Microstructural and magnetic properties of bilayered CoSiB/FeSiB and FeNbSiB/FeSiB ribbons

SOFT MAGNETIC MATERIALS CONFERENCE
BUDAPEST, HUNGARY
1-4 SEPTEMBER 2013

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Objectives

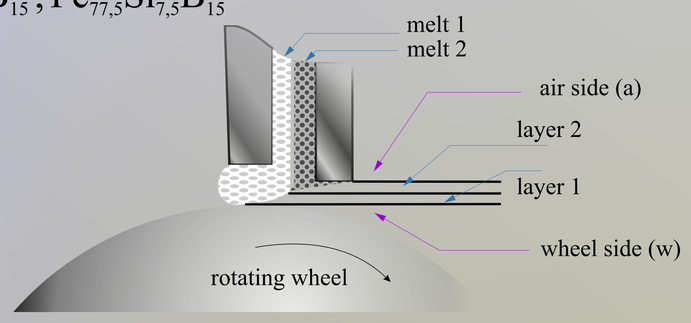
The comparison of CoSiB/FeSiB and FeNbSiB/FeSiB bilayered ribbons studied from the viewpoint of composition, morphology, and bulk and surface magnetic behavior for purpose of possible applications as magnetic sensors.

Experimental

Material:
As-quenched bilayered (BL) and single-layered (SL) ribbons prepared by planar flow casting (PFC)

Composition:
(BL) $Fe_{74,5}Nb_3Si_{13,5}B_9$(w)/$Fe_{77,5}Si_{7,5}B_{15}$(a), $Co_{72,5}Si_{12,5}B_{15}$(w)/$Fe_{77,5}Si_{7,5}B_{15}$(a)
(SL) $Fe_{74,5}Nb_3Si_{13,5}B_9$, $Co_{72,5}Si_{12,5}B_{15}$, $Fe_{77,5}Si_{7,5}B_{15}$

Dimensions:
(BL) 36 μm thick, 8 mm wide
(SL) 20 μm thick, 10 mm wide



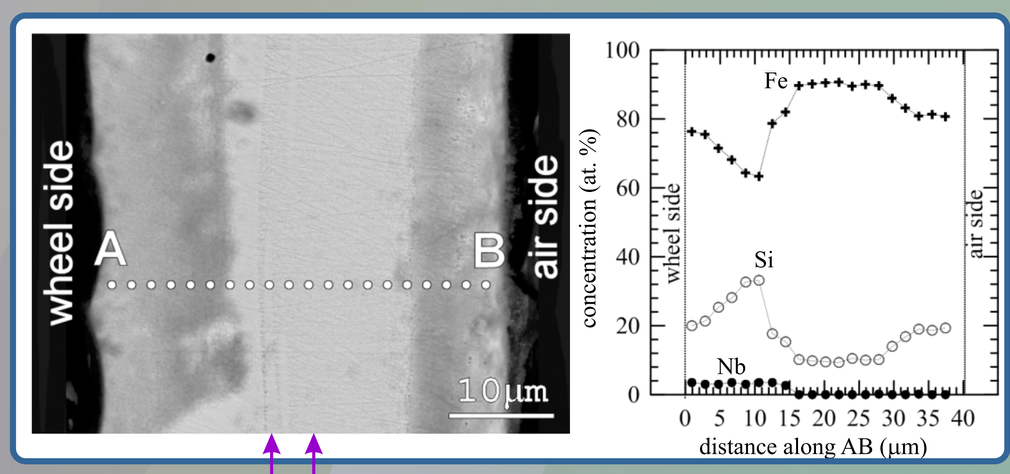
Methods:
Scanning electron microscopy (SEM), Magneto-optical Kerr effect techniques (MOKE), Vibrational sample magnetometer (VSM), Atomic force microscopy (AFM), Magnetic force microscopy (MFM)
(supplemental XRD, ^{57}Fe Mössbauer spectrometry)

Results and discussion

A Microstructure

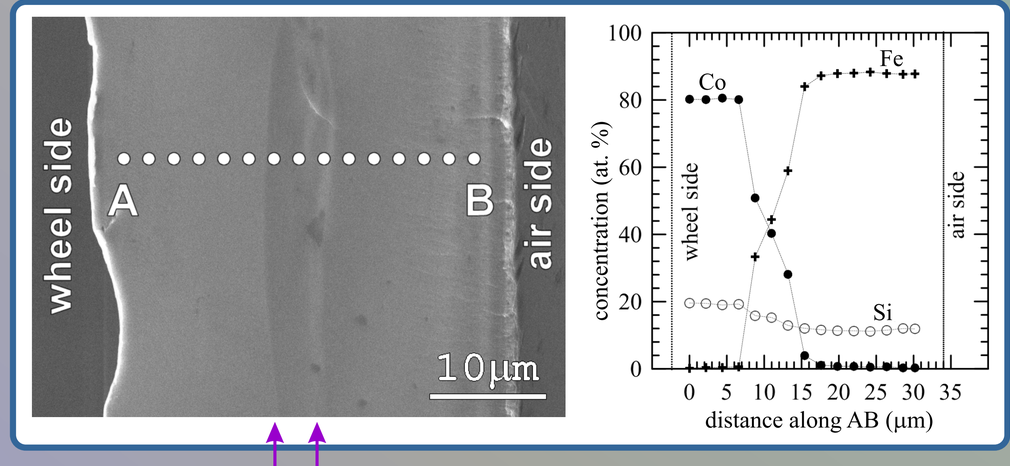
SEM
All structures are fully amorphous
(confirmed by X-ray diffraction and Mössbauer measurements)

Microstructure (left) and concentration profiles (right) of Fe, Nb and Si across the $Fe_{74,5}Nb_3Si_{13,5}B_9/Fe_{77,5}Si_{7,5}B_{15}$ ribbon



Thickness of interlayer - 5,5 μm up to 6 μm

Microstructure (left) and concentration profiles (right) of Fe, Co and Si across the $Co_{72,5}Si_{12,5}B_{15}/Fe_{77,5}Si_{7,5}B_{15}$ ribbon

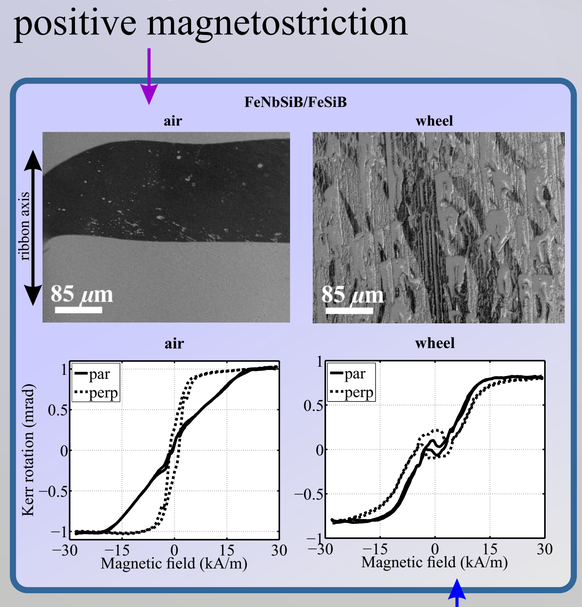


Thickness of interlayer - 5,5 μm up to 6 μm

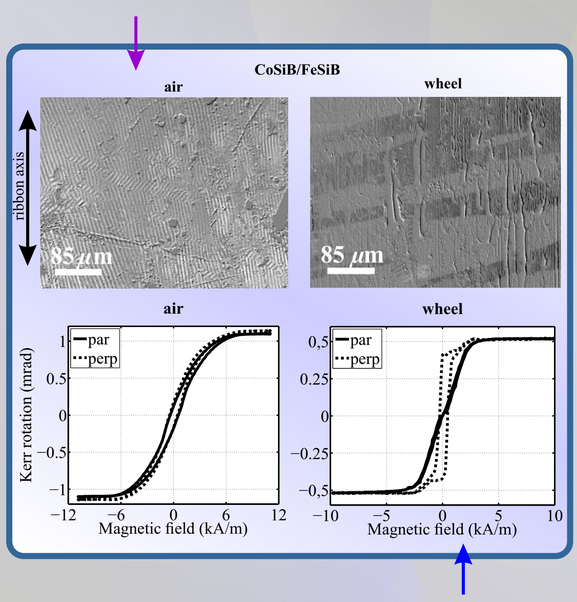
B Surface magnetic properties

MOKE
transverse in-plane anisotropy induced by compressive stress and positive magnetostriction

out-of-plane anisotropy induced by pressure while fixing the sample



inhomogeneous anisotropy induced by tensile stress

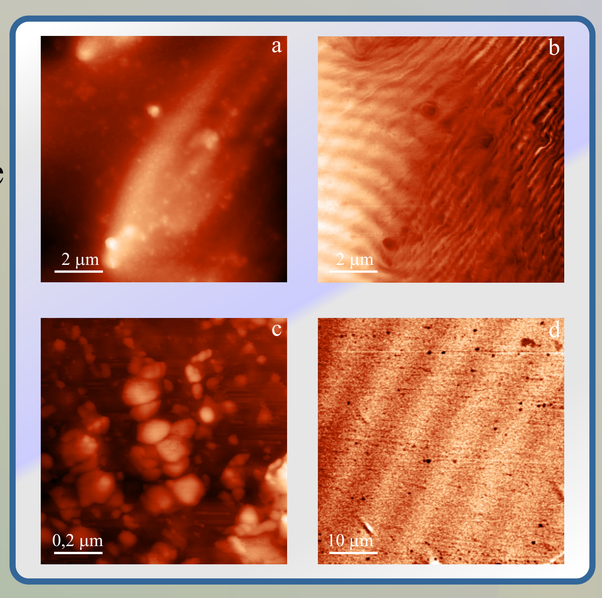


transverse in-plane anisotropy induced by tensile stress and negative magnetostriction

FeNbSiB/FeSiB

AFM
<u>wheel:</u>
rough surface, reflects the profile of the rotating wheel

<u>air:</u>
smooth surface, large number of small particles

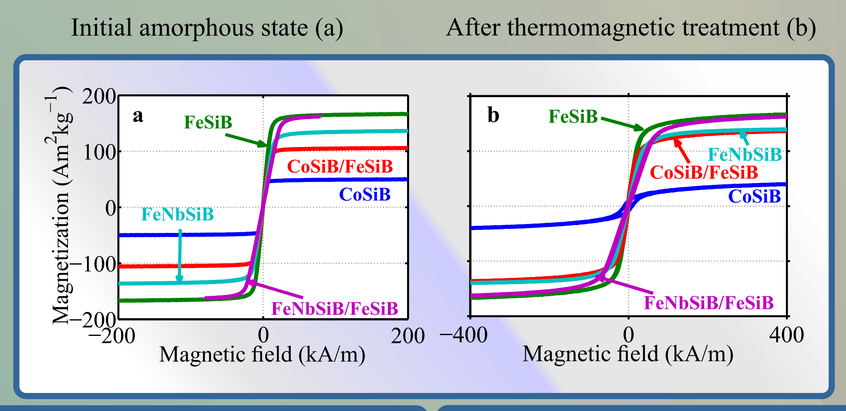


MFM
stripe-like domains

domain orientation follows the irregularities coming from the preparation process

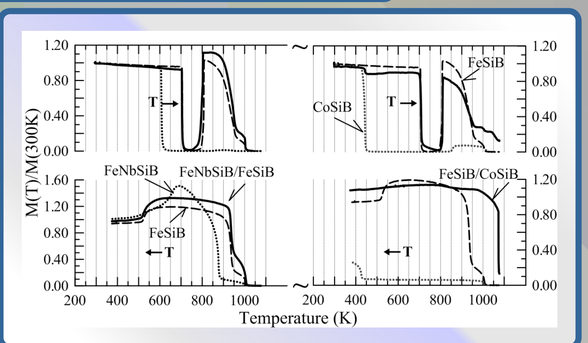
C Bulk magnetic properties

VSM
bulk hysteresis loops for BL and SL samples



Sample	J_{s1} (Am^2kg^{-1})	J_{r1}	H_{c1} (kA/m)	J_{s2} (Am^2kg^{-1})	J_{r2}	H_{c2} (kA/m)
CoSiB	50.28	5.37	0.42	43.82	8.49	9.87
FeNbSiB	136.92	0.30	0.19	141.63	6.56	1.03
FeSiB	167.11	1.60	0.28	171.12	8.05	1.69
CoSiB/ FeSiB	106.09	4.79	0.39	137.47	8.68	2.04
FeNbSiB/ FeSiB	164.88	0.30	0.16	167.71	3.34	1.27

Magnetic characteristics of ribbons obtained from VSM, (1, 2) - parameters measured before and after the temperature treatment



Applied constant magnetic field of the 4 kA/m

Conclusion

A The interlayer thickness of BL ribbons varies from 5,5 μm up to 6 μm.

B Surface magnetic anisotropy is changed drastically by fixation the produced coiled BL ribbon on the planar holder.
Strip-like magnetic domains were observed using the MFM technique.

C Bulk magnetic properties of both BL ribbons are affected mainly by FeSiB layer.