample.

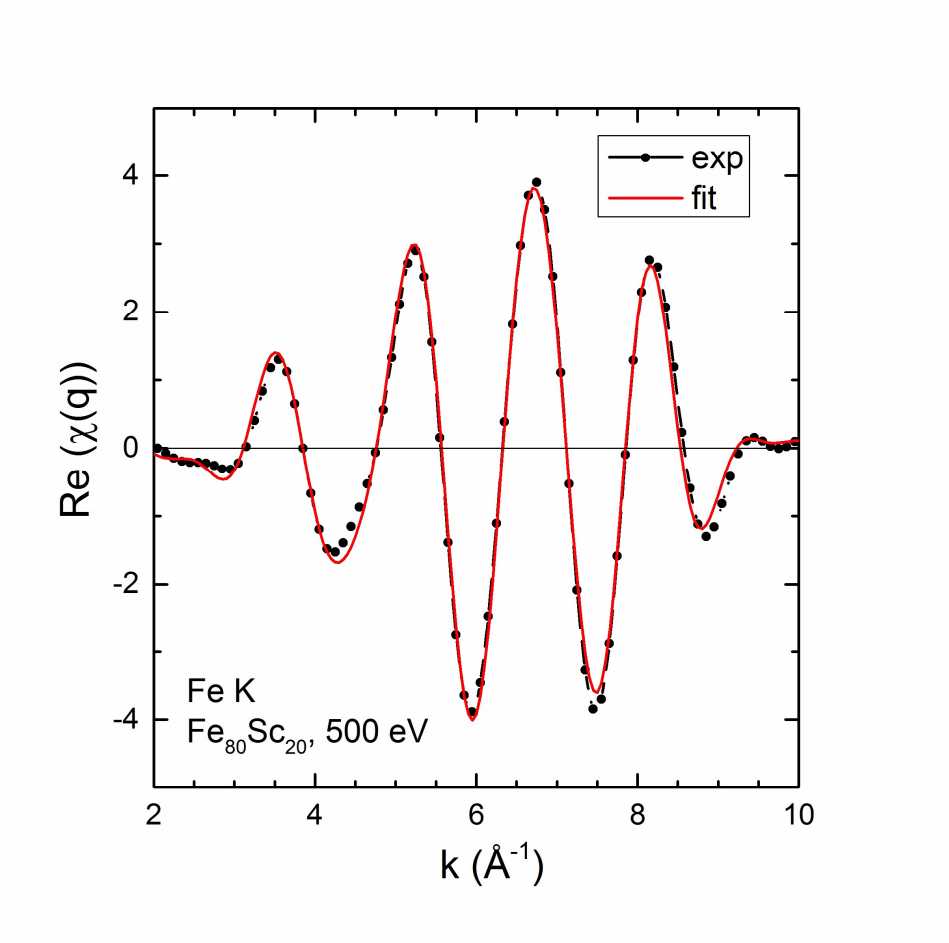

Figure 5: Fourier-filtered data and fit in *k*-space of the sample as in Figure 4.

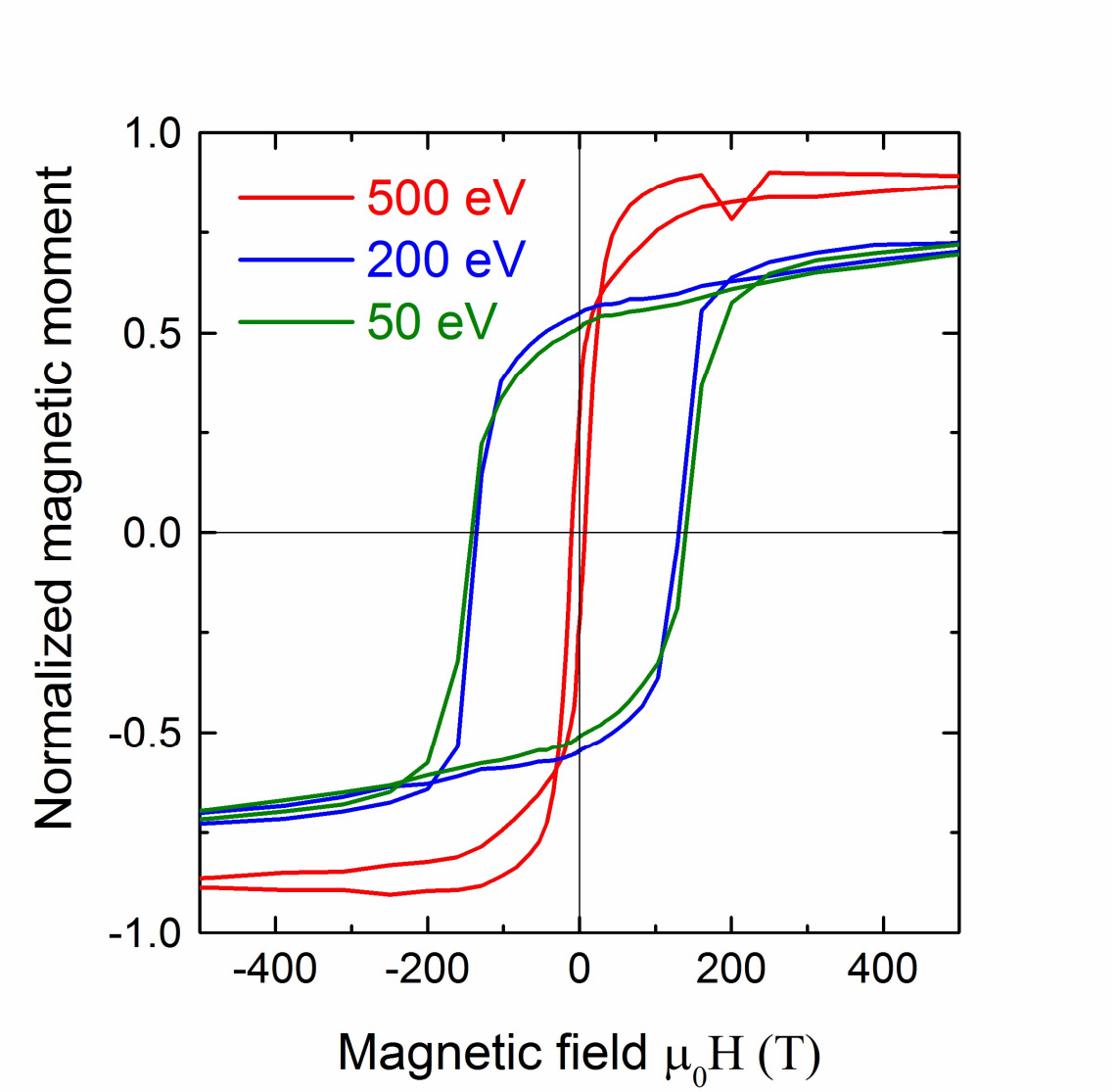

Figure 6: Magnetization M-H loops of cluster-assembled $Fe_{80}Sc_{20}$ samples deposited with 50, 100, 200, and 500 eV/cluster impact energies. The M-H loops were measured at 5 K.

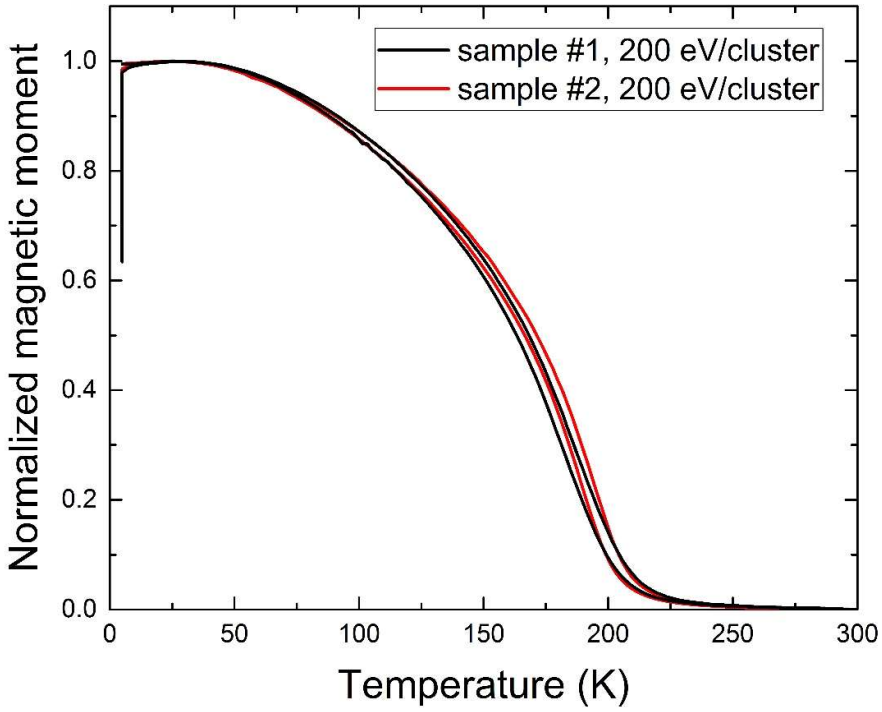

Figure 7: Temperature dependence of normalized magnetic moment measured on two different $Fe_{80}Sc_{20}$ cluster films deposited on silicon substrates with an impact energy of 200 eV/cluster. The ZFC/FC curves were measured with a SQUID magnetometer and an applied field of $\mu_0 H$ = 20 mT parallel to the sample surface.