Supplementary information

Mechanics of Nanoscale ε-Fe_2O_3/Organic Superlattices Towards Flexible Thin-Film Magnets

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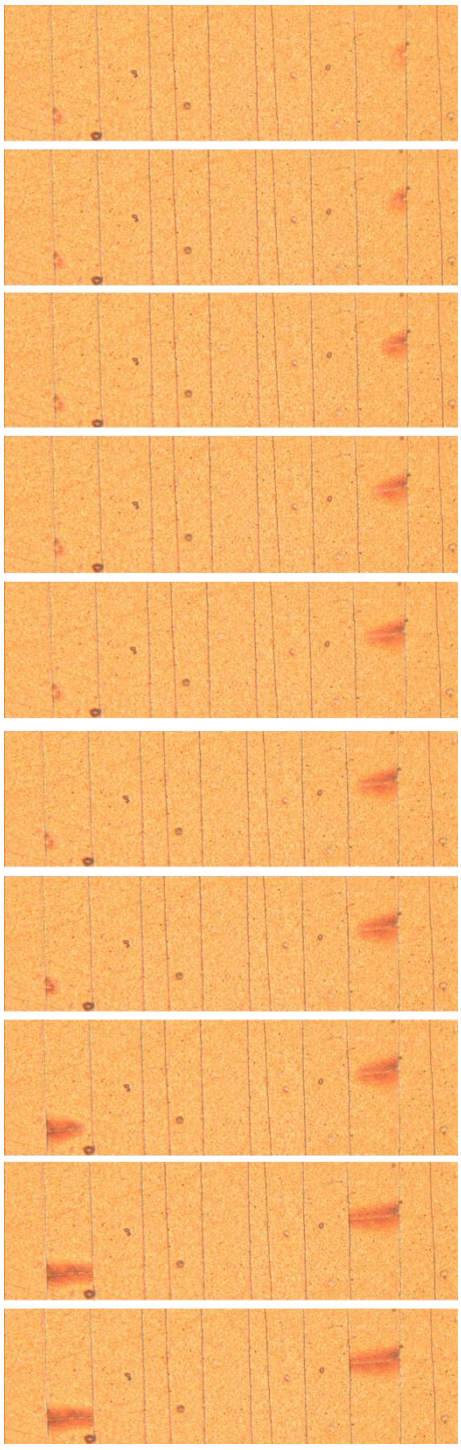

Figure S1. Optical micrographs for the ε-Fe_2O_3 film showing formation of two buckles. Evolution of the buckle from the triangular (top-view) shape into rectangular shape is depicted. Transverse cracks are seen to form at the apex of buckles along their shape evolution. The series begins from 2.2% tensile strain and spans over 0.14% strain interval (or 10s time interval). Width of each image is 300 μm.

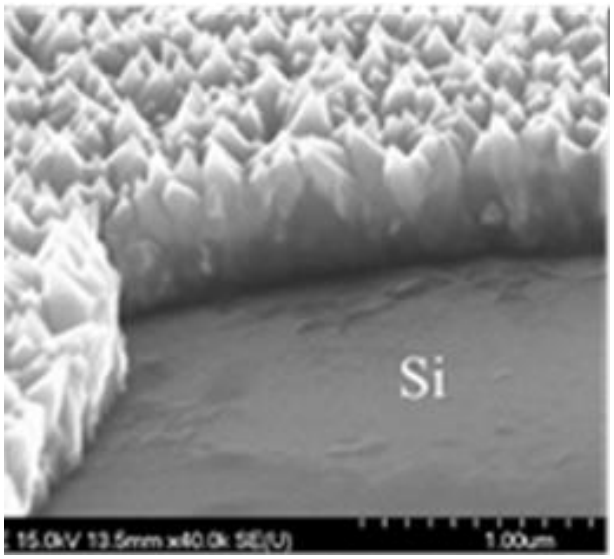

Figure S2. A tilted scanning-electron-microscope cross-section view of the ε-Fe_2O_3 film on Si substrate.

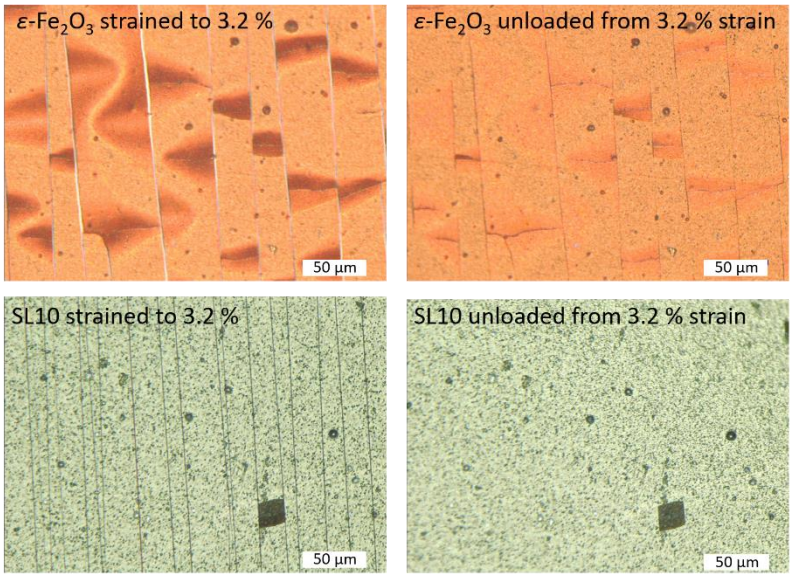

Figure S3. Optical top-view micrographs of the ε-Fe_2O_3 and SL10 film on the polyimide substrate after loading to 3.2 % tensile strain, and after subsequent unloading. Width of each image is 300 μm.

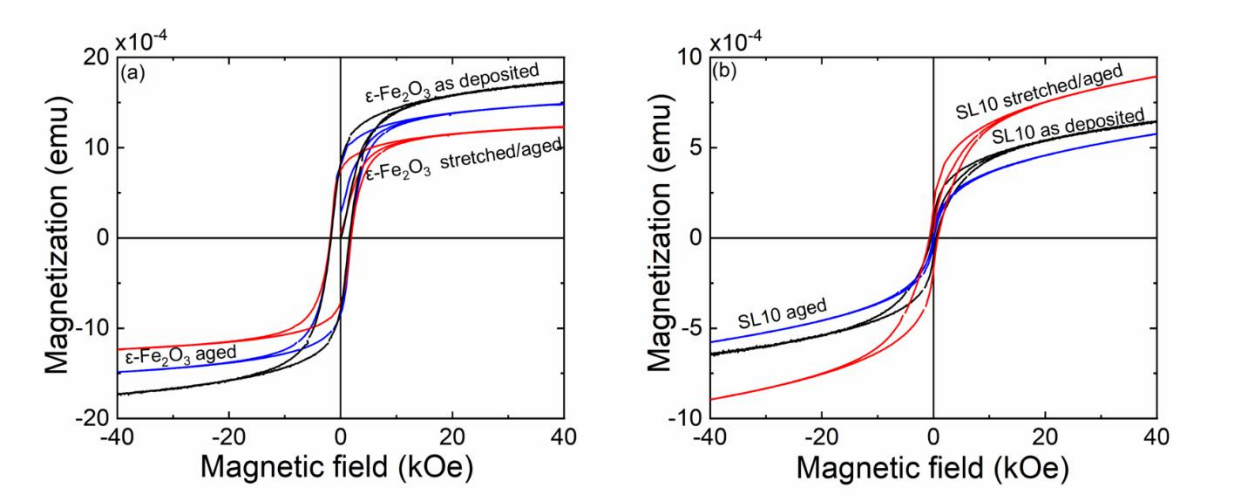

Figure S4. Magnetization vs. magnetic field curves for (a) the ε-Fe_2O_3 and (b) SL10 films. The data is shown for the as-deposited films and for the films after loading to 3.2 % tensile strain, followed by subsequent unloading. As the strained samples had undergone ~ 1 year storage in glovebox prior to the experiment, an additional reference measurement was done for unstrained samples with the same storage history ("aged").

Table S1. Fracture properties for the thin films: critical bending radius (R_c) on 50-µm thick polyimide, crack onset strain (COS), elastic modulus (E), cohesive strain ($\boldsymbol{\varepsilon_{coh}}$), and cohesive strength (σ_{coh}). The error bars represent the standard deviation over 3-5 measurements. The data is shown for values without thickness normalization.

Sample	**R_c (mm)**	**COS (%)**	***E* (GPa)**	**α**	**β**	**ε_{coh} (%)**	**σ_{coh} (MPa)**
ε-Fe_2O_3	7.5±0.3	0.34±0.02	152±33	2.8±0.4	0.027±0.008	0.58±0.09	885±126
SL1	5.3±0.2	0.48±0.02	145±37	5.0±1.1	0.015±0.004	0.66±0.06	948±80
SL10	2.9±0.4	0.88±0.10	70±20	6.8±1.7	0.021±0.003	1.18±0.07	824±48
Fe-TP	1.9±0.2	1.30±0.11	32±8	39±16	0.015±0.002	≥1.45±0.12	≥462±37

Table S2. Interfacial properties for the film/substrate systems (polyimide substrate): saturation crack density (*CDs*), saturation crack spacing (L_s), interfacial shear strain (ε_i), and interfacial shear strength (σ_i). The error bars represent the standard deviation over 3-5 measurements. The data is shown for values without thickness normalization.

Sample	CD_s **(mm^{-1})**	L_s **(µm)**	ε_i **(%)**	σ_i **(MPa)**
ε-Fe_2O_3	34±4	30±4	0.011±0.003	17±4
SL1	39±9	27±8	0.016±0.005	23±7
SL10	54±7	19±2	0.057±0.007	40±5
Fe-TP	≥414±12	≤2.4±0.07	≥0.21±0.012	≥ 67±4