Influence of mechanical bending on magnetic properties in NiO and CoO thin films

E.Oleś,[1] P.Dróżdż,[1] J.Kanak,[2] M.Zając,[3] A.Kwiatkowski,[1] M.Szpytma,[3]
M.Ślęzak,[1] T.Ślęzak,[1] and A.Kozioł-Rachwał[1]

[1] *Faculty of Physics and Applied Computer Science,*
AGH University of Krakow, Kraków, Poland
[2] *Institute of Electronics, AGH University of Krakow, Kraków, Poland*
[3] *National Synchrotron Radiation Centre SOLARIS,*
Jagiellonian University, Kraków, Poland

Mechanical strain engineering via flexible substrates offers reversible and continuous control over thin film properties in a single sample, enabling access to deformation states unattainable with conventional rigid substrates. While strain-induced modification of ferromagnetic properties has been demonstrated in oxide thin films on mica, systematic investigation of antiferromagnetic oxides remains limited [1,2].

We investigated the mechanical strain response of antiferromagnetic NiO and CoO thin films deposited on muscovite mica substrates by molecular beam epitaxy under controlled oxygen partial pressure. The combination of mechanical flexibility, crystallinity, and high thermal stability of mica, enabling oxide growth at elevated temperatures, makes it a suitable platform for strain-tunable antiferromagnetic systems [3,4]. X-ray diffraction confirmed (111)-oriented growth of the oxide thin films. Uniform compressive strain was applied by bending the mica-supported films into a cylindrical geometry. The magnetic response of the antiferromagnetic films was probed using synchrotron-based X-ray magnetic linear dichroism (XMLD). Additionally, magneto-optical Kerr effect measurements on Fe/CoO bilayers grown on mica demonstrated how mechanical strain influences the exchange interaction at the ferromagnet/antiferromagnet interface.

This study extends mechanical strain investigations to antiferromagnetic oxide thin films and provides experimental insight into strain-dependent magnetic behavior in NiO and CoO.

References:

[1] P. Makushko, T. Kosub, O. V. Pylypovskyi, et al., Nat. Commun. 13 (2022) 6745.
[2] C. Schmitt, A. Rajan, G. Beneke, et al., Nano Lett. 24 (2024) 1471.
[3] G. Bo, X. Xu, K. Meng, et al., npj Spintronics 3 (2025) 48.
[4] J. Liu, Y. Feng, R. Tang, R. Zhao, J. Gao, D. Shi, H. Yang, Adv. Electron. Mater. 4 (2018) 1700522.

This work was supported by the Grant No. 2020/38/E/ST3/00086 founded by the National Science Centre, Poland.