Manipulation of Antiferromagnetic Coupled Thin Film Systems by Ion Beam Irradiation

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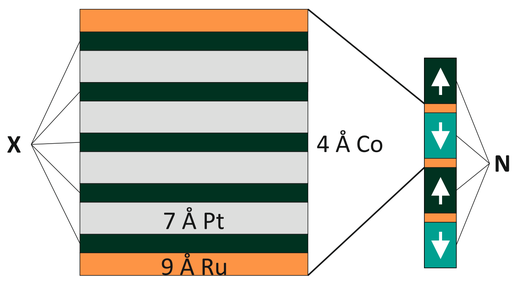
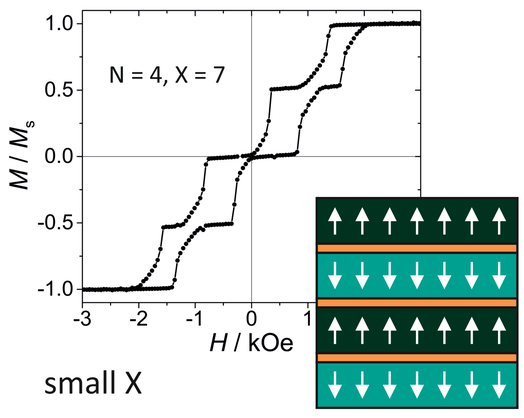
Introduction

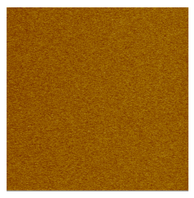


- Co/Pt multilayers with perpendicular anisotropy
- AF (antiferromagnetic) coupled via Ru interlayer
- competition between interlayer exchange energy, perpendicular anisotropy and magnetostatic energy terms

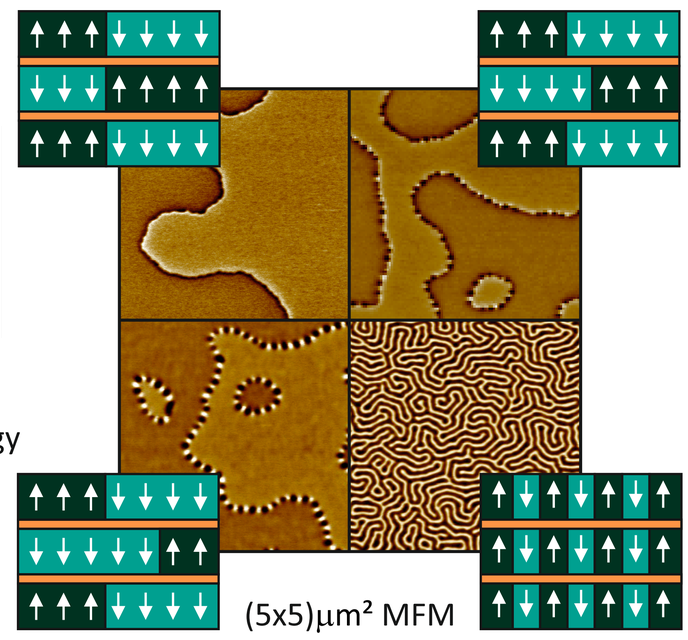


small X

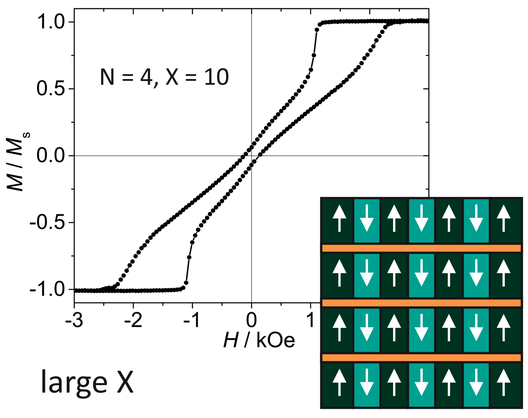
↑ anisotropy energy
AF interlayer exchange energy
demagnetization energy



(5x5)µm² MFM at remanence

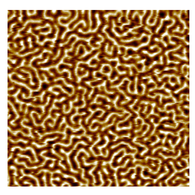


(5x5)µm² MFM after out of plane demagnetization



large X

↑ anisotropy energy
demagnetization energy
AF interlayer exchange energy

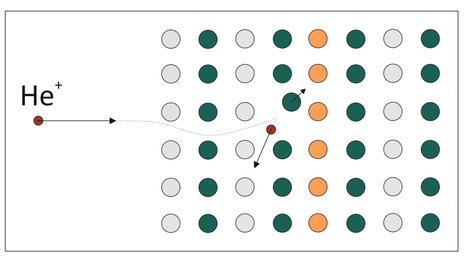


(5x5)µm² MFM at remanence

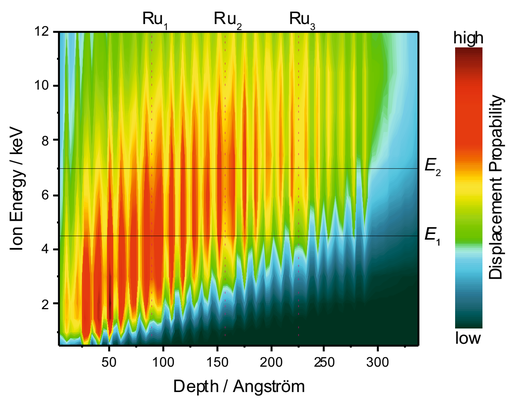
[1]
[2]

SRIM

Simulation of **S**topping and **R**ange of **I**ons in **M**atter



- Monte Carlo package SRIM was run
- two He^+ energies were selected for mainly affecting the Ru interfaces by displacing Ru and Co atoms at the interface
  -> AF interlayer exchange energy will be weakened



shows the displacement propability with respect to the energy of the incident He^+ ions and target depth of the system N = 4, X = 6

[3]

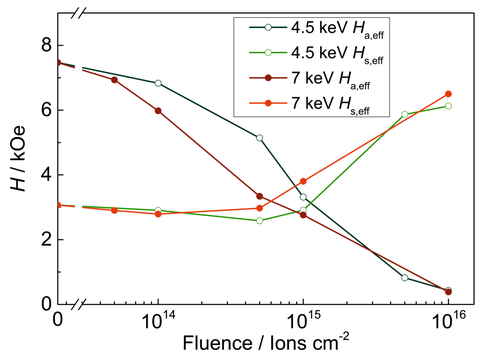
Summary

- out of plane measurements show that the magnetic anisotropy decreases with increasing fluence for both energies
- exchange is weakened more efficiently by E_{ion} = 4.5 keV than with 7 keV
- for low fluences the MFM images show domain walls consisting of stripe domains
- for high fluences the samples show a reorientation of the preferential orientation of the magnetization
- for highest irradiation doses we obtain a weakly AF-coupled system with strongly reduced perpendicular magnetic anisotropy

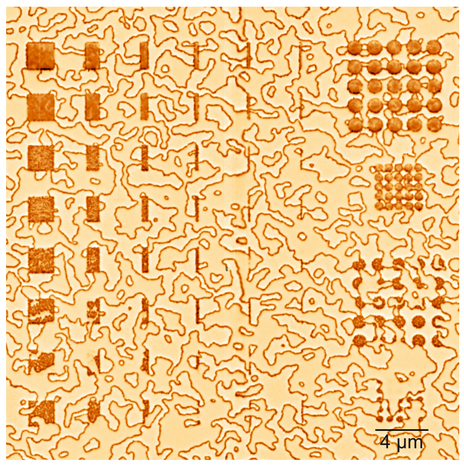
Outlook

- next step is to study the tuning of the magnetic configuration locally to create laterally heterogeneous structures of co-existing magnetic phases

1 $H_{s,eff}$ and $H_{a,eff}$ are defined as H at 95% of the out of plane and in plane M respectively.



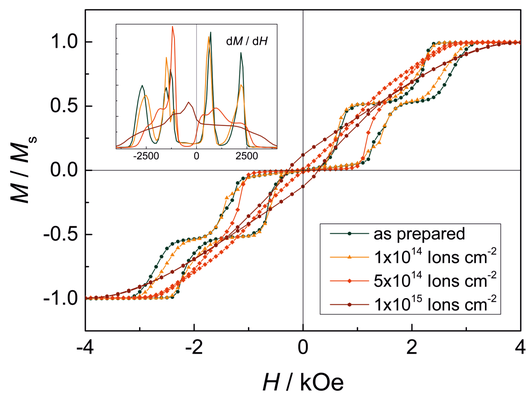
$H_{s,eff}^{1}$ and $H_{a,eff}^{1}$ as a function of irradiation



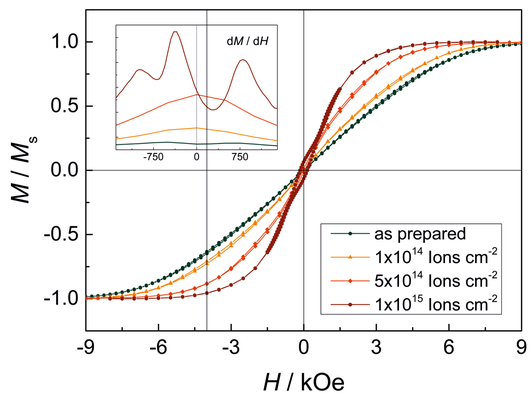
MFM picture of the first local irradiated pattern

Results

SQUID-VSM measurements of the system N = 4, X = 6



out of plane hysteresis for samples irradiated by He^+ of E_{ion} = 4.5 keV



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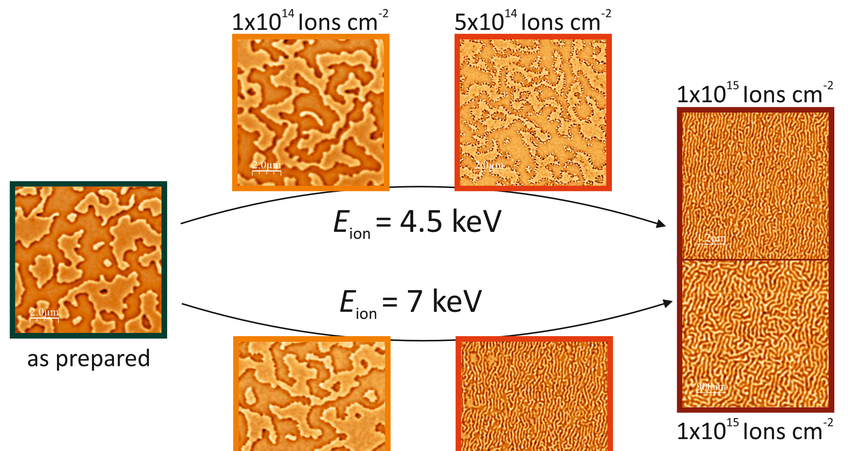
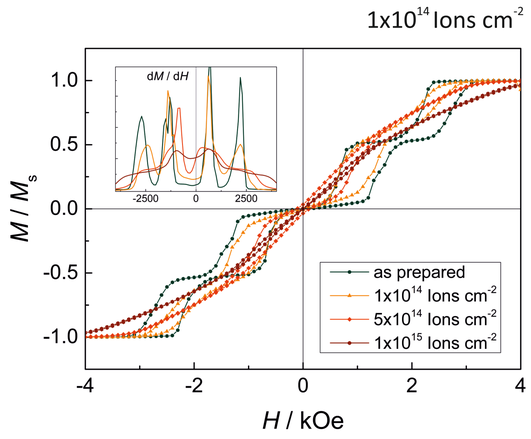
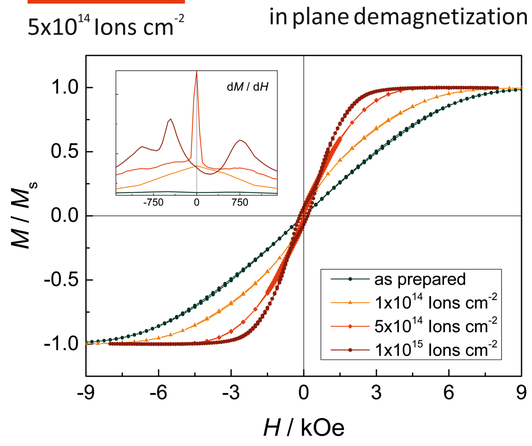


MFM images token after in plane demagnetization



out of plane hysteresis for samples irradiated by He^+ of E_{ion} = 7 keV



in plane hysteresis for samples irradiated by He^+ of E_{ion} = 7 keV

Acknowledgment

We would like to acknowledge HGST for the samples prepared by Olav Hellwig and Eric Fullerton, Roman Böttger for support and service at the IBC at HZDR and Christian Riedel for MOKE support.

[1] Olav Hellwig et al., J. Mag. Mag. Mat. 319, 2007
[2] Olav Hellwig et al., PRL 91, 2003
[3] J. Ziegler et al., *The Stopping of Ions in Matter* (Pergamon, New York, 1985), SRIM 2013 code

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