Rotating Magnetization with Lattice Strain

Altering crystal structure of unique magnetic films manipulates of magnetization orientation

- Magnetic anisotropy defines the functionality in many applications including magnetic data storage, strong permanent magnets, and electrical transformers.
- Sr_2FeMoO_6 (SFMO) and Sr_2CrReO_6 (SCRO) are unique magnetic materials whose strong anisotropy aligns with crystalline structure ("magneto-crystalline anisotropy") that arises from the heavy elements Mo and Re.
- Researchers at The Ohio State University's Center for Emergent Materials have shown that the magneto-crystalline anisotropy of SFMO can be manipulated (strain-tuned) to change the direction anisotropy by varying the material on which the SFMO is grown (substrate).
- They have shown SCRO to have an extraordinarily large magneto-crystalline anisotropy—much larger than any other magnetic materials known to date—also by manipulating the substrate on which the SCRO is grown.
- The discovery of these new characteristics in SFMO and SCRO provides a platform for investigating the underlying magnetic interactions in magnet oxides and offers the opportunity for new applications.

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Changing the material on which SFMO is grown rotates the magneto-crystalline anisotropy

Film lattice (stretched out of plane)

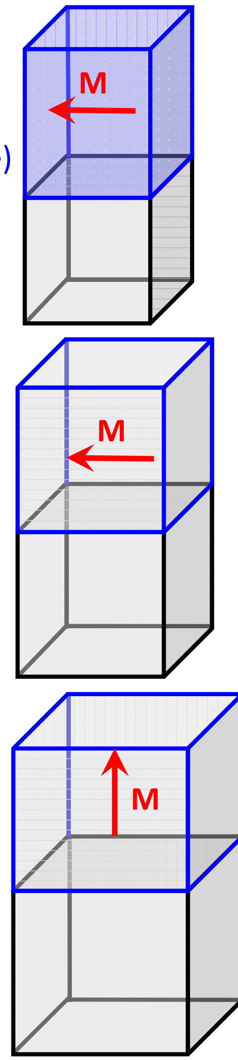
Substrate (smaller lattice)

Film lattice (cubic)

Substrate (perfectly matched lattice)

Film lattice (stretched in-plane)

Substrate (larger lattice)



- Substrate with finer crystal lattice
  → Film lattice stretched out of plane.
- Magnetization (**M**) lies in-plane because
  - Magneto-crystalline anisotropy lies along shorter lattice axis
  - This adds to shape anisotropy (always in plane)

- Substrate with perfectly matched lattice
  → Cubic film lattice (un-stretched).
- In-plane **M** is easier to rotate
  - zero magneto-crystalline anisotropy
  - shape anisotropy (always in plane)

- Larger substrate lattice
  → Film lattice stretched in plane.
- Out-of-plane **M** due to
  - Magneto-crystalline anisotropy lies out of plane (along shorter lattice axis) overcoming shape anisotropy (in-plane).

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