Magneto-ionic control of chiral magnetic textures for neuromorphic computing

PIC2 em Engenharia Física Tecnológica - Pitch

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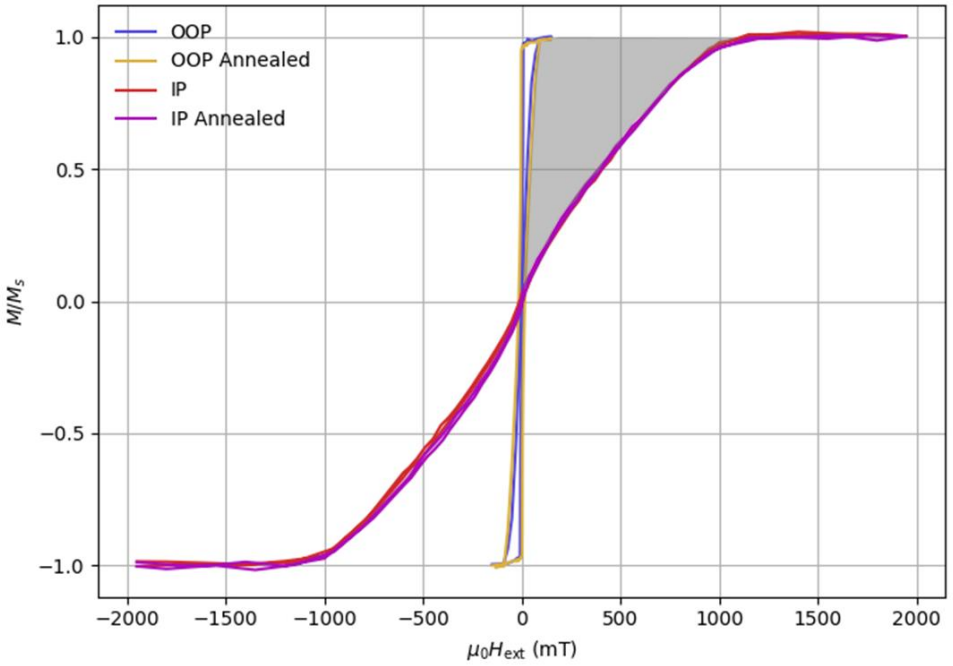
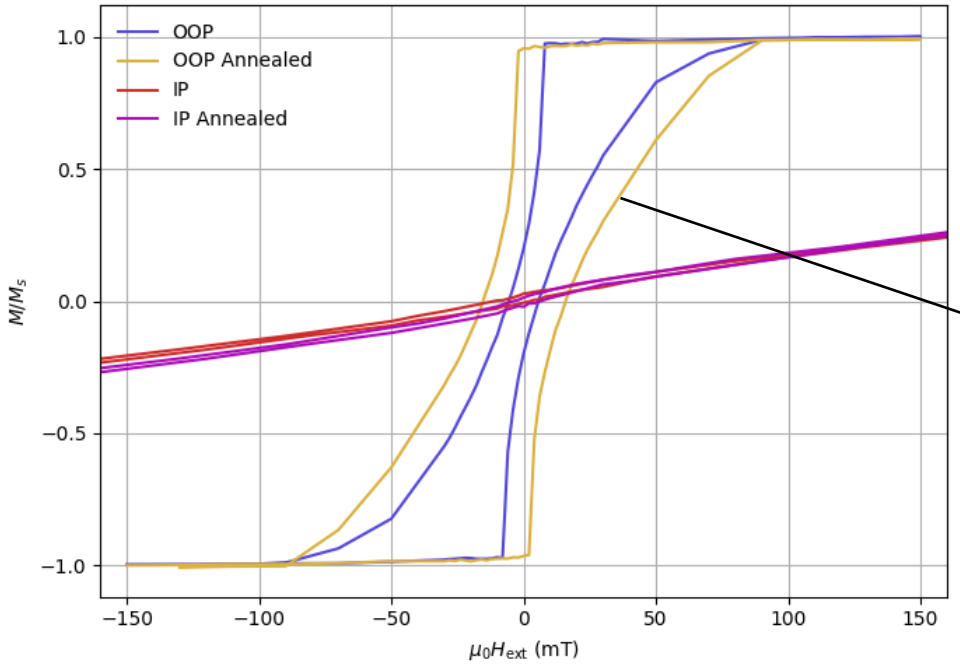
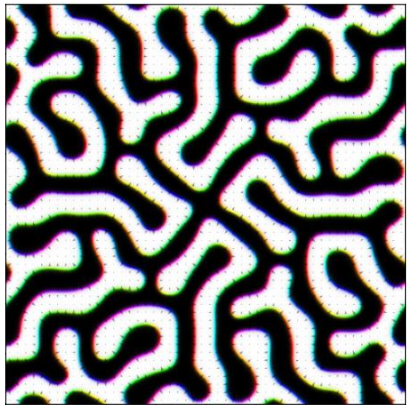
Magnetization and anisotropy



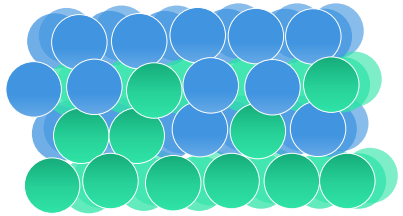


Changing maze domain area



$M_s = (820 \pm 120)\ kA/m$

No change in saturated magnetization due to annealing



Co/Pt intermixing

$$E_{mc} = \int_0^M \mu_0 \mathbf{H} \cdot d\mathbf{M}$$

$$K_u = K_{\text{eff}} + \frac{\mu_0 M_s^2}{2}$$

As-grown:

$K_{eff} = (490 \pm 60)\ kJ/m^3$

$K_u = (910 \pm 130)\ kJ/m^3$

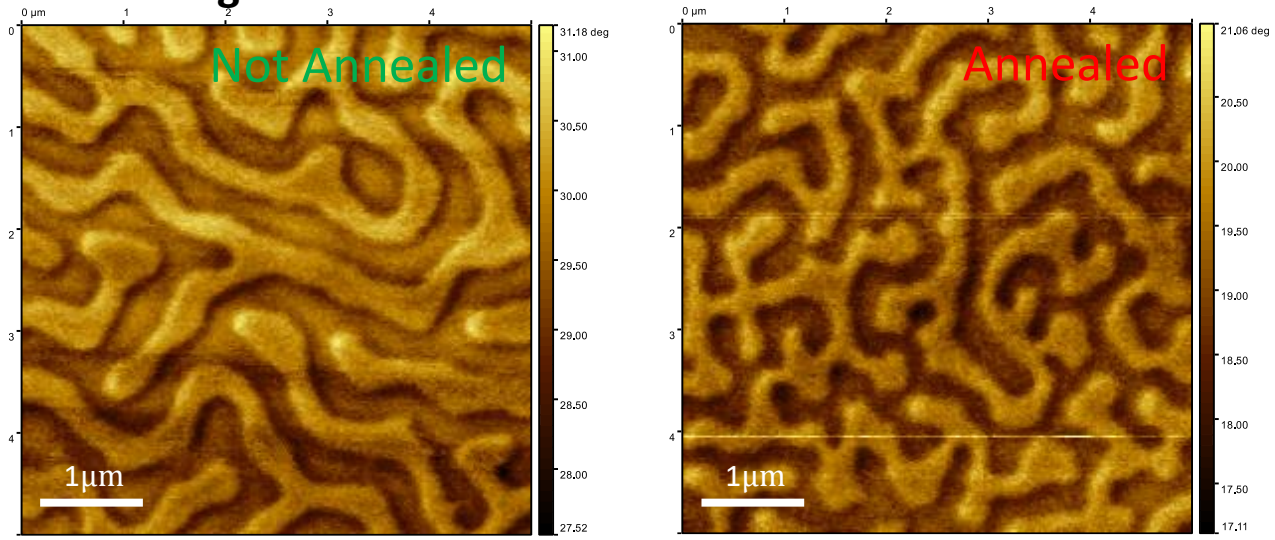
Annealed:

$K_{eff} = (480 \pm 60)\ kJ/m^3$

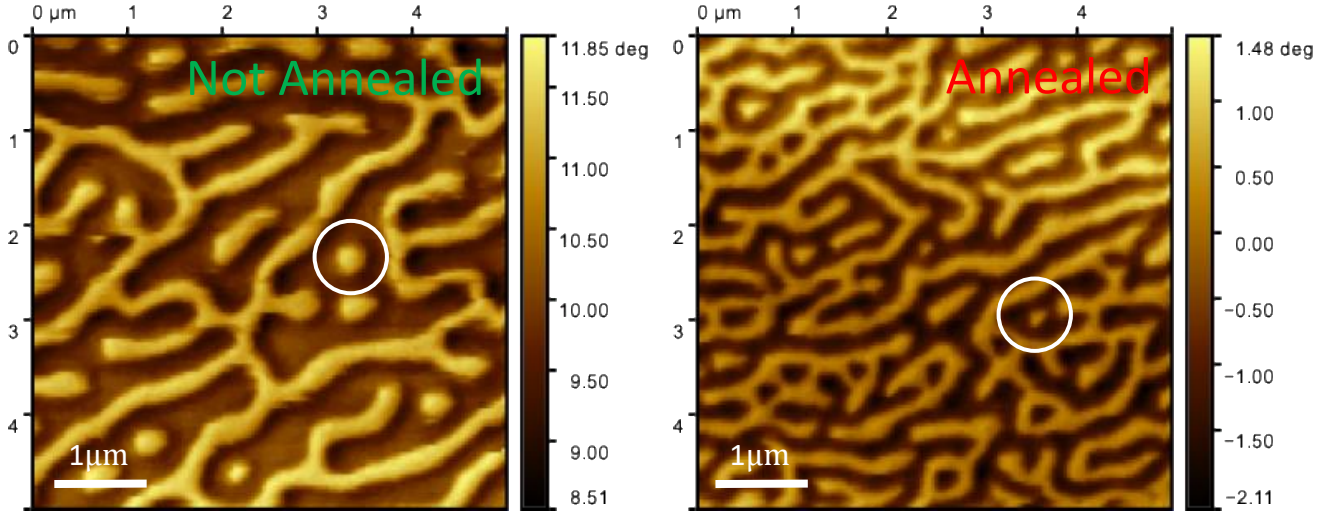
$K_u = (900 \pm 130)\ kJ/m^3$

Demagnetized state imaging

OOP Demag



IP Demag



DMI varies with annealing

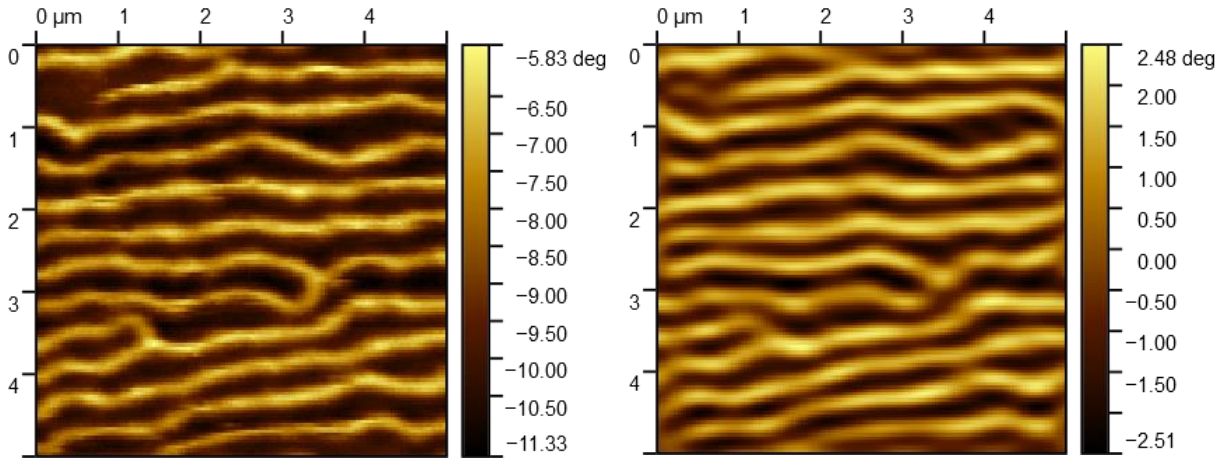
decrease of domain size and increase in periodicity by a factor of **2**

Isolated skyrmions size:

Not annealed ~300 nm

Annealed ~150 nm

Domain periodicity

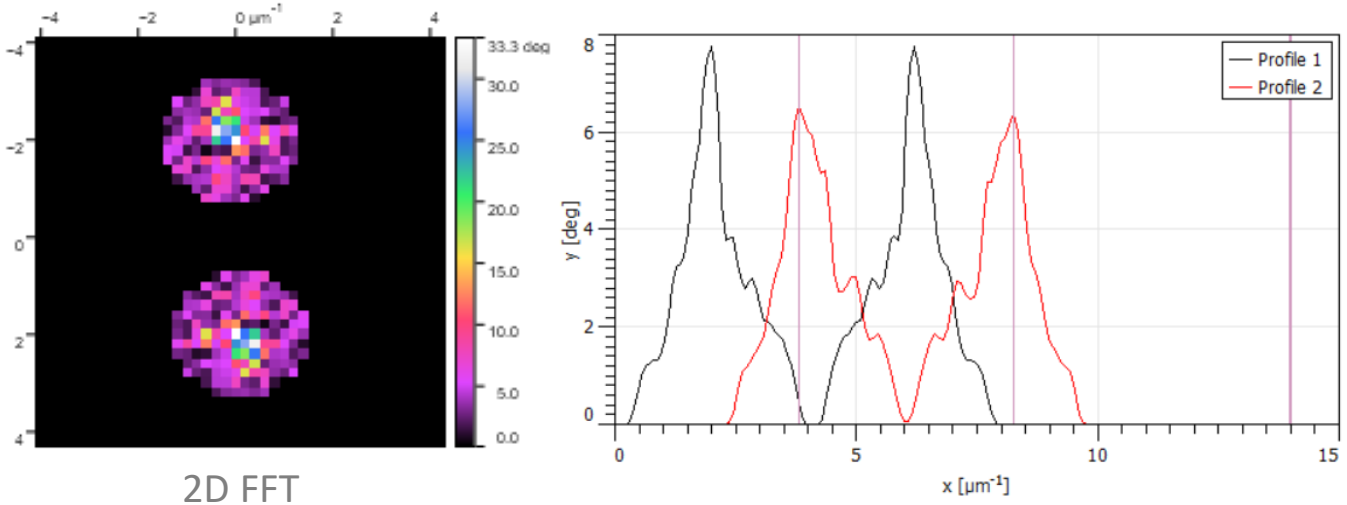


Raw MFM Filtered MFM

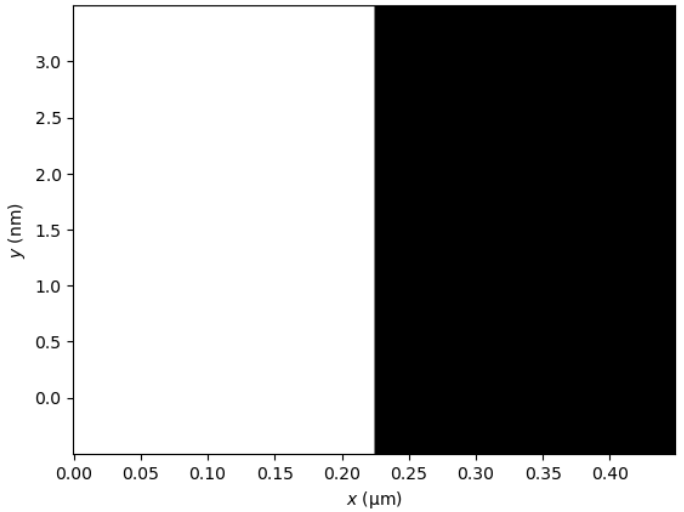
IP demagnetization with 10º tilt and smaller field decay

Domain periodicity (450 ± 20) nm

Find DMI strength, **D**, and exchange constant, **A**, that minimizes the total energy for a stripe configuration with a near 450 nm periodicity.

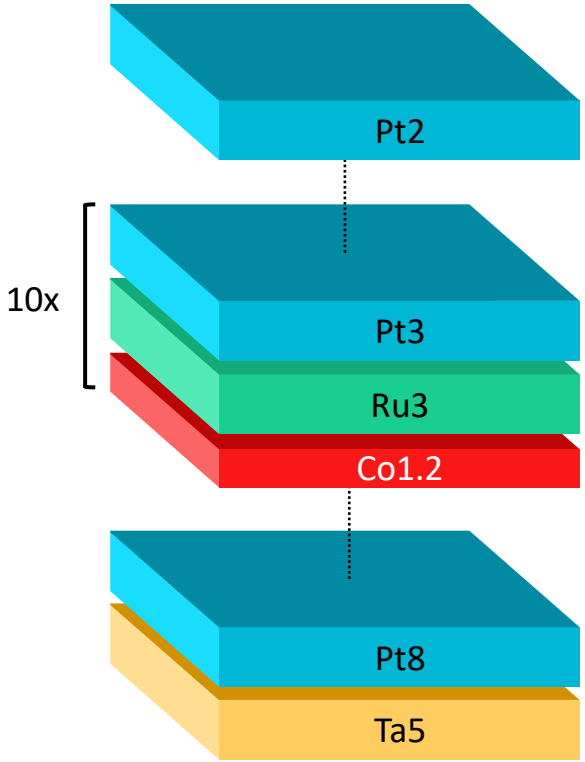


2D FFT Fourier Amplitude Profile

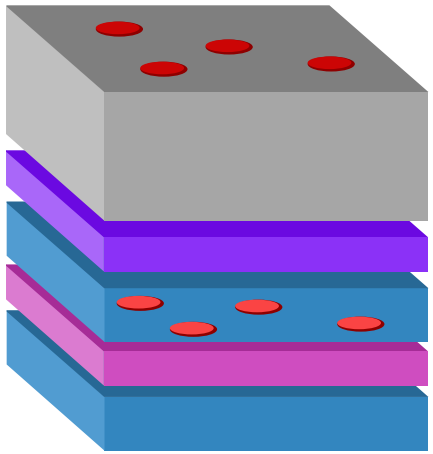


Future directions

1) Study the effect of thickness and layer repetition



2) Skyrmions imprinting for TMR readout



Skyrmion hosting Co/Ru/Pt-based multilayer

Imprinting spacer

CoFeB (~1 nm)
MgO (~1.4 nm)
CoFeB (~1 nm)
} MTJ

3) Voltage control of anisotropy writing