# Magnetic ratchet effect in cylindrical nanowires


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ICV Instituto de Cerámica y Vidrio

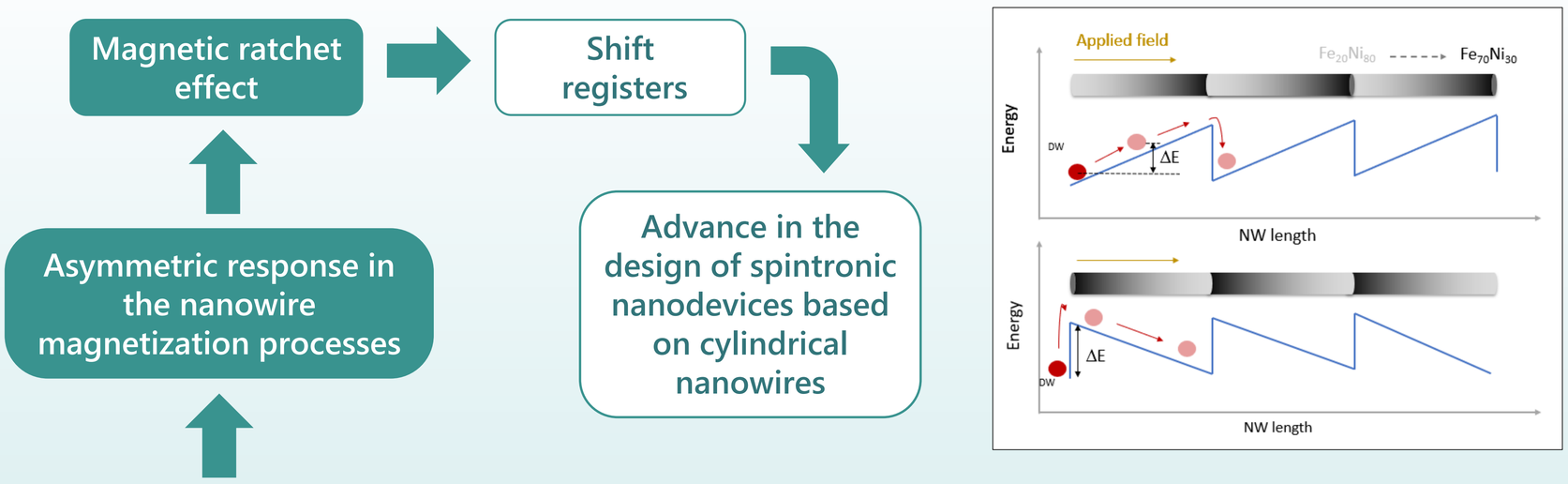

## Motivation

### Previous work

The introduction of local changes in composition in permalloy nanowires can act as efficient pinning sites for the domain walls (DWs)[1].
DWs can be moved by applying external magnetic or electric fields[2].

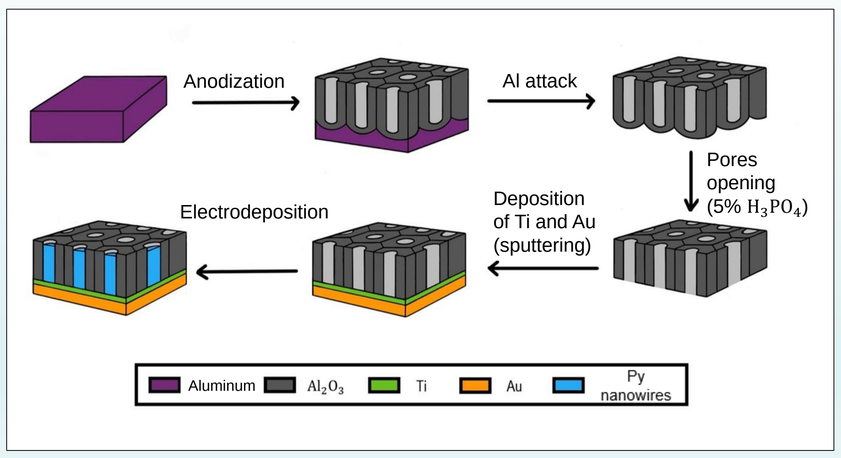
### Objectives

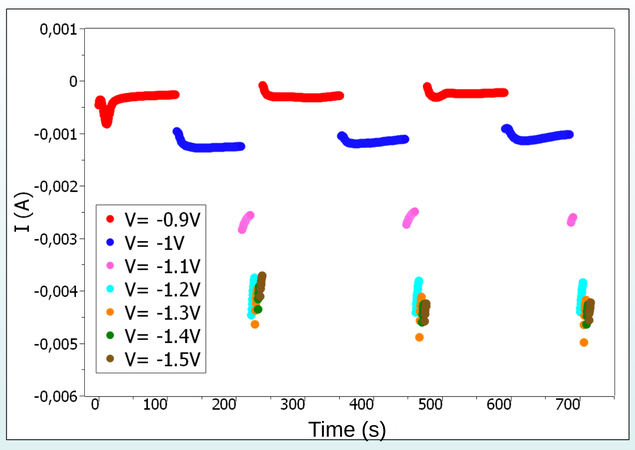
Design and synthesize FeNi ferromagnetic nanowires, introducing an asymmetry in the energy of the domain walls through a composition gradient in the axial direction of the nanowire.



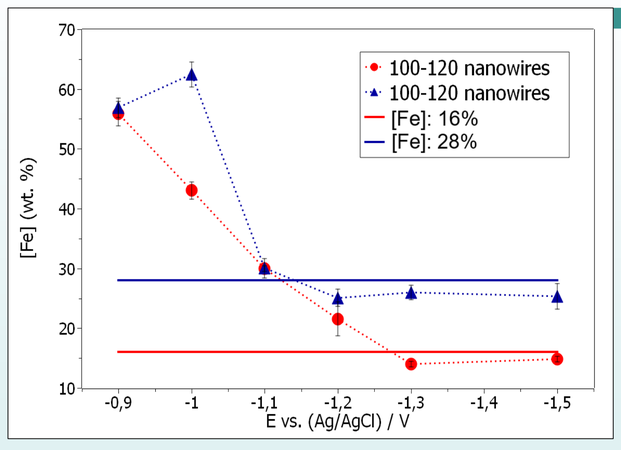

## Synthesis

### Synthesis of the ratchets



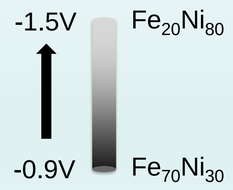




Electrodeposition procedure → Sequence of pulses of different duration and voltage



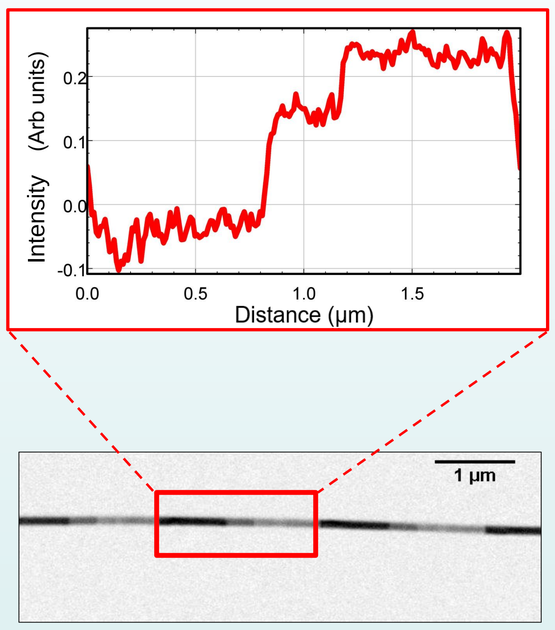

Calibration of the Fe-Ni ratio as a function of the applied voltage

We can control the composition by changing the applied voltage




## Characterization

### TXM

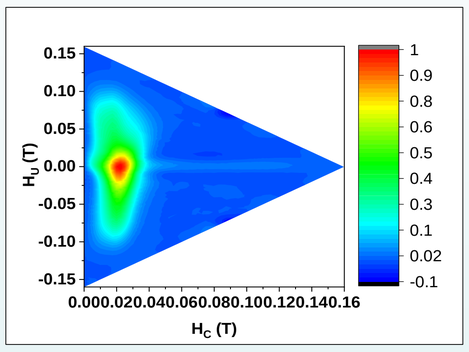



Chemical structure of the nanowires with composition gradients of 2 μm in length

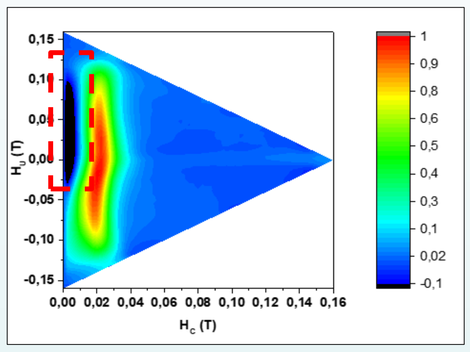
## Magnetic behaviour

### FORC measured in arrays of nanowires

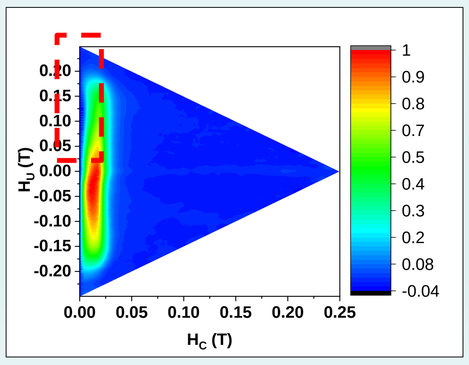
Ny nanowires



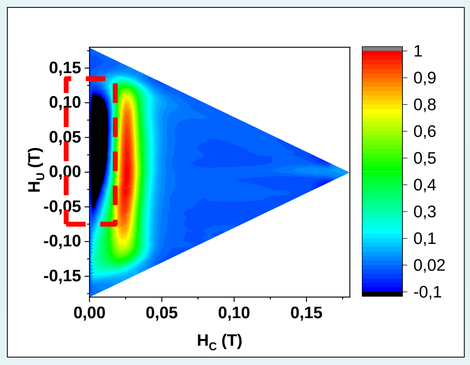

Ratchet 2 μm



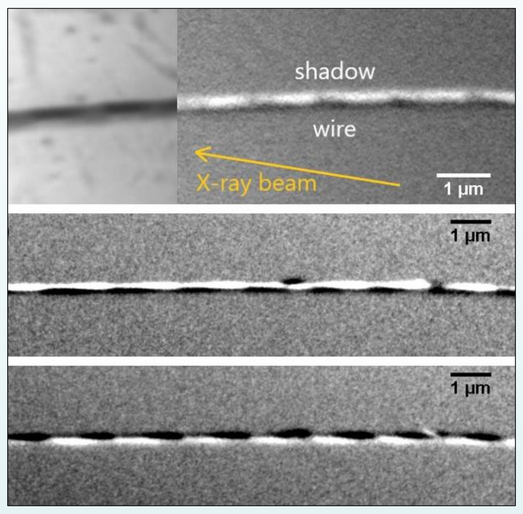

Ratchet 1 μm




Ratchet 4 μm




### XMCD-PEEM




- ❖ Asymmetric response by applying increasing pulses of magnetic field
- ❖ Well-defined asymmetry in the FORC diagram that can be attributed to the magnetic ratchet effect.
- ❖ Shorter ratchet's lengths increase the magnetic interaction field while longer ratchets decrease them

## Conclusions

✓ It has been possible to design and synthesize magnetic FeNi nanowires with gradual variations in composition along the axial direction.
✓ Composition variations can be introduced in a controllable and reproducible way by applying voltage pulses during growth.
✓ Preliminary magnetic measurements have shown the presence of magnetic asymmetries due to the composition gradient and, therefore, to the existence of a magnetic ratchet effect.

## References


[1] S. Ruiz-Gómez et al. Nanoscale. (2020) 17880-17885.
[2] S. Ruiz-Gómez et al. Sci. Rep. (2018) 16695.