SUPPLEMENTAL MATERIAL

Intrinsic magnetic properties for $\mathrm{SmFe}_{12-x}T_x$ thin films via high-throughput experiments and machine learning techniques

Daisuke Ogawa,[1,*] Ryotaro Akagi,[1] Keitaro Sodeyama,[1] and Yukiko K. Takahashi[1,†]

[1]*National Institute for Materials Science, Tsukuba 305-0047, Japan*

Table S1: Summary of elements, corresponding fluorescence X-rays, and peak positions used in the XRF analysis. Monochromators (LiF(200), PET, and Ge) were employed to isolate characteristic X-ray wavelengths based on atomic numbers and fluorescence characteristics.

	1-12 phase		additive elements, T													
Element	Sm	Fe	Al	Si	Ti	V	Cr	Mn	Co	Ni	Mo	Ru	Rh	Pd	Ta	W
Atomic number	62	26	13	14	22	23	24	25	27	28	42	44	45	46	73	74
Fluorescence X-ray	Lα1		Kα1										Lα1			
Energies [keV]	5.64	6.40	1.49	1.74	4.51	4.95	5.41	5.90	6.92	7.48	17.48	19.28	2.70	2.84	8.15	8.39
Monochromators	LiF(200)		PET		LiF(200)								Ge		LiF(200)	
Peak Position [deg.]	66.3	57.6	143.8	109.0	86.3	77.1	69.5	63.0	52.9	48.7	20.3	18.4	89.1	83.6	44.5	43.1

Table S2: Combinatorial deposition conditions and resulting compositions of $Sm_yFe_{12-x}Ti_x$ thin films at each positions.

ID	Condition	Sputtering Power [W]				Position	Composition [at.%]			$Sm_yFe_{12-x}Ti_x$		
		Sm	Fe	Fe	Ti		Sm	Fe	Ti	y	12-x	x
1	Deposition 1	120	120	120	25	No.2	9.08	86.45	4.46	1.20	10.80	0.59
2	Deposition 1	120	120	120	25	No.5	9.86	87.49	2.65	1.31	10.69	0.35
3	Deposition 1	120	120	120	25	No.8	10.47	86.63	2.90	1.40	10.60	0.39
4	Deposition 1	120	120	120	25	No.11	11.36	86.92	1.71	1.54	10.46	0.23
5	Deposition 2	100	120	120	25	No.2	6.41	89.19	4.40	0.82	11.18	0.56
6	Deposition 2	100	120	120	25	No.5	6.98	89.08	3.93	0.90	11.10	0.51
7	Deposition 2	100	120	120	25	No.8	7.93	88.60	3.47	1.03	10.97	0.45
8	Deposition 2	100	120	120	25	No.11	8.10	89.27	2.64	1.06	10.94	0.34

TABLE S3: Comprehensive data of $Sm_yFe_{12-x}T_x$ thin films including sputtering conditions, compositions, thickness, lattice constants, and magnetic properties.

ID	Gen.	T	Power [W]				Posi.	Compo. [at.%]			$Sm_yFe_{12-x}T_x$			Thick.	Lattice const.		Magnetic properties		
			Sm	Fe	Fe	T	No.	Sm	Fe	T	y	12-x	x	t[nm]	a[nm]	c[nm]	M_s[T]	T_c[K]	H_k[T]
1	1	Ti	120	120	120	25	2	9.08	86.45	4.46	1.20	10.80	0.59	327	0.848	0.4847	1.131	563.5	10.63
2	1	Ti	120	120	120	25	5	9.86	87.49	2.65	1.31	10.69	0.35	350	0.847	0.4868	1.158		
3	1	Ti	120	120	120	25	8	10.47	86.63	2.90	1.40	10.60	0.39	372	0.845	0.4879	1.204	526.1	
4	1	Ti	120	120	120	25	11	11.36	86.92	1.71	1.54	10.46	0.23	378	0.844	0.4883	1.100	526.6	
5	1	Ti	100	120	120	25	2	6.41	89.19	4.40	0.82	11.18	0.56	285	0.849	0.4795	1.339		
6	1	Ti	100	120	120	25	5	6.98	89.08	3.93	0.90	11.10	0.51	297	0.849	0.4805	1.425	539.8	10.93
7	1	Ti	100	120	120	25	8	7.93	88.60	3.47	1.03	10.97	0.45	322	0.850	0.4820	1.478	546.9	11.00
8	1	Ti	100	120	120	25	11	8.10	89.27	2.64	1.06	10.94	0.34	337	0.847	0.4830	1.426	545.0	10.90
9	1	V	120	120	120	25	2	8.31	87.10	4.59	1.09	10.91	0.60	331	0.849	0.4825	1.104	596.2	11.48
10	1	V	120	120	120	25	5	9.20	87.21	3.59	1.22	10.78	0.47	352	0.849	0.4837	1.097	558.1	
11	1	V	120	120	120	25	8	10.28	86.54	3.18	1.37	10.63	0.43	371	0.842	0.4854	1.224		
12	1	V	120	120	120	25	11	10.70	86.72	2.58	1.44	10.56	0.35	390	0.844	0.4865	1.128	549.2	
13	1	V	105	120	120	25	2	6.54	88.75	4.71	0.84	11.16	0.60	297	0.858	0.4791	1.357	621.9	

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* d.ogawa@shinetsu.jp

† takahashi.yukiko@nims.go.jp

ID	Gen.	T	Power [W]				Posi. No.	Compo. [at.%]			$Sm_y Fe_{12-x} T_x$			Thick. t[nm]	Lattice const.		Magnetic properties		
			Sm	Fe	Fe	T		Sm	Fe	T	y	$12-x$	x		a[nm]	c[nm]	M_s[T]	T_c[K]	H_k[T]
14	1	V	105	120	120	25	5	7.14	88.74	4.11	0.92	11.08	0.53	315	0.861	0.4794	1.345	596.4	
15	0	V	105	120	120	25	8	8.03	88.71	3.26	1.05	10.95	0.43	369					
16	1	V	105	120	120	25	11	8.89	88.37	2.74	1.17	10.83	0.36	348	0.846	0.4829	1.323		11.15
17	1	Mo	120	120	120	10	2	8.52	87.53	3.95	1.12	10.88	0.52	308	0.853	0.4803	1.128	517	11.08
18	1	Mo	120	120	120	10	5	8.95	87.66	3.39	1.18	10.82	0.45	330	0.852	0.4813	1.146	520	9.01
19	0	Mo	120	120	120	10	8	10.08	87.68	2.24	1.35	10.65	0.30	345					
20	1	Mo	120	120	120	10	11	10.36	86.94	2.71	1.39	10.61	0.36	363	0.845	0.4866	1.173		
21	1	Mo	110	120	120	6	2	7.18	90.80	2.02	0.93	11.07	0.26	284	0.852	0.4807	1.385		
22	1	Mo	110	120	120	6	5	7.76	90.37	1.87	1.01	10.99	0.24	302	0.848	0.4813	1.334	530	11.20
23	1	Mo	110	120	120	6	8	8.26	91.37	0.38	1.08	10.92	0.05	313	0.846	0.4825	1.379		
24	1	Mo	110	120	120	6	11	8.47	91.05	0.48	1.11	10.89	0.06	328	0.843	0.4836	1.393		
25	0	W	120	120	120	12	2	7.12	88.61	4.27	0.92	11.08	0.55	317			1.033		
26	1	W	120	120	120	12	5	7.67	88.23	4.10	1.00	11.00	0.53	323	0.851	0.4798	1.214	529.7	10.85
27	1	W	120	120	120	12	8	8.35	88.42	3.23	1.09	10.91	0.42	355	0.849	0.4809	1.238		
28	1	W	120	120	120	12	11	8.95	88.05	3.01	1.18	10.82	0.40	367	0.854	0.4816	1.168		
29	1	W	120	120	120	8	2	7.24	89.78	2.97	0.94	11.06	0.38	282	0.842	0.4801	1.328		
30	1	W	120	120	120	8	5	7.87	89.64	2.48	1.03	10.97	0.32	303	0.849	0.4810	1.318	542.2	10.20
31	1	W	120	120	120	8	8	8.45	89.55	2.00	1.11	10.89	0.26	316	0.846	0.4823	1.347		
32	1	W	120	120	120	8	11	9.04	89.31	1.65	1.19	10.81	0.22	339	0.845	0.4836	1.277		
33	0	Ta	105	120	120	8	2	7.32	88.77	3.91	0.95	11.05	0.51	275					
34	0	Ta	105	120	120	8	5	7.65	89.23	3.13	0.99	11.01	0.41	293					
35	1	Ta	105	120	120	8	8	7.99	89.48	2.53	1.04	10.96	0.33	318		0.482	1.280	559.9	8.88
36	1	Ta	105	120	120	8	11	8.73	88.97	2.29	1.15	10.85	0.30	318		0.4839	1.368		
37	1	Ta	114	130	130	5	2	7.62	90.46	1.92	0.99	11.01	0.25	285	0.847	0.4811			
38	1	Ta	114	130	130	5	5	8.31	89.94	1.75	1.09	10.91	0.23	307		0.4821			
39	0	Ta	114	130	130	5	8	9.19	89.57	1.24	1.21	10.79	0.16	324					
40	1	Ta	114	130	130	5	11	9.63	89.20	1.16	1.28	10.72	0.15	316		0.485			
41	1	NA	105	120	120	0	2	7.03	92.97	0.00	0.91	11.09	0.00	279	0.849	0.480	1.539	577.6	11.15
42	1	NA	105	120	120	0	5	7.17	92.83	0.00	0.93	11.07	0.00	294	0.853	0.4798	1.560		

ID	Gen.	T	Power [W]				Posi. No.	Compo. [at.%]			$Sm_y Fe_{12-x} T_x$			Thick. t[nm]	Lattice const.		Magnetic properties		
			Sm	Fe	Fe	T	No.	Sm	Fe	T	y	$12-x$	x	t[nm]	a[nm]	c[nm]	M_s[T]	T_c[K]	H_k[T]
43	0	NA	105	120	120	0	8	8.24	91.76	0.00	1.08	10.92	0.00	322					
44	1	NA	105	120	120	0	11	8.42	91.58	0.00	1.10	10.90	0.00	334			1.524	533.6	12.37
45	1	Cr	105	120	120	25	2	5.92	81.90	12.18	0.76	11.24	1.55	296	0.854	0.4782	1.302		
46	0	Cr	105	120	120	25	5	6.59	84.10	9.31	0.85	11.15	1.20	304					
47	1	Cr	105	120	120	25	8	7.11	83.52	9.37	0.92	11.08	1.21	324	0.861	0.4783	1.427		
48	1	Cr	105	120	120	25	11	7.43	86.06	6.51	0.96	11.04	0.84	339	0.858	0.4789	1.374		
49	1	Cr	110	120	120	12	2	6.73	87.09	6.17	0.87	11.13	0.79	279	0.854	0.4793	1.503		
50	1	Cr	110	120	120	12	5	6.84	87.44	5.72	0.88	11.12	0.74	309	0.848	0.4798	1.393		
51	0	Cr	110	120	120	12	8	7.91	88.47	3.62	1.03	10.97	0.47	340					
52	1	Cr	110	120	120	12	11	8.38	88.53	3.09	1.10	10.90	0.40	349	0.847	0.482	1.369	573.6	11.2
53	0	Si	110	120	120	15	2	6.78	91.16	2.05	0.87	11.13	0.26	277					
54	0	Si	110	120	120	15	5	7.64	90.40	1.96	0.99	11.01	0.25	309					
55	1	Si	110	120	120	15	8	8.02	90.45	1.52	1.05	10.95	0.20	334		0.4844			
56	1	Si	110	120	120	15	11	8.75	89.91	1.34	1.15	10.85	0.18	328		0.4828	1.290	566	10.67
57	0	Al	110	120	120	15	2	6.64	91.29	2.07	0.85	11.15	0.27	271			1.396		
58	0	Al	110	120	120	15	5	7.32	90.95	1.73	0.95	11.05	0.22	299					
59	0	Al	110	120	120	15	8	8.25	90.34	1.40	1.08	10.92	0.18	328					
60	1	Al	110	120	120	15	11	9.35	90.43	0.22	1.24	10.76	0.03	328	0.833	0.4845			
61	0	Al	115	120	120	20	2	6.43	91.04	2.53	0.82	11.18	0.32	282					
62	1	Al	115	120	120	20	5	7.66	90.27	2.06	1.00	11.00	0.27	303		0.4872	1.425		
63	1	Al	115	120	120	20	8	8.24	89.78	1.98	1.08	10.92	0.26	320		0.4857	1.523		
64	1	Al	115	120	120	20	11	8.55	89.90	1.55	1.12	10.88	0.20	337	0.845	0.4848	1.469	526.5	10.53
65	0	Al	110	120	120	10	2	7.08	91.12	1.80	0.91	11.09	0.23	278					
66	1	Al	110	120	120	10	5	6.99	91.53	1.48	0.90	11.10	0.19	297		0.4855	1.464		
67	0	Al	110	120	120	10	8	7.96	90.81	1.23	1.04	10.96	0.16	320					
68	1	Al	110	120	120	10	11	7.51	91.37	1.12	0.97	11.03	0.15	334	0.847	0.4828	1.428	522.4	10.66
69	0	Si	115	120	120	25	2	5.55	94.39	0.06	0.70	11.30	0.01	255					
70	0	Si	115	120	120	25	5	8.10	91.86	0.05	1.06	10.94	0.01	296					
71	0	Si	115	120	120	25	8	8.87	91.08	0.05	1.17	10.83	0.01	317					

ID	Gen.	T	Power [W]				Posi. No.	Compo. [at.%]			$\mathrm{Sm}_y\mathrm{Fe}_{12-x}T_x$			Thick. t[nm]	Lattice const.		Magnetic properties		
			Sm	Fe	Fe	T		Sm	Fe	T	y	$12\text{-}x$	x		a[nm]	c[nm]	M_s[T]	T_c[K]	H_k[T]
72	0	Si	115	120	120	25	11	8.74	91.17	0.08	1.15	10.85	0.01	332					
73	0	Si	110	120	120	7	2	6.50	92.21	1.29	0.83	11.17	0.17	254					
74	1	Si	110	120	120	7	5	6.77	92.18	1.06	0.87	11.13	0.14	262		0.4812	0.970		
75	1	Si	110	120	120	7	8	7.41	91.84	0.75	0.96	11.04	0.10	292		0.4816	1.500		
76	1	Si	110	120	120	7	11	8.02	91.23	0.75	1.05	10.95	0.10	319	0.862	0.4821	1.410	576.5	10.84
77	1	Ta	112	120	120	8	2	6.49	90.20	3.30	0.83	11.17	0.42	269			1.486		
78	1	Ta	112	120	120	8	5	7.15	89.80	3.05	0.92	11.08	0.39	304	0.850	0.4796	1.431		
79	1	Ta	112	120	120	8	8	7.72	90.20	2.08	1.00	11.00	0.27	318	0.856	0.4800	1.414		
80	1	Ta	112	120	120	8	11	8.45	89.63	1.92	1.11	10.89	0.25	328	0.851	0.4815	1.416	571.5	11.40
81	0	Mn	120	120	120	25	2	6.05	81.77	12.17	0.77	11.23	1.55	269					
82	0	Mn	120	120	120	25	5	6.75	82.42	10.83	0.87	11.13	1.39	304					
83	0	Mn	120	120	120	25	8	7.57	83.87	8.56	0.98	11.02	1.11	318					
84	0	Mn	120	120	120	25	11	8.90	83.21	7.89	1.17	10.83	1.04	328					
85	0	Mn	120	120	120	9	2	6.29	89.41	4.30	0.81	11.19	0.55	269					
86	0	Mn	120	120	120	9	5	6.48	89.47	4.05	0.83	11.17	0.52	304					
87	0	Mn	120	120	120	9	8	7.73	89.07	3.20	1.01	10.99	0.42	318					
88	0	Mn	120	120	120	9	11	8.30	89.25	2.45	1.09	10.91	0.32	328					
89	0	Ru	120	120	120	15	2	7.13	83.95	8.92	0.92	11.08	1.15	269					
90	0	Ru	120	120	120	15	5	7.56	84.70	7.74	0.98	11.02	1.00	304					
91	0	Ru	120	120	120	15	8	8.90	84.42	6.68	1.17	10.83	0.88	318					
92	0	Ru	120	120	120	15	11	9.54	84.83	5.62	1.27	10.73	0.75	328					
93	0	Ni	120	120	120	25	2	6.26	79.82	13.93	0.80	11.20	1.78	269					
94	0	Ni	120	120	120	25	5	6.72	80.74	12.54	0.86	11.14	1.61	304					
95	0	Ni	120	120	120	25	8	7.84	81.62	10.55	1.02	10.98	1.37	318					
96	0	Ni	120	120	120	25	11	8.52	82.41	9.07	1.12	10.88	1.19	328					
97	0	Ni	120	120	120	8	2	6.75	89.54	3.71	0.87	11.13	0.48	320					
98	0	Ni	120	120	120	8	5	7.23	89.44	3.33	0.93	11.07	0.43	360					
99	0	Ni	120	120	120	8	8	8.09	88.89	3.02	1.06	10.94	0.39	362					
100	1	Ni	120	120	120	8	11	9.02	88.65	2.33	1.19	10.81	0.31	376		0.4824	1.262		

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ID	Gen.	T	Power [W]				Posi. No.	Compo. [at.%]			$Sm_y Fe_{12-x} T_x$			Thick. t[nm]	Lattice const.		Magnetic properties		
			Sm	Fe	Fe	T	No.	Sm	Fe	T	y	$12-x$	x	t[nm]	a[nm]	c[nm]	M_s[T]	T_c[K]	H_k[T]
101	0	Ru	120	120	120	7	2	6.27	91.64	2.09	0.80	11.20	0.27	329					
102	0	Ru	120	120	120	7	5	6.36	91.70	1.95	0.81	11.19	0.25	354					
103	1	Ru	120	120	120	7	8	6.97	91.43	1.60	0.90	11.10	0.21	364	0.8516	0.4818	1.229		
104	1	Ru	120	120	120	7	11	7.72	90.86	1.43	1.00	11.00	0.19	370	0.8477	0.4825	1.224		
105	0	Ru	120	120	120	13	2	5.70	87.46	6.84	0.73	11.27	0.87	269					
106	0	Ru	120	120	120	13	5	6.39	88.04	5.57	0.82	11.18	0.71	304					
107	0	Ru	120	120	120	13	8	7.12	88.39	4.49	0.92	11.08	0.58	318					
108	0	Ru	120	120	120	13	11	8.08	88.16	3.76	1.05	10.95	0.49	328					
109	1	Mn	120	120	120	5	2	6.76	91.37	1.87	0.87	11.13	0.24	330	0.850	0.480	1.209		
110	1	Mn	120	120	120	5	5	7.29	90.97	1.73	0.94	11.06	0.22	345	0.850	0.480	1.233		
111	1	Mn	120	120	120	5	8	7.92	90.68	1.40	1.03	10.97	0.18	394	0.851	0.481	1.147		
112	1	Mn	120	120	120	5	11	8.46	90.20	1.34	1.11	10.89	0.18	394	0.842	0.482	1.187		
113	0	Pd	150	70	70	3	2	10.33	80.12	9.55	1.38	10.62	1.28	133					
114	0	Pd	150	70	70	3	5	10.53	79.64	9.83	1.41	10.59	1.32	151					
115	1	Pd	150	70	70	3	8	11.58	82.94	5.48	1.57	10.43	0.74	157		0.4836	0.802		
116	1	Pd	150	70	70	3	11	12.45	81.17	6.38	1.71	10.29	0.87	167		0.4831	0.833		
117	0	Pd	150	105	105	3	2	5.74	89.19	5.07	0.73	11.27	0.65	178					
118	0	Pd	150	105	105	3	5	6.24	89.81	3.95	0.80	11.20	0.51	191					
119	1	Pd	150	105	105	3	8	6.95	90.27	2.78	0.90	11.10	0.36	206		0.4834	1.173		
120	1	Pd	150	105	105	3	11	7.32	89.60	3.08	0.95	11.05	0.40	214		0.4832	1.245		
121	1	Rh	150	105	105	3	2	6.27	89.84	3.89	0.80	11.20	0.50	175		0.4829	1.309		
122	1	Rh	150	105	105	3	5	6.47	89.93	3.60	0.83	11.17	0.46	174		0.4823	1.396		
123	1	Rh	150	105	105	3	8	6.77	90.15	3.08	0.87	11.13	0.40	187		0.4817	1.360		
124	1	Rh	150	105	105	3	11	7.26	89.84	2.90	0.94	11.06	0.38	205		0.4817	1.344		