Influence of magnetostriction on cross-section magnetic properties in bilayered ribbons

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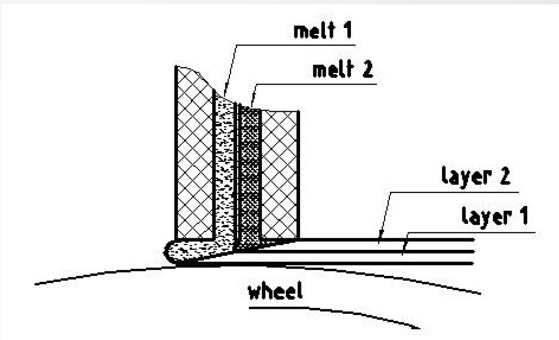
Samples

- 36 μm thick and 8 mm wide
- $Co_{69}Fe_2Cr_7Si_8B_{14}$/$Co_{59}Fe_{12}Cr_7Si_8B_{14}$ - denoted Co/Co
- $Co_{72.5}Si_{12.5}B_{15}$/$Fe_{77.5}Si_{7.5}B_{15}$ - denoted Co/Fe
- samples were prepared by Planar Flow Casting (PFC)
- PFC uses one cruicible divided into two chambers



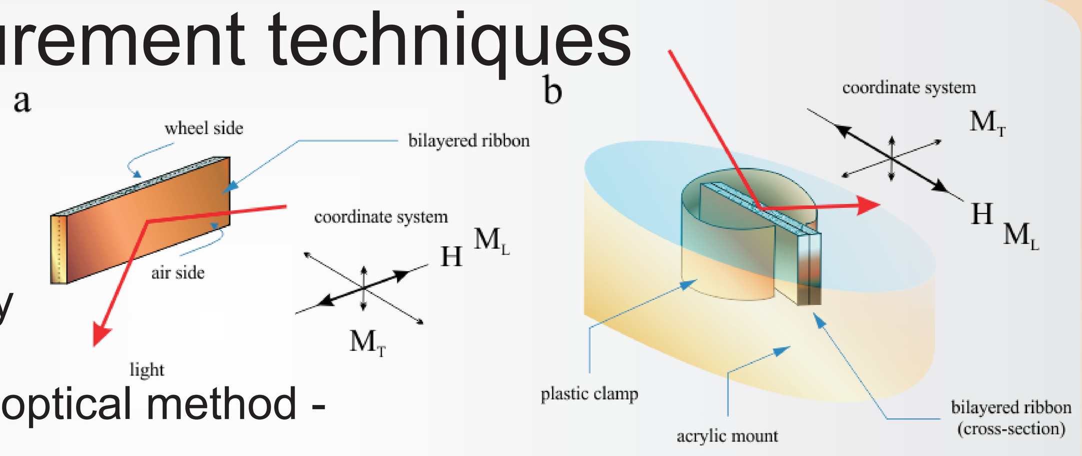
Nozzle of the crucible

ribbon	layer	side	magnetostriction λ_s (ppm)
Co/Co	$Co_{69}Fe_2Cr_7Si_8B_{14}$	wheel	-1.0
	$Co_{59}Fe_{12}Cr_7Si_8B_{14}$	air	+4.0
Co/Fe	$Co_{72.5}Si_{12.5}B_{15}$	wheel	-2.6
	$Fe_{77.5}Si_{7.5}B_{15}$	air	+32.0

Measurement techniques

Microstructure:
- X-ray diffraction
- Nanoindentation
- Scanning electron microscopy

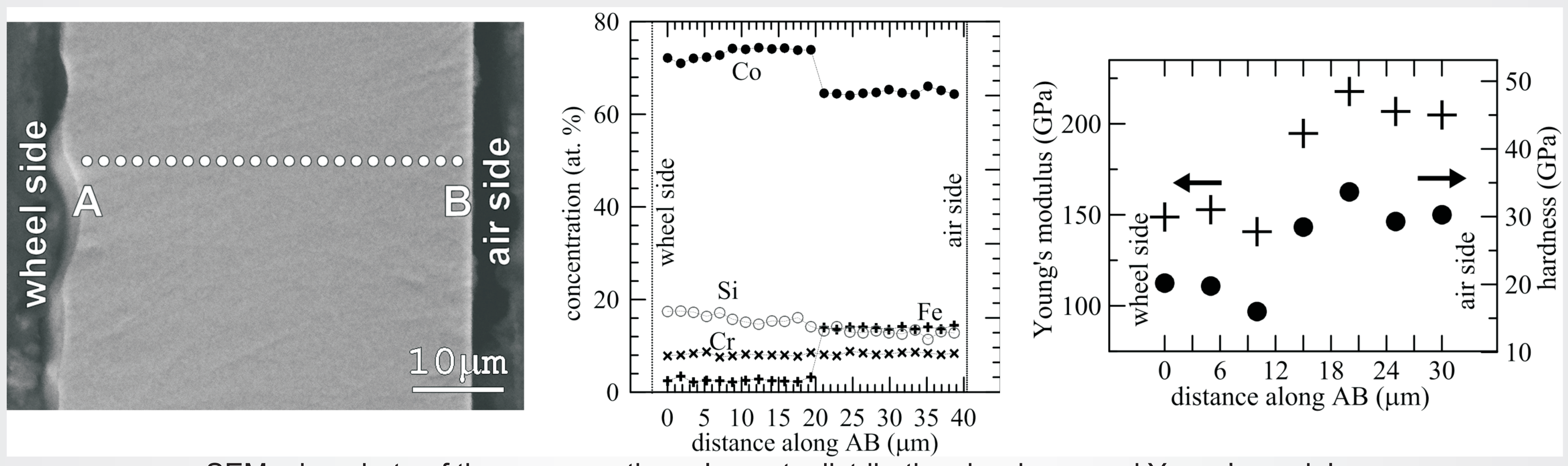
Surface magnetic properties:
- differential intensity magneto-optical method - hysteresis loops
- MOKM (magneto-optical Kerr microskopy) - domain structure



Measurement magneto-optical configurations

Microstructure

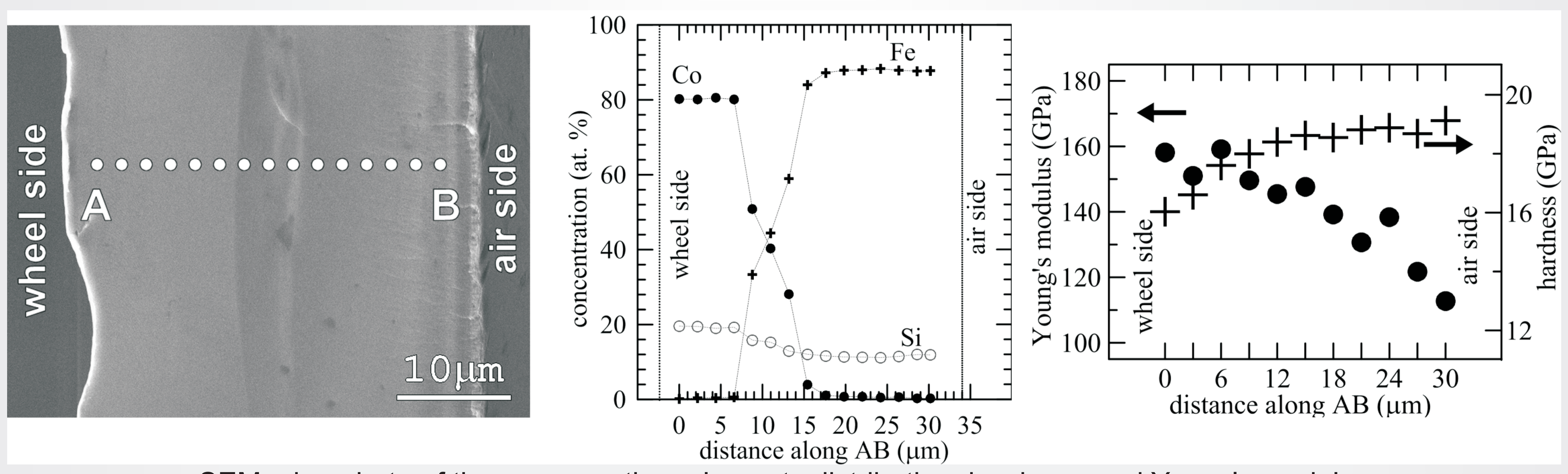
Co/Co sample



SEM microphoto of the cross-section, elements distribution, hardness and Young's modulus

- Narrow interface, almost invisible in the SEM due to the similar element composition in the layers .
- Sharp transition of element content across the interface and sharp changes in the both hardness and Young's modulus.

Co/Fe sample

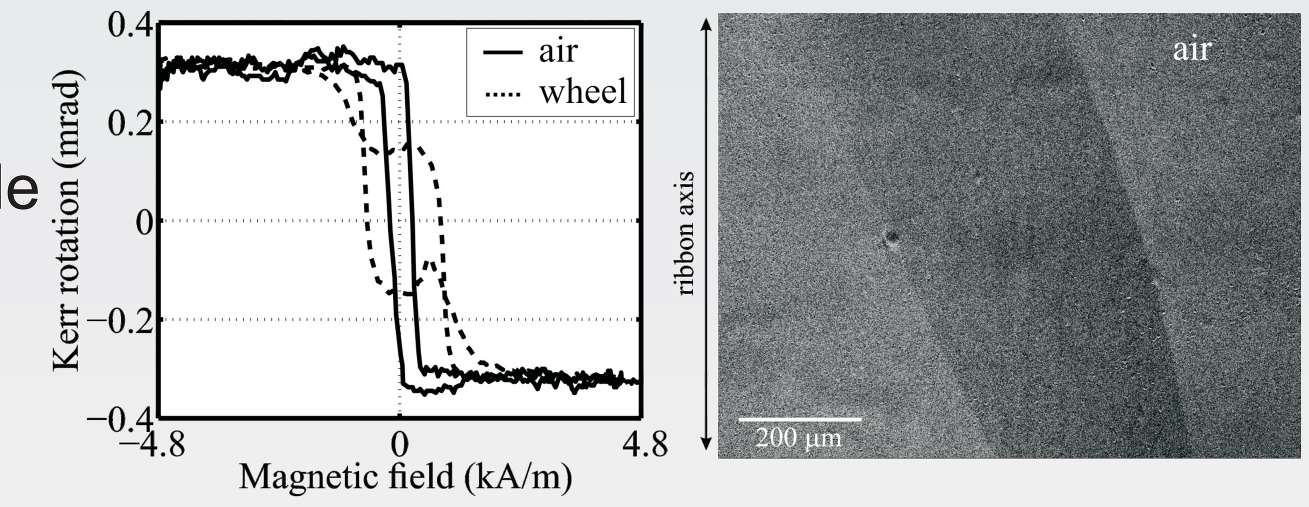


SEM microphoto of the cross-section, elements distribution, hardness and Young's modulus

- Much broader and visible interface.
- Slower transition of elements across the interlayer featured by mixing of Co and Fe.
- Almost continuously changes of both mechanical characteristics.
- Strong influence of the interlayer on the bulk magnetic properties.

Magneto-optical properties

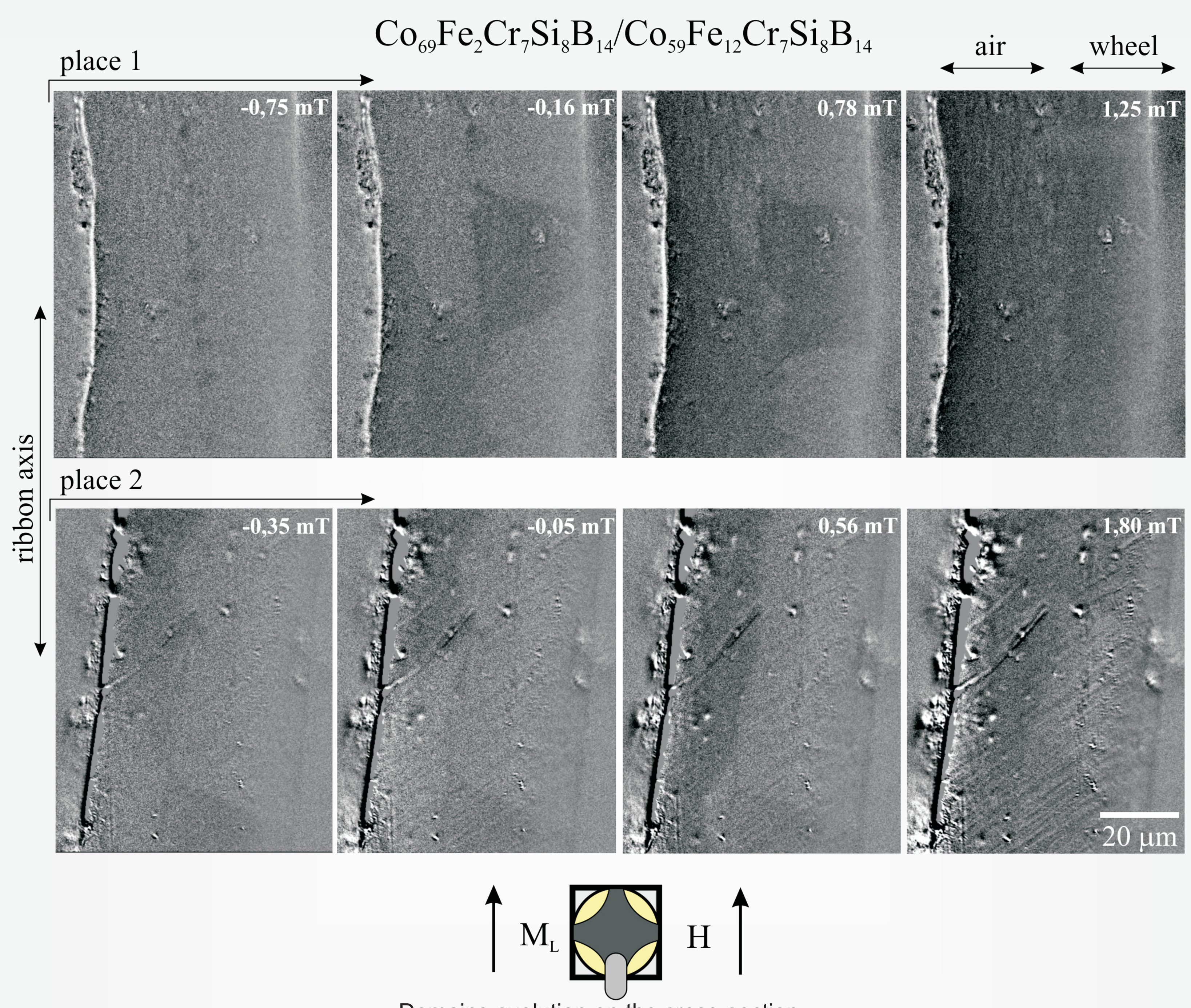
Co/Co sample - surface



MOKE hysteresis loops and domain structure on the air side

- Typical rectangular hysteresis loops with the fast reversal and corresponding band magnetic domains measured on the air side.
- At the wheel side the hysteresis loops exhibit the presence of two different magnetic phases.

Co/Co sample - cross-section

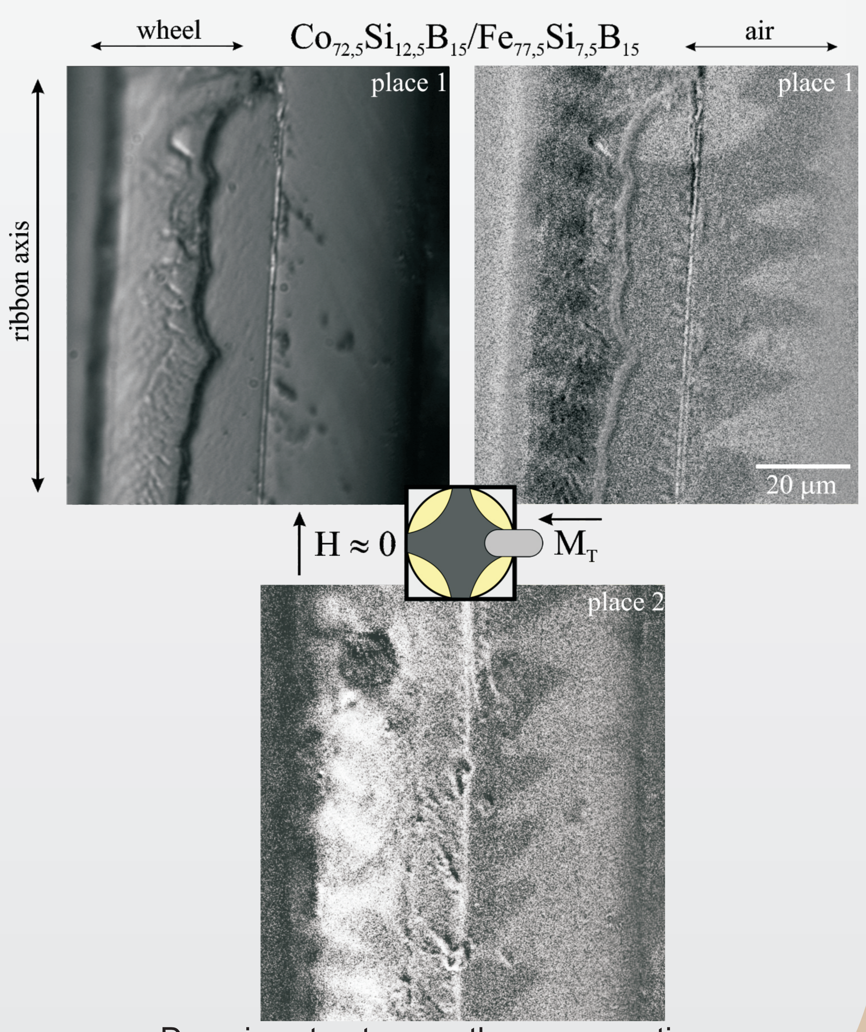


Domains evolution on the cross-section

- Domains do not cross the interface and they move only inside the layers.
- The domains arise and change at low magnetic fields and they disappear first on the air side
- The domain evolution in the layers correspond with the hysteresis loops measured from air and wheel side.

Co/Fe sample - cross-section

- Magnetostriction coefficients of both layers markedly differ in comparison to Co/Co sample.
- Domains are presented in the remanence state.
- Domains crosse the interface.
- Narrow band domains, almost perpendicular to the ribbon axis, are observed close to both surfaces.
- On the wheel side they remain practically unchanged when penetrating deeper below the surface, while on the air side they gradually spread towards the interface.



Domains structure on the cross-section

CONCLUSIONS

The obtained results yield an importance of the chemical composition and accompanying dissimilar magnetostriction coefficients of the layers. The results obtained at the CoFeCrSiB-based sample, the layers of which differ only slightly in the Co/Fe ratio, yield thin interlayer and the magnetic domains are extended only inside the layers but they originate close to the interface. Contrarily, the physical properties of the CoSiB/FeSiB sample change from one side to the other across the thicker interlayer and, moreover, the markedly different magnetostriction coefficients evoke coiling the sample and inducing additional stresses influencing the fully different magnetic domain patterns.

Acknowledgments

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