# Domain Wall Engineering in Double-Exchange-Bias Patterns for Static Magnetic Stray Field Control

A. Vereijken,[1] V. Vanakalapu,[1] C. Janzen,[1] R. Huhnstock,[1] T. Saerbeck,[2] and A. Ehresmann[1]

[1] *Institute of Physics & Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Germany*
[2] *Institute Laue-Langevin, Grenoble, France*

The exchange bias (EB) effect arises from the interfacial exchange coupling between a ferromagnet (FM) and an antiferromagnet (AFM), giving rise to a unidirectional magnetic anisotropy in the FM [1]. This effect has been employed in Lab-on-Chip (LOC) systems, particularly with magnetic particle (MP) transport [2] and sensors [3]. In such LOC systems, ion bombardment induced magnetic patterning (IBMP) of EB layers provides a versatile approach to generate static magnetic field landscapes (MFLs) guiding the particles [2]. For in-plane magnetized domain configurations, these MFLs emerge from the ferromagnetic domain walls (DWs), whose structural properties therefore play a decisive role in the resulting field distribution.

This work demonstrates that sandwiching the FM between two AFM layers, i.e., introducing a second EB interface, adds an additional degree of freedom for modifying the DWs in such patterned EB systems. A central addressed question is whether the two EB interfaces act independently of each other.

Compared to the single EB system [4], stripe patterned $Ir_{17}Mn_{83}/Co_{70}Fe_{30}/Ir_{17}Mn_{83}$ trilayer systems exhibit an effective EB field slightly exceeding twice that of the single interface case. Comprehensive characterization using magnetometry, polarized neutron reflectometry, and magnetic force microscopy reveals that the enhanced EB effect is accompanied by a reduction in DW width and stronger out-of-plane components of the stray fields above the DWs. Both findings demonstrate that the introduction of a second EB interface constitutes an additional design parameter for engineering MFLs in LOC applications.

**References:**

[1] W.H., Meiklejohn; C.P. Bean Phys. Rev., 1956, 102, 1413-1414.
[2] D., Holzinger ACS Nano, 2015, 9(7), 7323-7331.
[3] J.C.S. Kools IEEE Transactions on Magnetics, 1996, 32(4), 3165 – 3184.
[4] M., Merkel Phys. Rev. B, 2022, 106(1), 014403.