Annealing Magnetic Thin Films In a Magnetic Field

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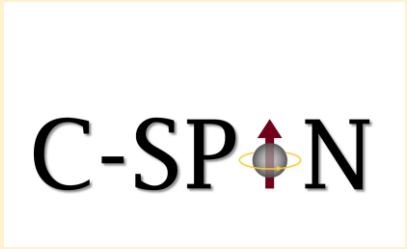


Who Could Use a Better Computer?

1.

2.

3.

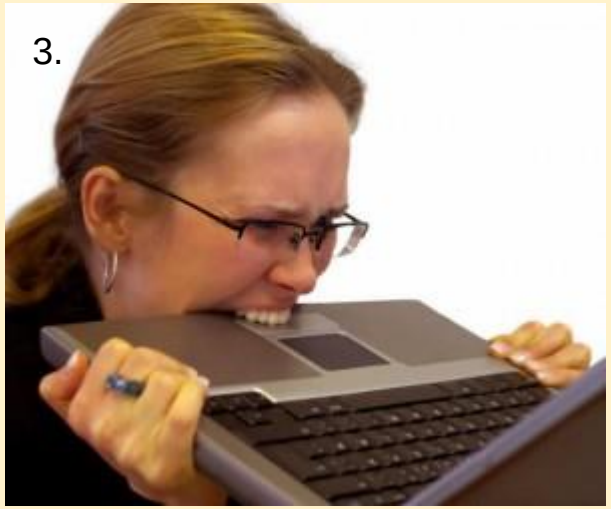
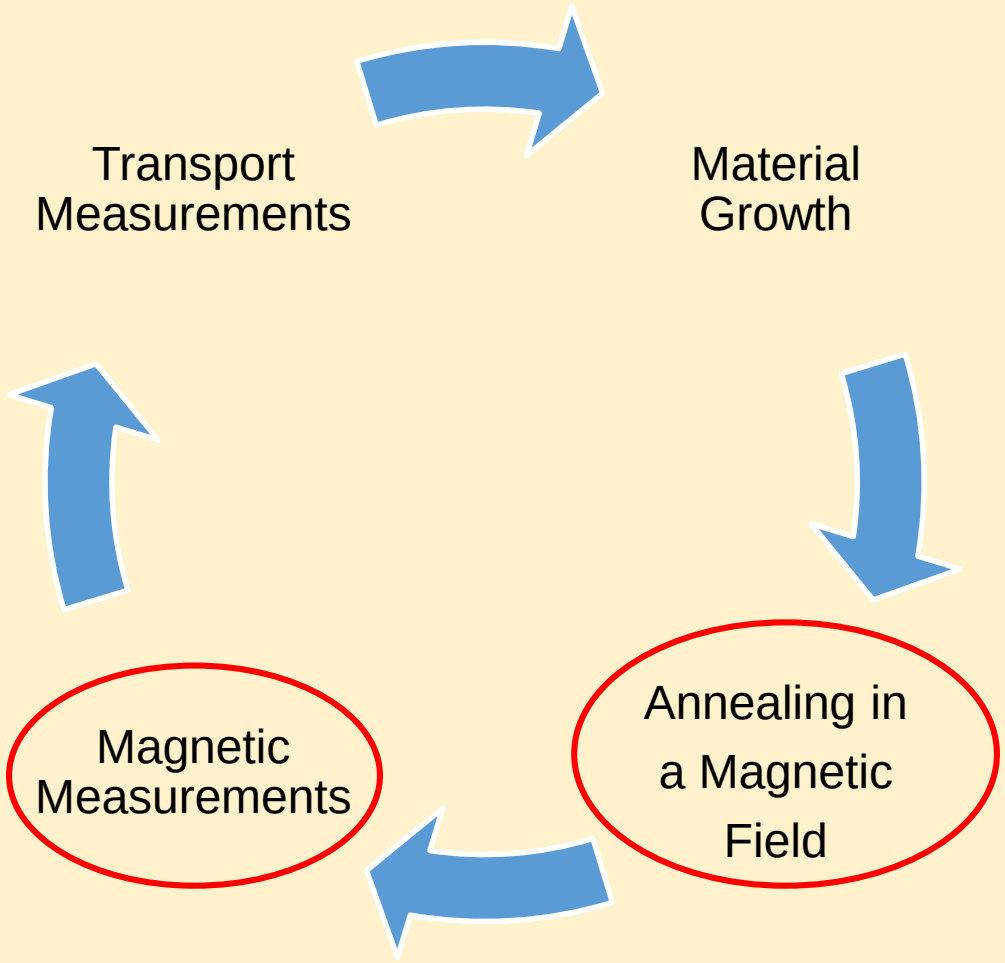
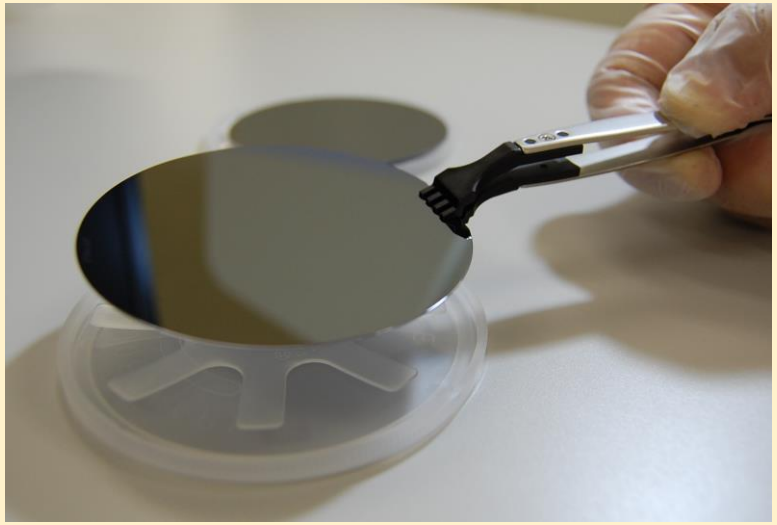


Photo Sources

1.Ratkacher Station
2.North American Computer
3.A1 Computer

The Complete Process of Material Refinement



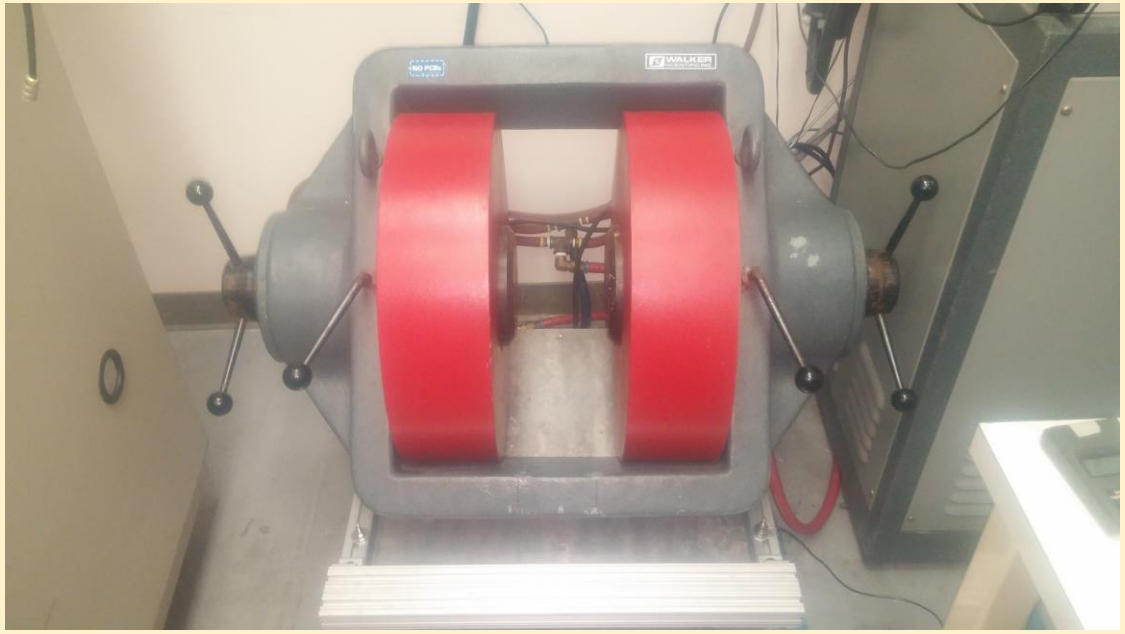


Source: QD Laser

Enable Vacuum Annealing Within Magnetic Field

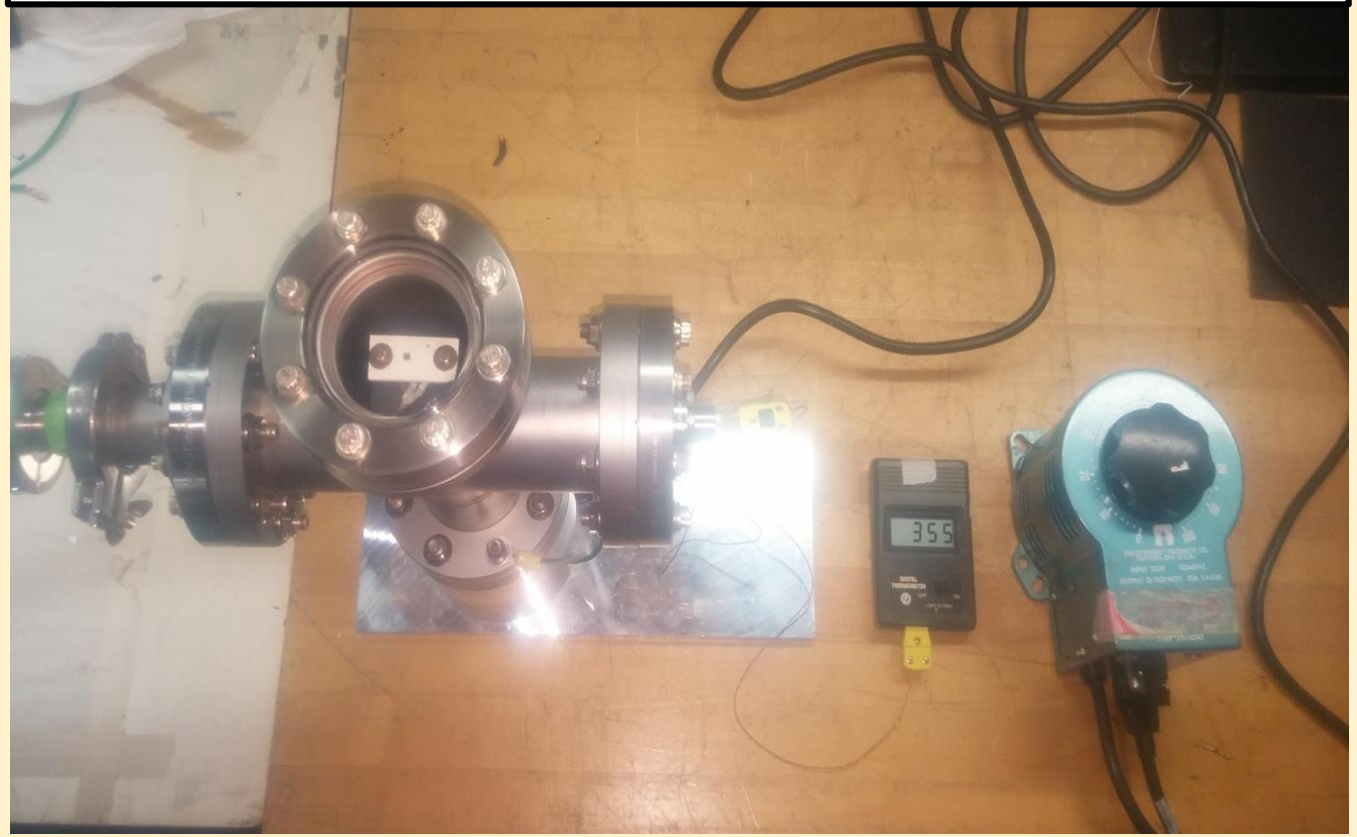
- Construct vacuum strip annealer
  Annealer must:
  - Fit in between two magnets
  - Operate between 200°C and 600°C
  - Have no magnetic components
  - Not outgas at high temperatures in vacuum

- Use the vacuum strip annealer to facilitate experiments on thin films grown in the lab.

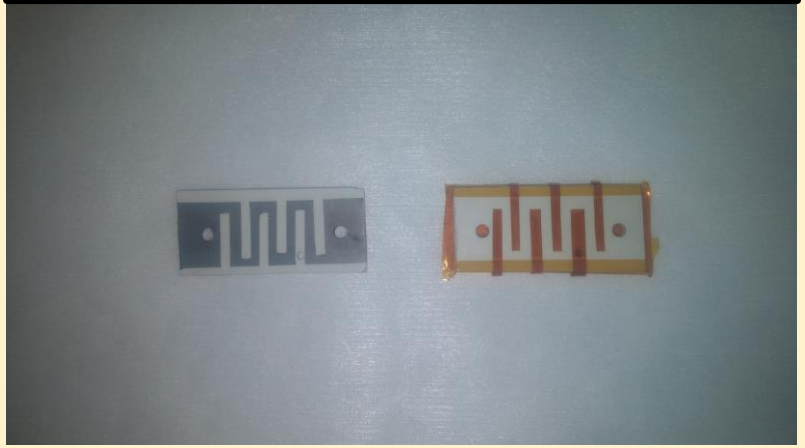


Goal #1 Complete - Vacuum Strip Annealer

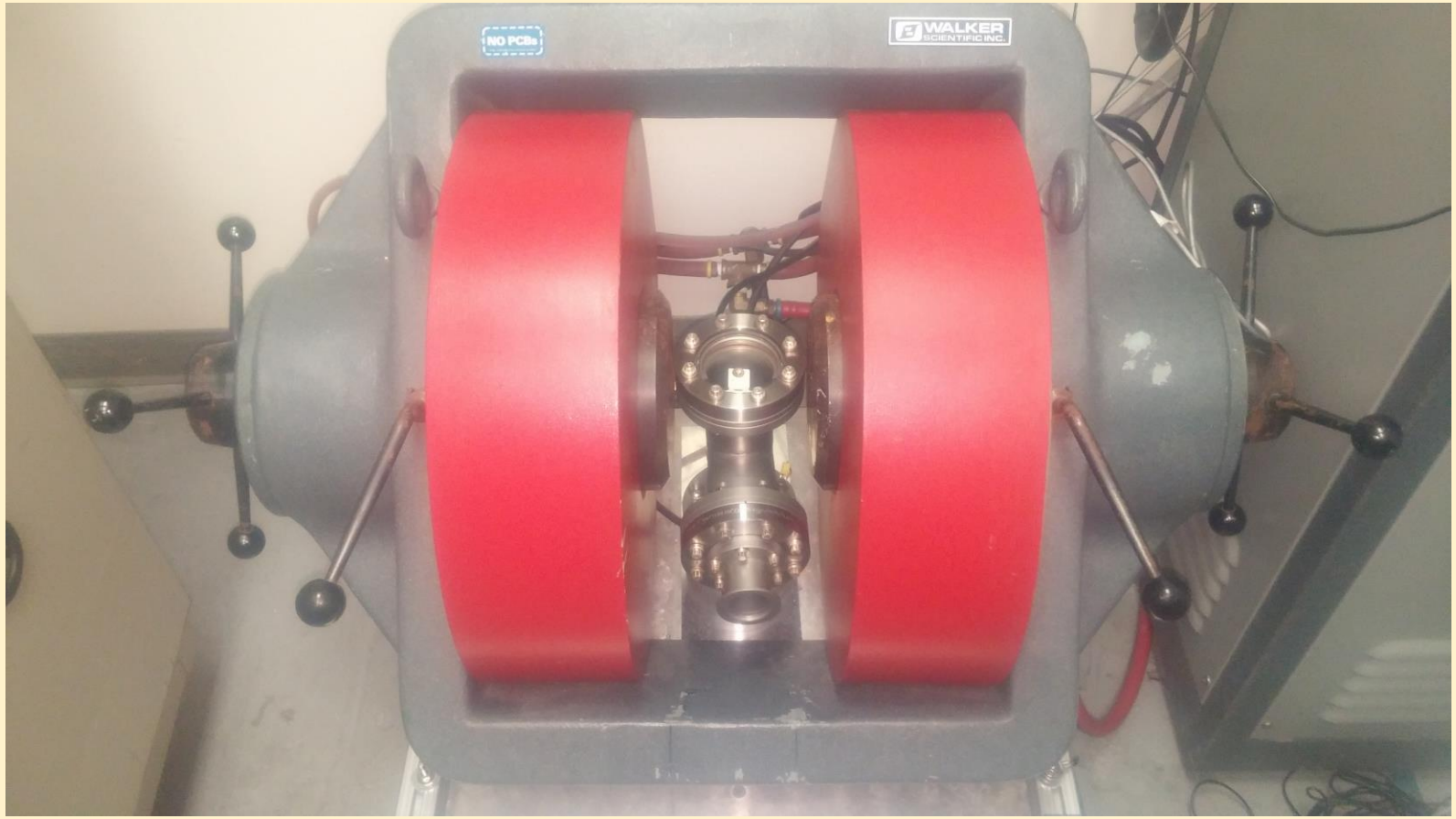
Vacuum strip annealer with associated components



Heating element machined from Boron Nitride with Titanium Tungsten sputter deposition



Experimental Setup for Annealing in Magnetic Field

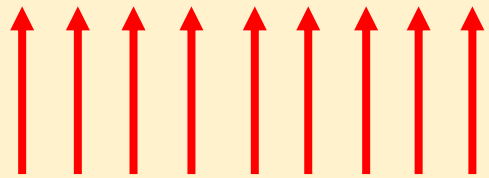
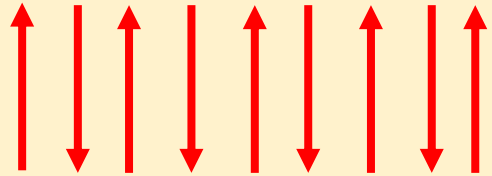


Crystalline Thin Film Materials With Magnetic Properties

➔Material Growth

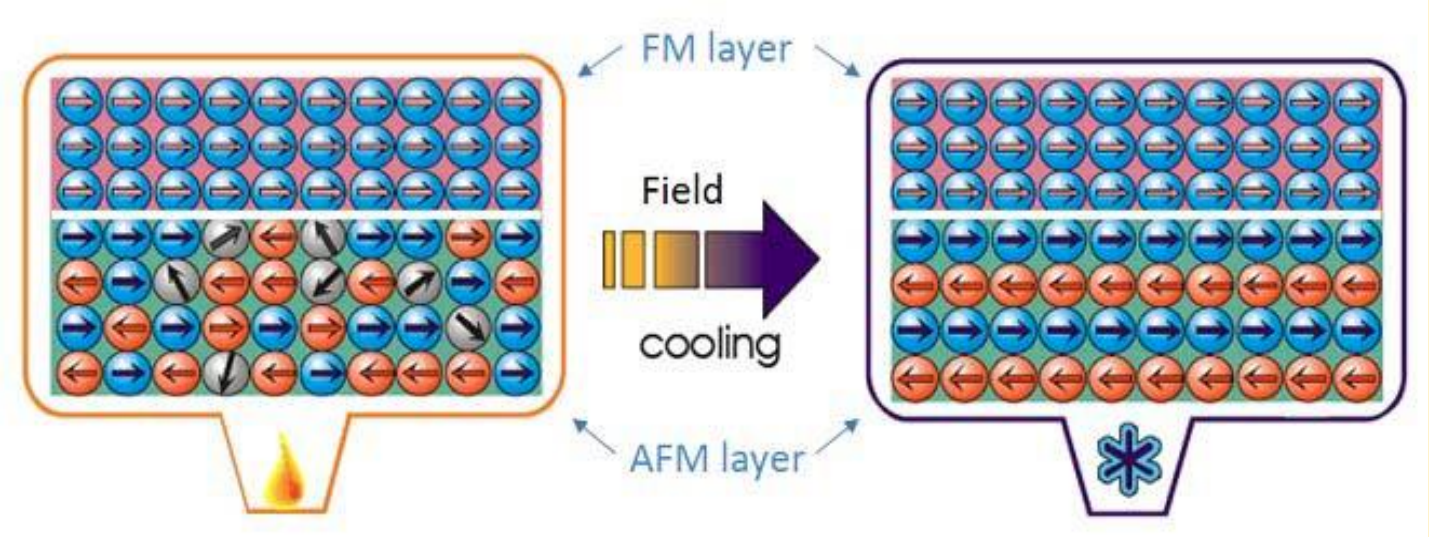
- ◆ Ferromagnetic/Antiferromagnetic Crystalline Thin Films

Magnetic Transition Temperature
Curie Temperature for Ferromagnets
Néel Temperature for Antiferromagnets

Magnetic Dipole Moment (Below magnetic transition temperature with no externally applied magnetic field)	
Ferromagnetic	
Antiferromagnetic	

What Happens When You Anneal in a Magnetic Field?

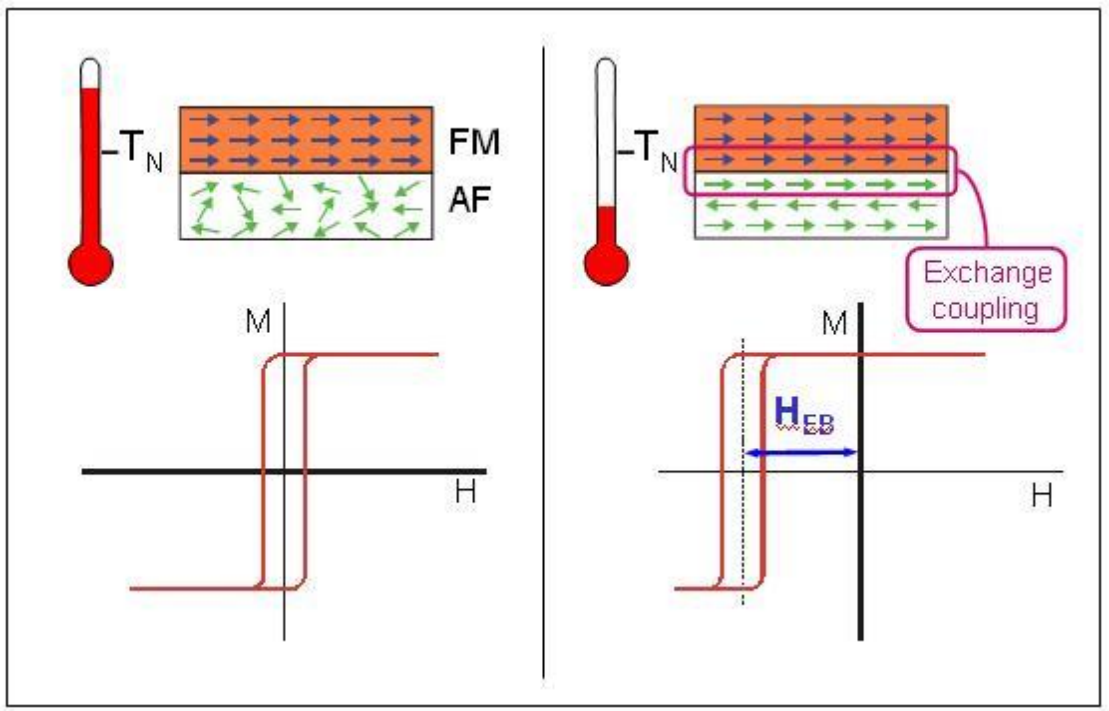
No externally applied magnetic field



With externally applied magnetic field

After magnetic thermal annealing, an antiferromagnet becomes much more ordered and pins the adjacent ferromagnetic layer.

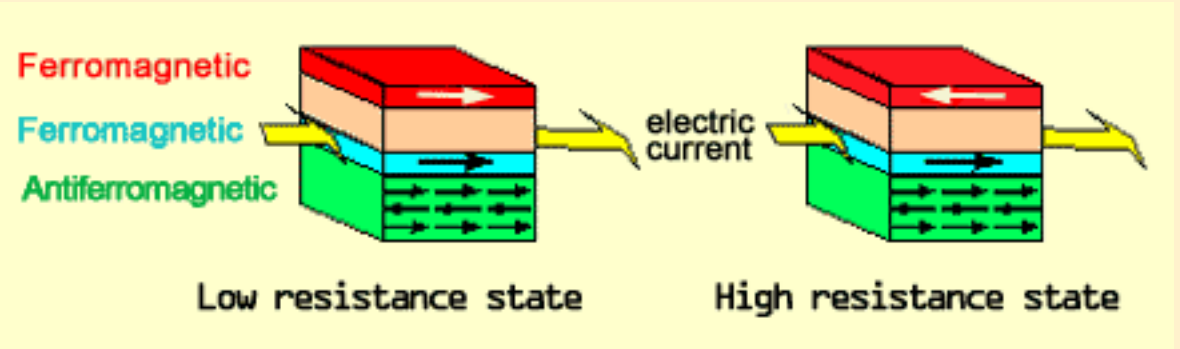
Expected Magnetism and The Exchange Bias



Above the Néel temperature of the AFM all its spins are disordered. Below T_N they become ordered and the exchange coupling between FM and AFM spins leads to the shift of the hysteresis loop.

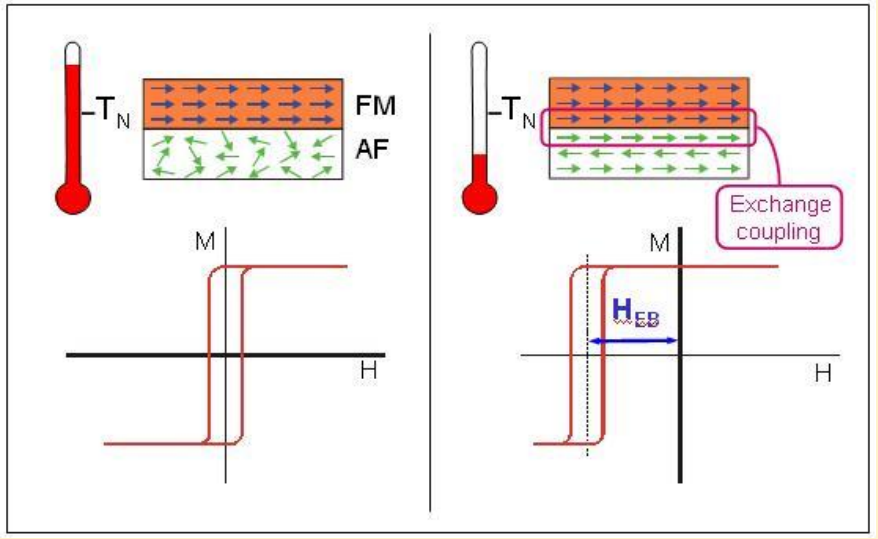
Source: Schuller Nanoscience Group, UCSD

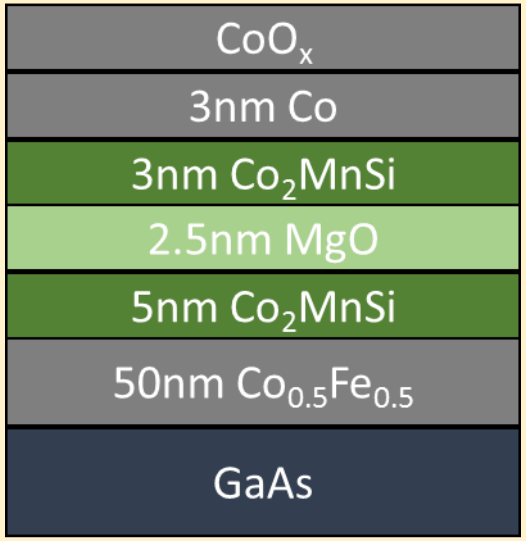
Magnetic Memory Cell

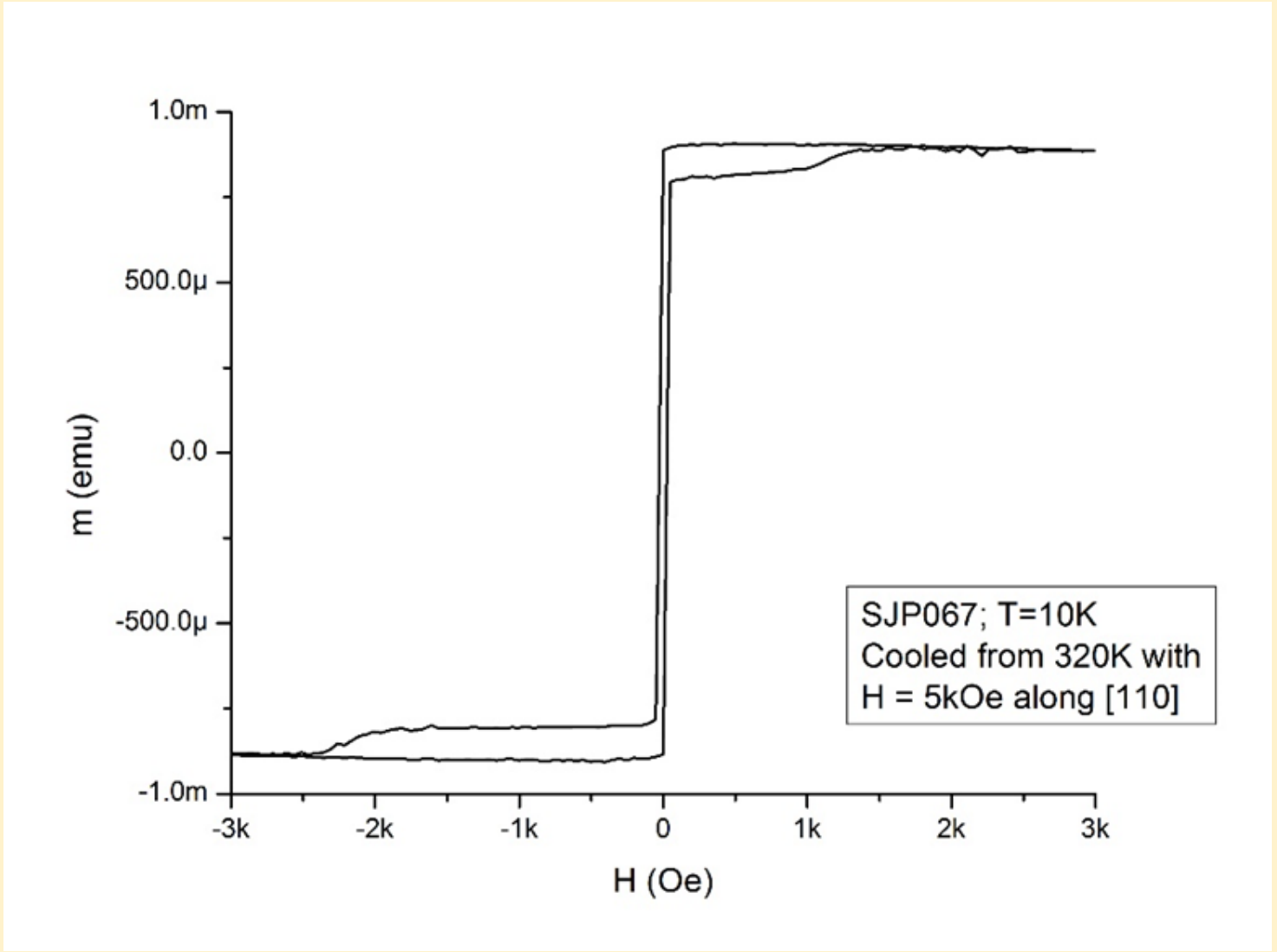


Source: Berkeley Lab

Magnetic Measurement Data





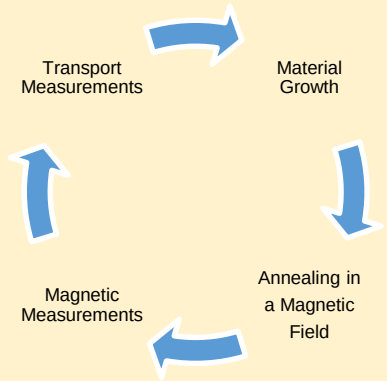


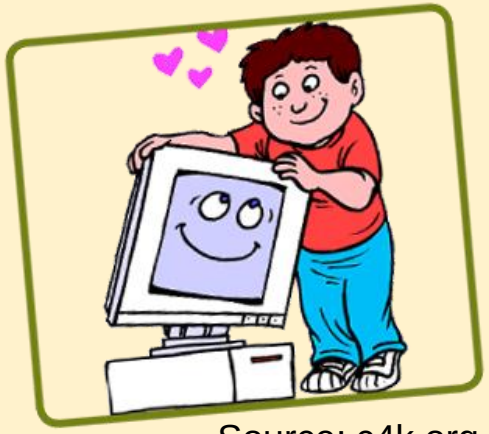
Conclusion and Future Direction

- ➔Annealing in a magnetic field is a vital step in creating magnetic memory storage used in computers and other electronics

- ➔Improvements to Vacuum Strip Annealer
  - ◆Heating element is very sensitive and is easily damaged
  - ◆Difficult to load samples

- ➔Improvements to Crystalline Thin Films
  - ◆Continue magnetic and transport measurements
  - ◆Optimization of magnetic materials systems





Source: c4k.org