Magnetization reversal in Fe(001) films grown on MgO(001) by magnetic field assisted molecular beam epitaxy

B. Blyzniuk,[1] A. Dziwoki,[1,2] K. Freindl,[1] A. Kozioł Rachwał,[3] E. Madej,[1] E. Młyńczak,[1] M. Szpytma,[3] D. Wilgocka-Ślezak,[1] J. Korecki,[1] and N. Spiridis[1]

[1] *Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Niezapominajek 8, 30-239 Kraków, Poland*
[2] *PREVAC sp. z o.o., Raciborska Str. 61, 44-362 Rogów, Poland*
[3] *AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, al. Mickiewicza 30, 30-059 Kraków, Poland*

Molecular beam epitaxy (MBE) is a powerful tool in modern thin film technologies, including electronic, optoelectronic, spintronic or sensoric application. In the traditional MBE film growth is controlled by substrate temperature, deposition rate and partial pressure of reactive gases. Applying the magnetic fields (MF), although uncommon for ultra-high vacuum (UHV) MBE growth, should not be ignored in the synthesis, processing of thin films, especially in ferroic systems [1]. Whereas post-deposition annealing under MF at high temperatures is known as a method of shaping desired magnetic anisotropy, engineering of magnetic properties using MF-assisted MBE was unexplored. Recently, we have developed a method of growing epitaxial films under external MF [2], and showed how this MF affects both in-plane and out-of-plane magnetization reversal for epitaxial magnetite films. In the present contribution we apply this method to epitaxial Fe(001) films on MgO(001).

Fe(001) films, 10 nm thick, were grown on MgO(001) substrates in a multi-chamber UHV system (base pressure $3*10^{-10}$ mbar), including MBE facility and standard surface characterization techniques. Combination of flag-style and PTS-style sample holders [3] (the latter including permanent magnets for generation of MF) and a sophisticated two-station 4-axis manipulator allowed us an easy transfer of the substrate between the stations proper of a given preparation step (cleaning, deposition, annealing). For the *ex situ* measurements the films were protected with 3 nm of MgO.

The role of the external magnetic field for the magnetization reversal process was revealed by measuring the full in-plane angular dependence of the hysteresis loops for MF applied during deposition along the Fe easy [100] and hard [110] in plane axes, using a sample deposited without MF as a reference. The MOKE loops were further interpreted by magnetic domain imaging.

References:

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[2] Dziwoki, A. et al. Materials 2023, 16, 1485
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