

# Current-density-modulated Antiferromagnetic Domain Switching in CoO(001)/Pt Bilayer Revealed by Optical Imaging

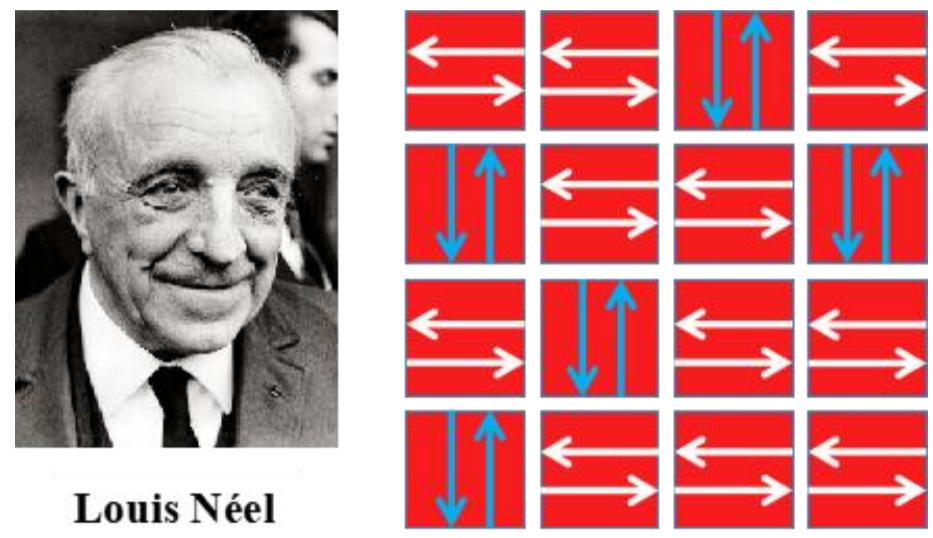


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## Motivation

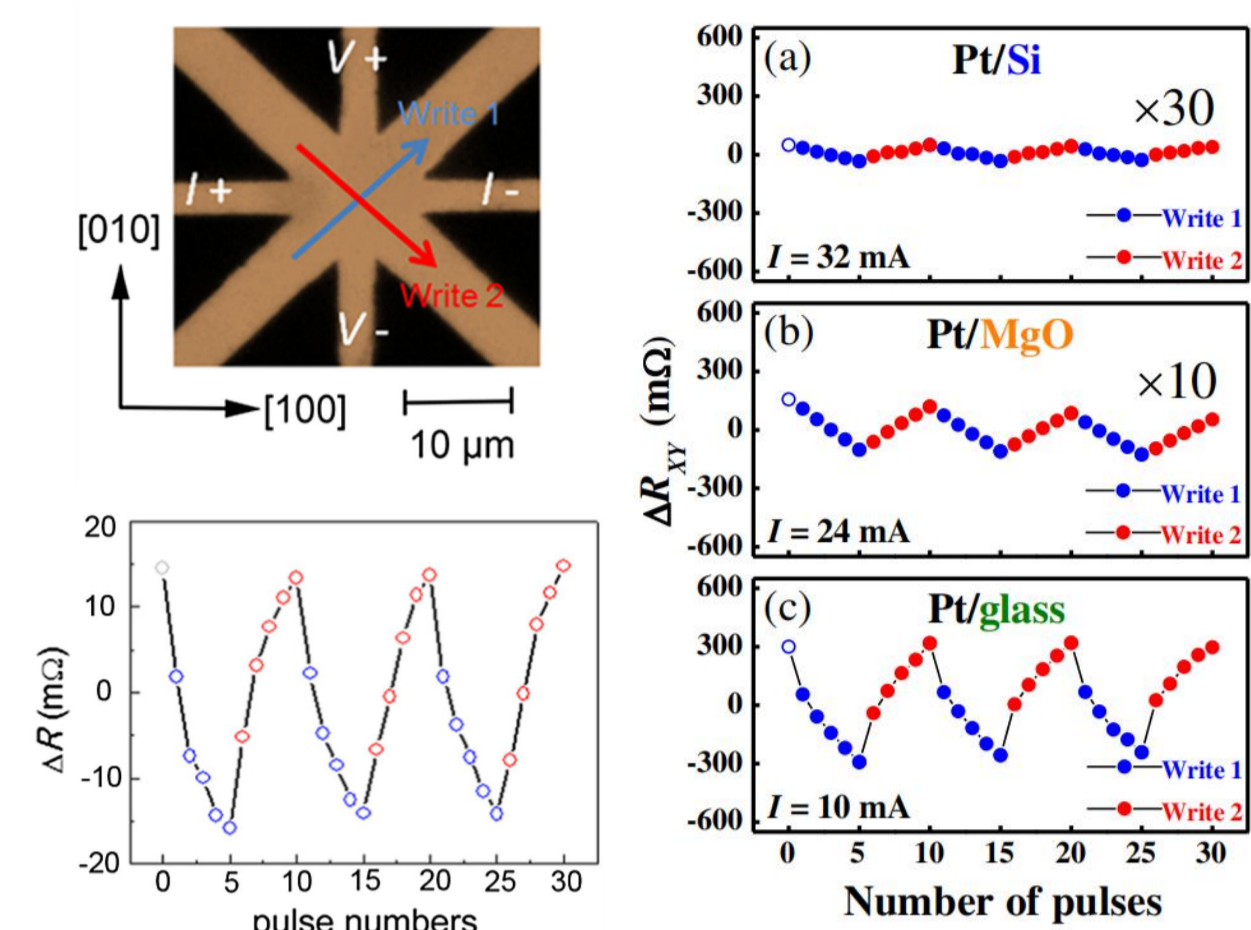
### Antiferromagnetic Spintronics



- ✓ High-density data storage
- ✓ Absence of stray fields
- ✓ Ultrafast dynamics (THz)
- ✓ High energy efficiency

➤ Attractive and promising!

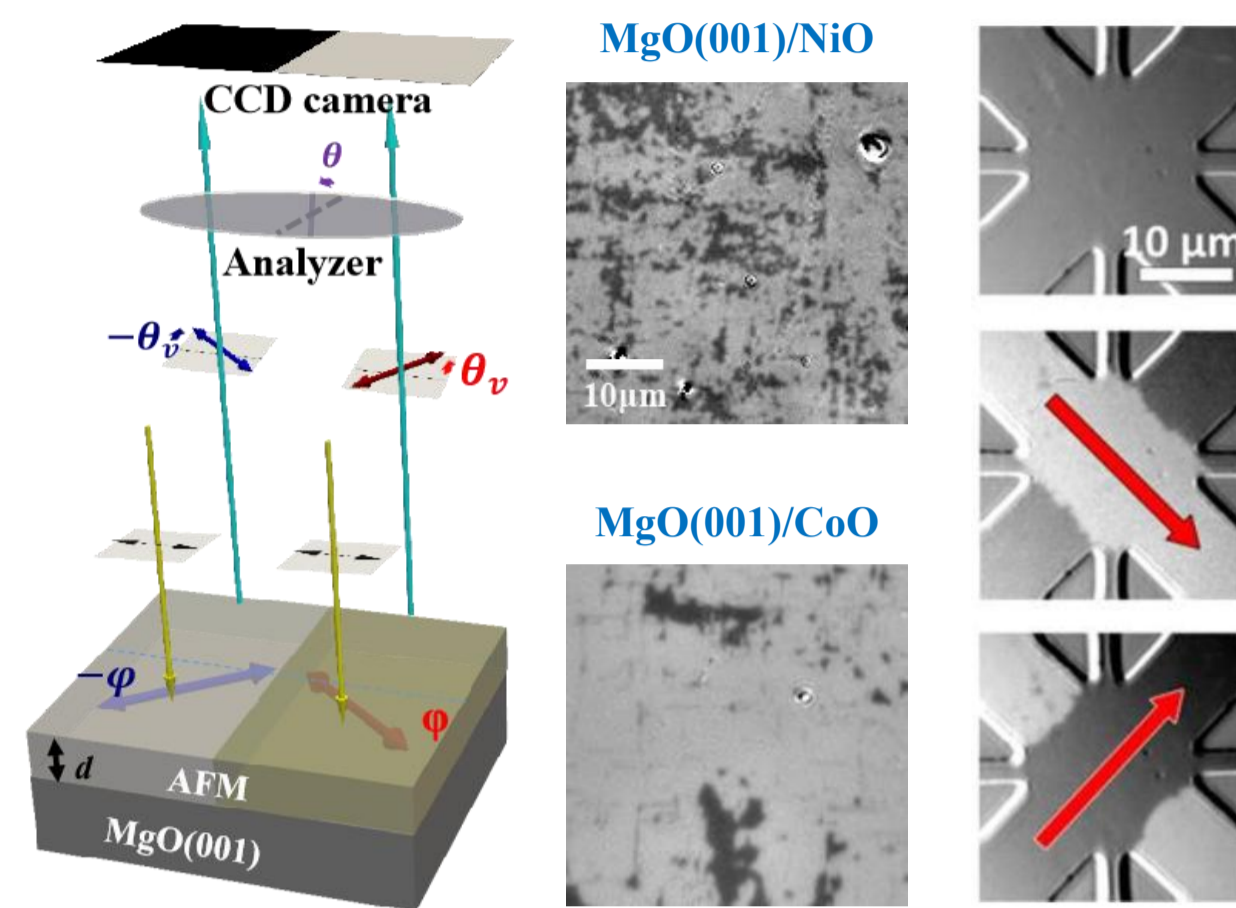
### Electrical detection of AFM domain switching



X.Z. Chen, et al. PRL (2018) C. C. Chiang, et al. PRL (2019)

➤ Non-magnetic origin?

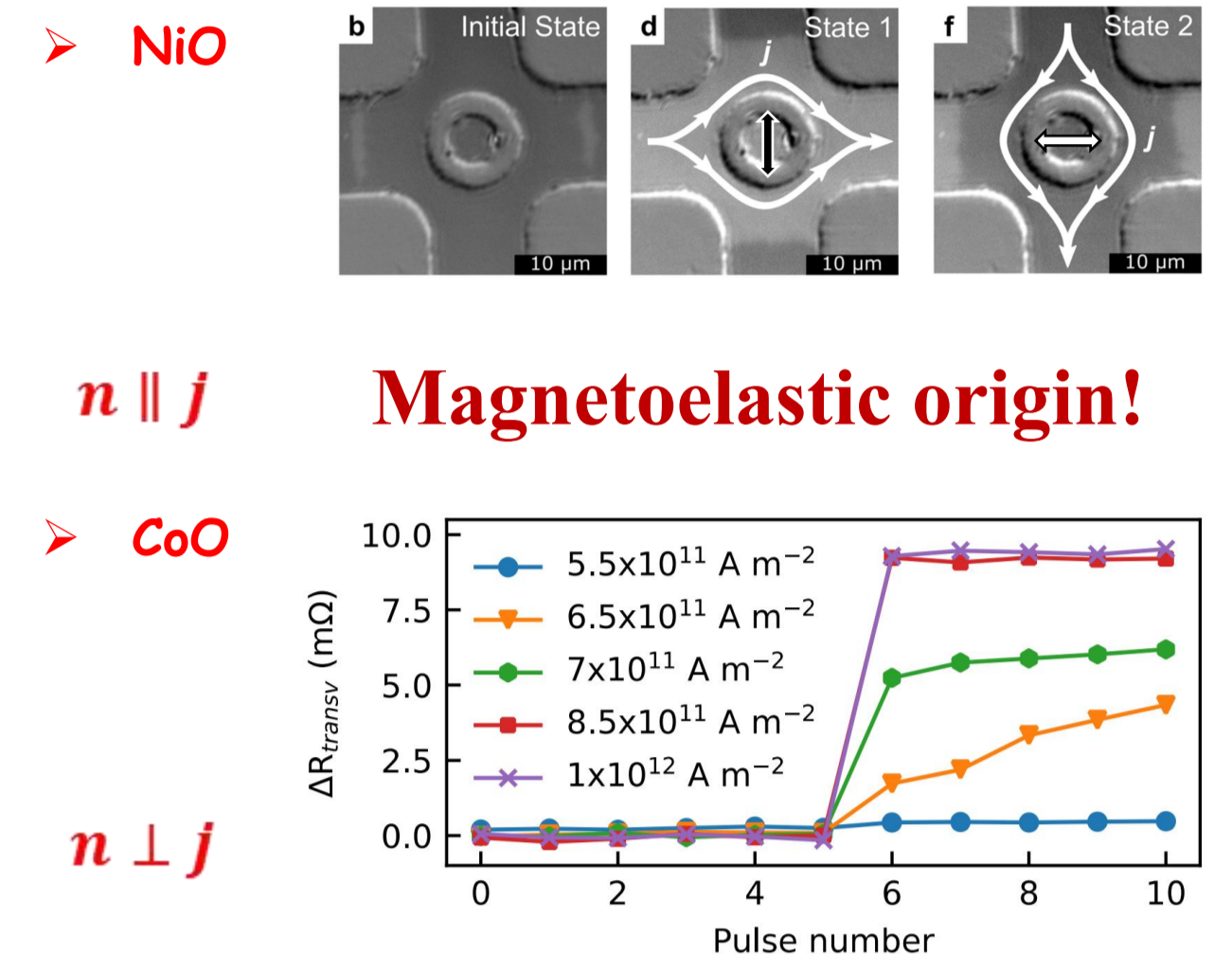
### Direct imaging of AFM domain



J. Xu, et al. Phys. Rev. B (2019) F. Schreiber, et al. APL (2020)  
 J. Xu, et al. New J. Phys. (2020)

➤ Real domain switching!

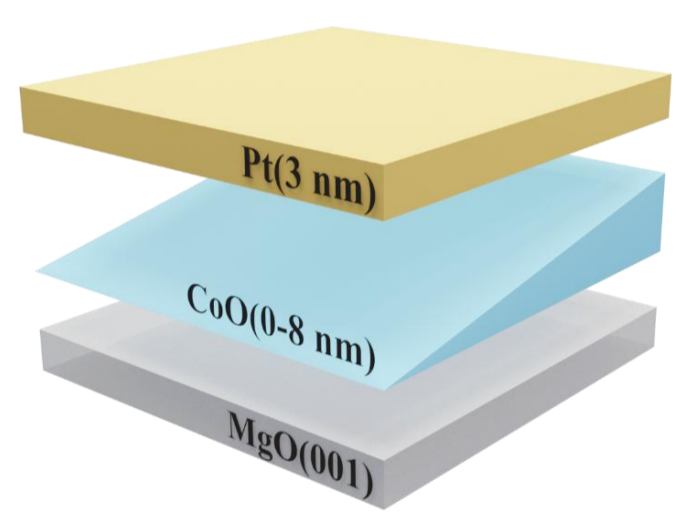
### Current switching mechanism



➤ AFM domain switching in CoO?

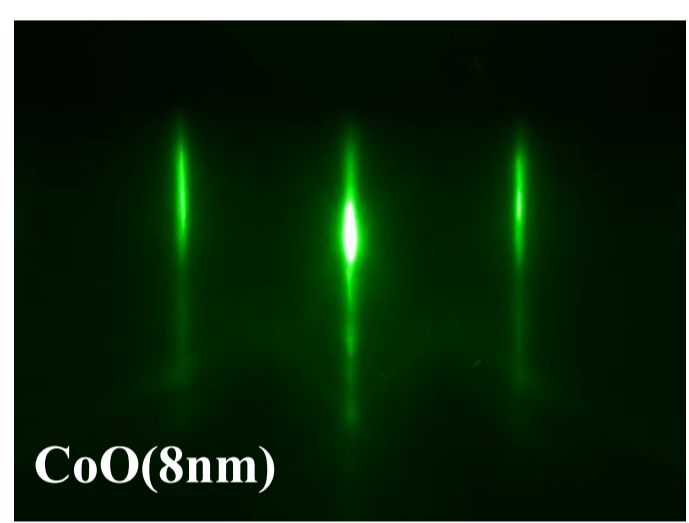
## Sample preparation and measurement

### Sample structure



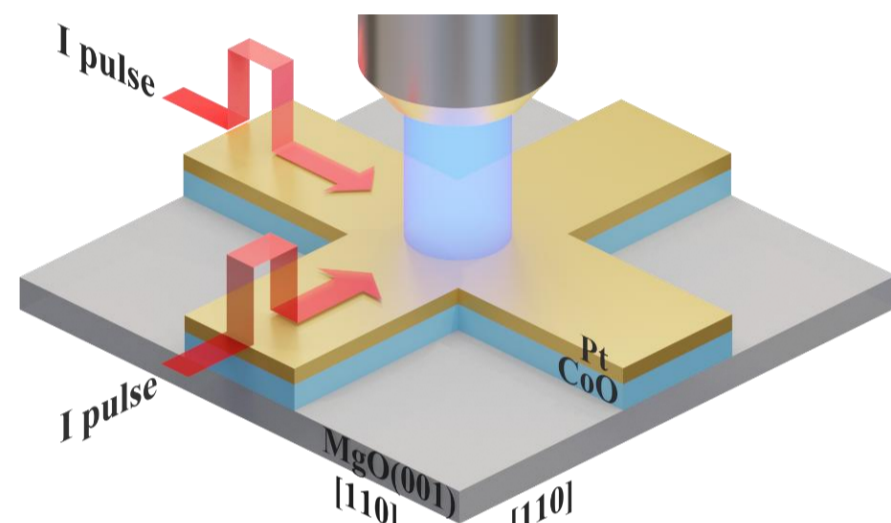
CoO wedge film

### RHEED pattern



High quality single crystal film

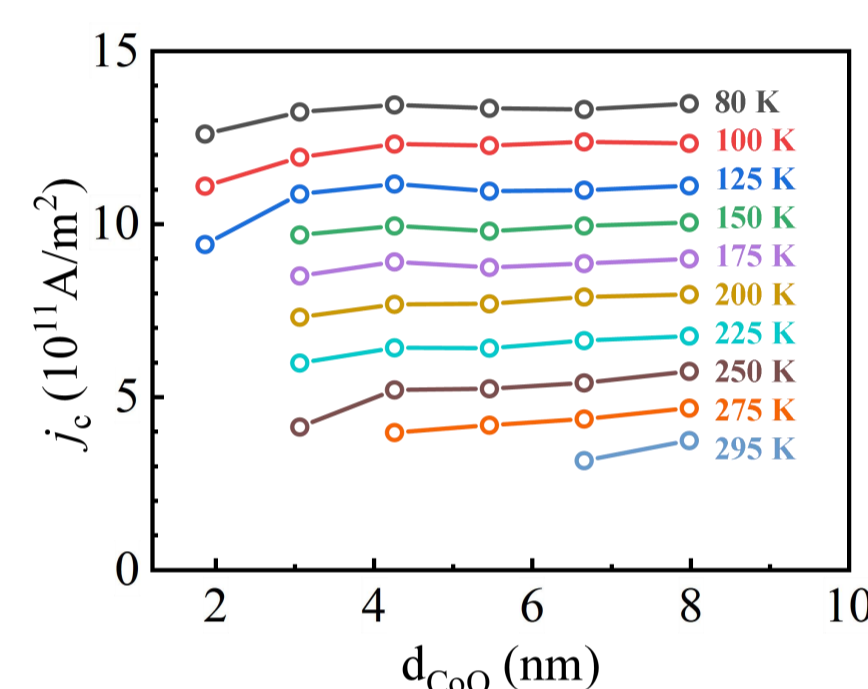
### Measurement



Imaging domain switching

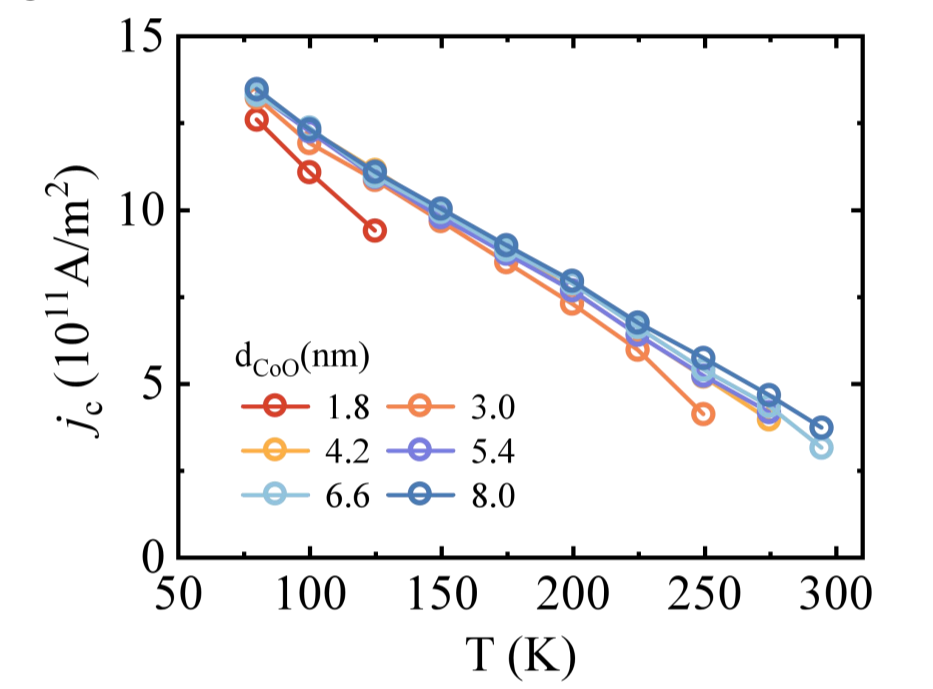
## Mechanism for current switching

### $j_c$ Vs. $d_{CoO}$



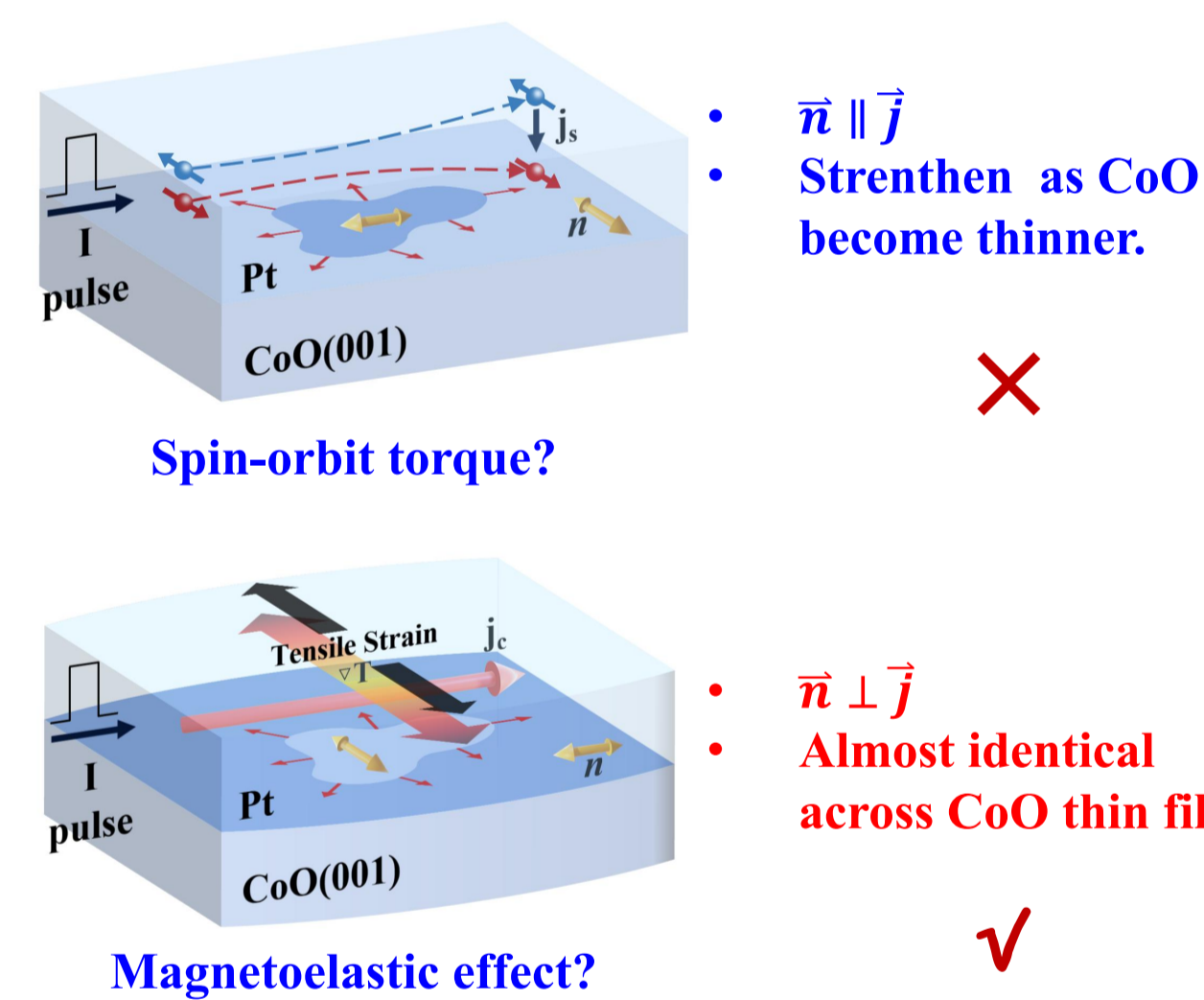
$J_c$  is independent of  $d_{CoO}$  with a fixed  $T$

### $j_c$ Vs. $T$

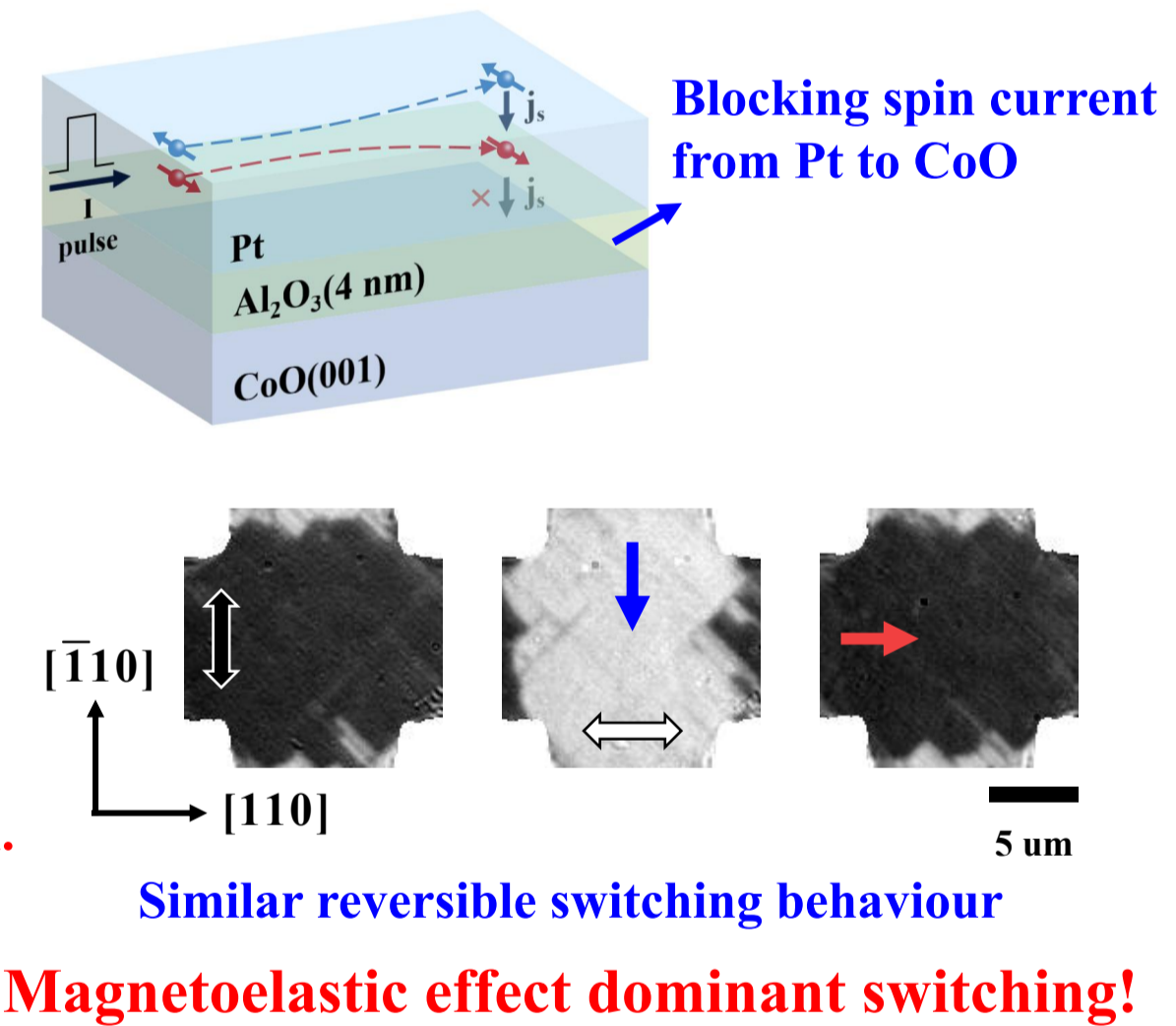


$J_c$  decreases linearly with the  $T$

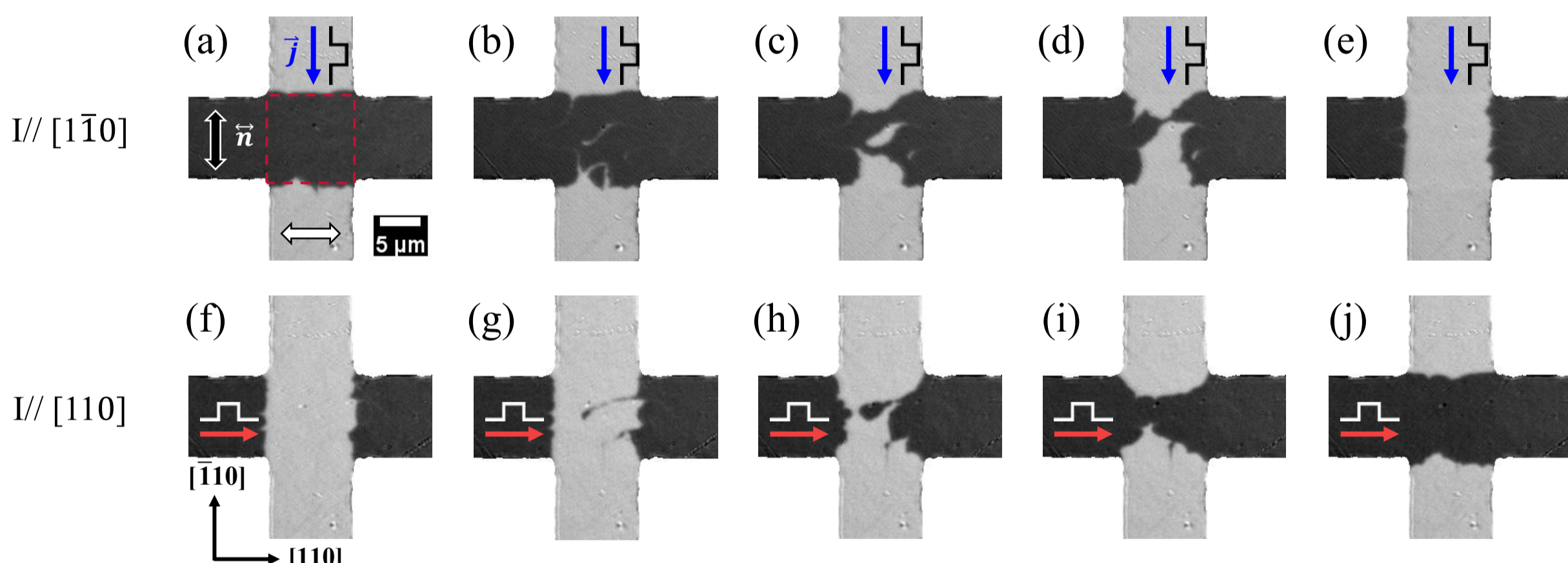
### Possible switching mechanisms



### Identify switching mechanism



## T dependence switching

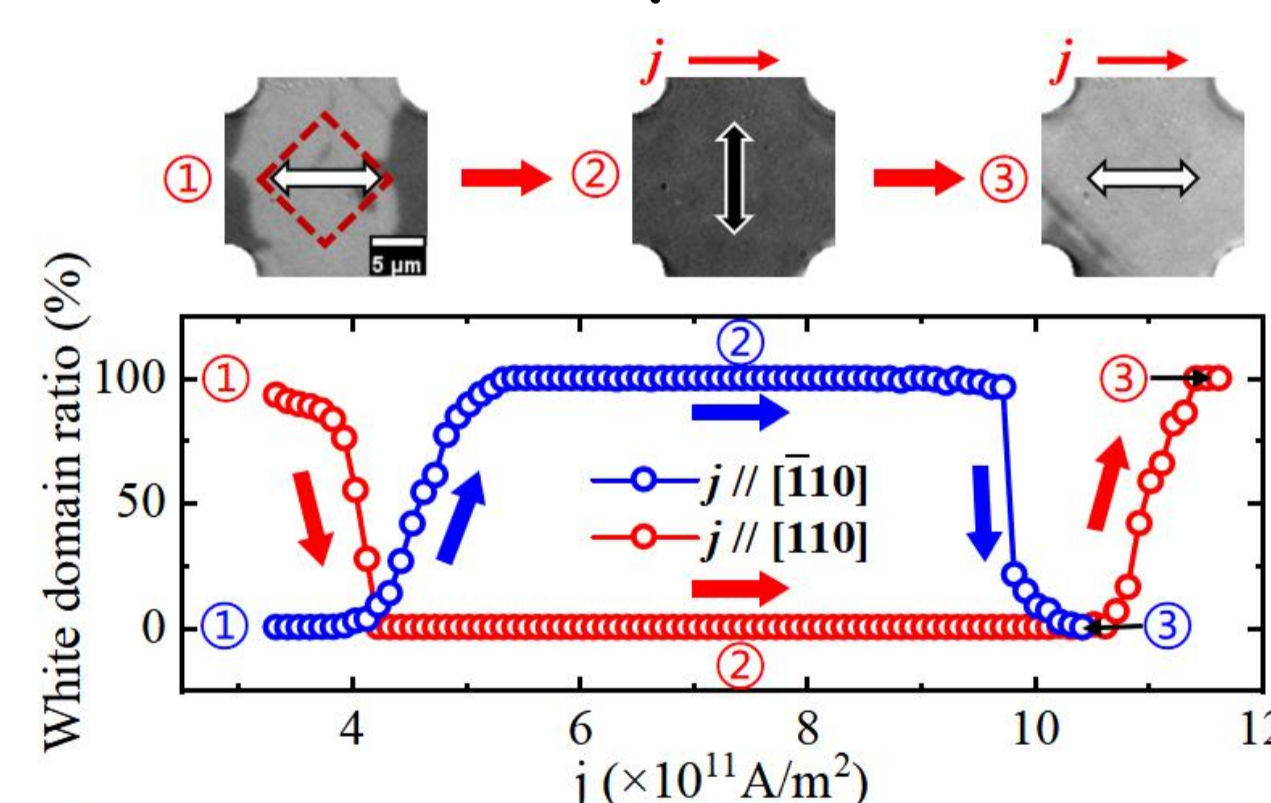


➤ Reversible and clear AFM domain switching.

➤ AFM domain switching could be realized within a wide range of temperature for 8 nm CoO.

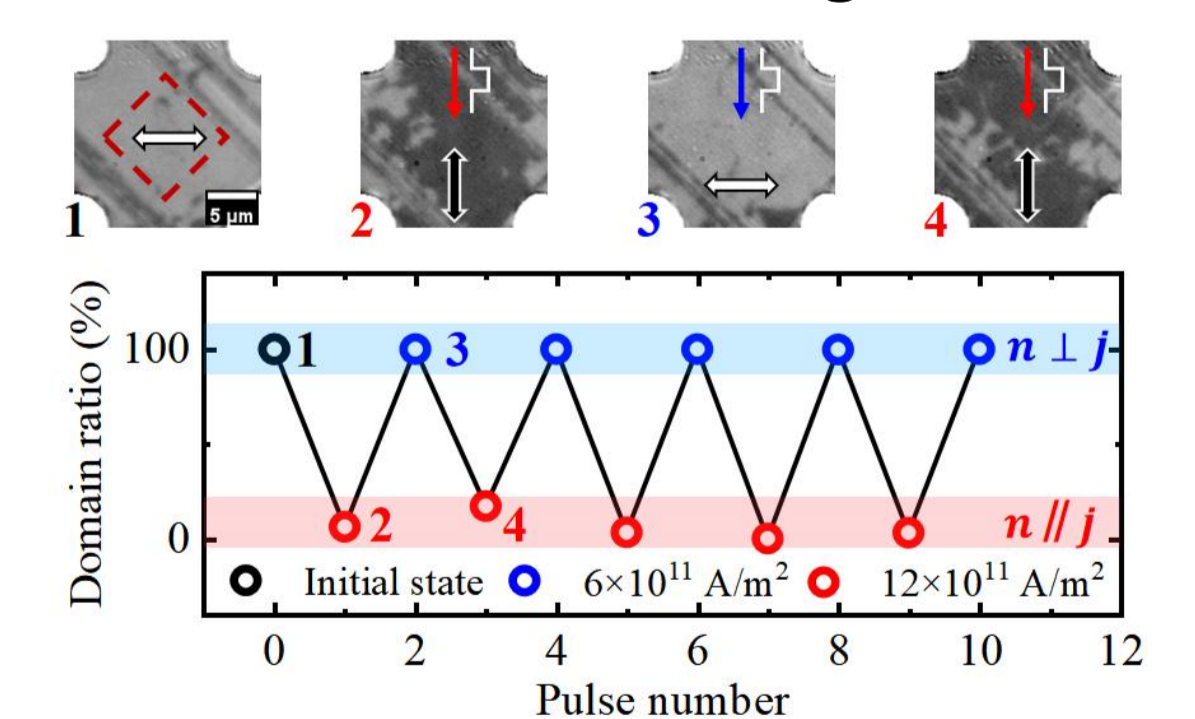
## Current-density-modulated switching

### Switching curve with increasing current density

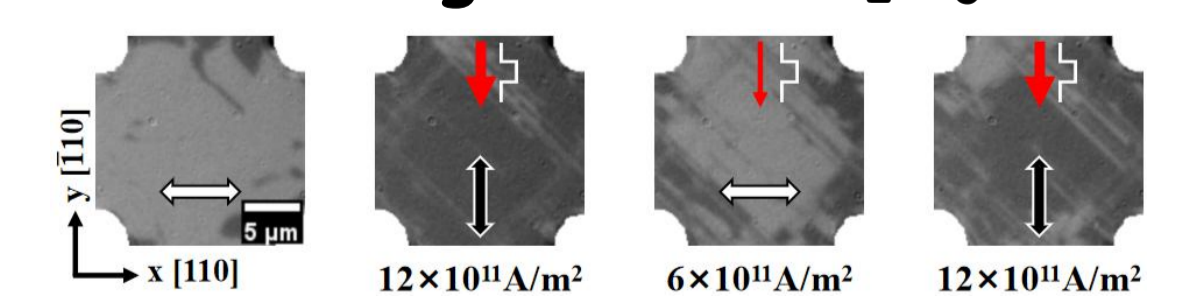


➤ Switching polarity changes at higher  $j$

### Reversible switching

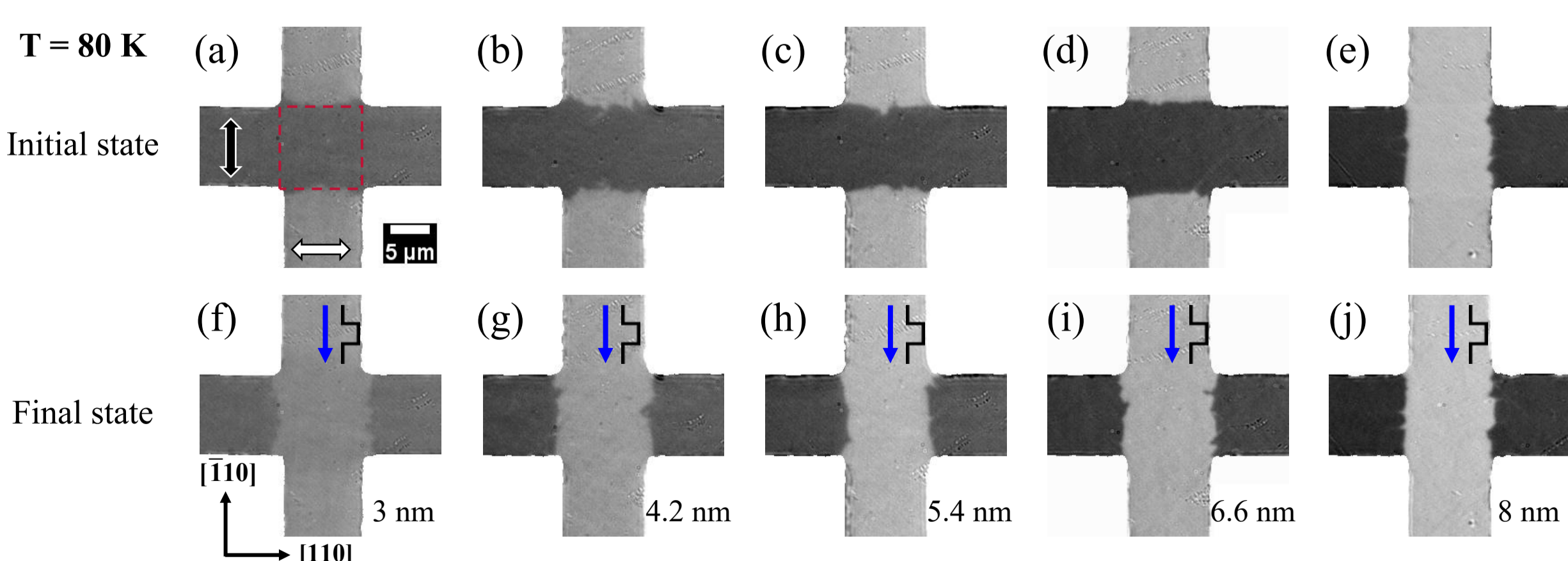


➤ Switching in CoO/Al<sub>2</sub>O<sub>3</sub>/Pt



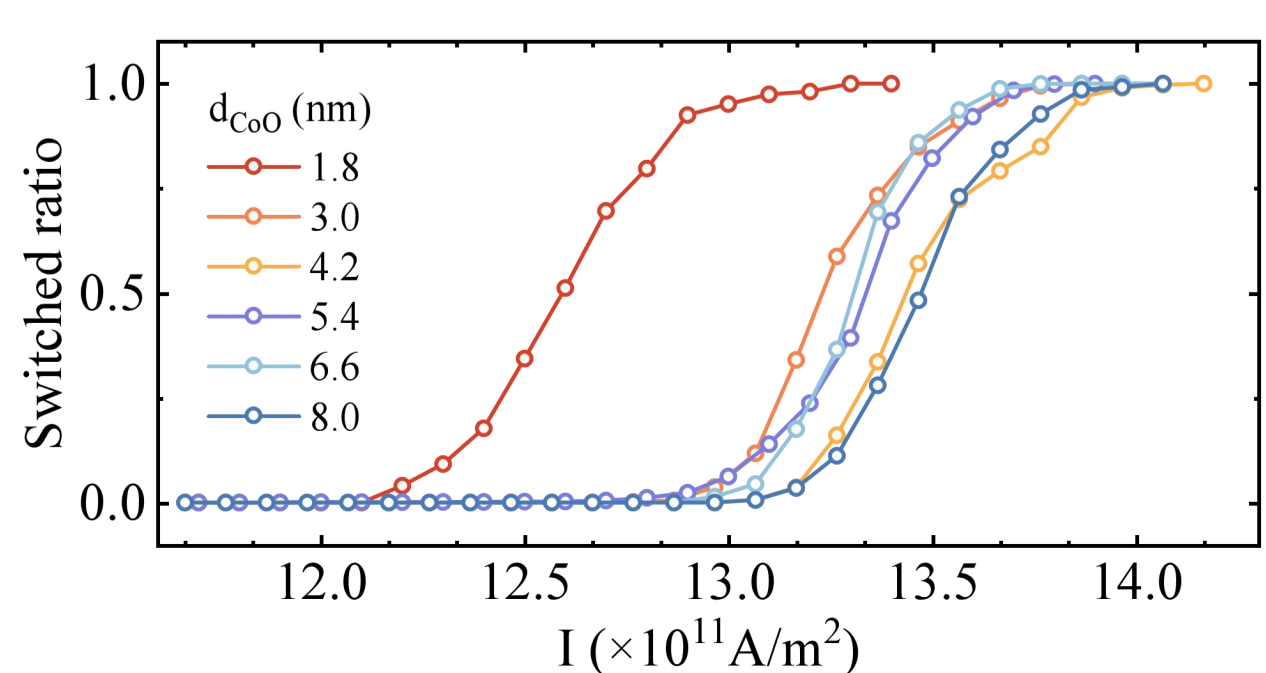
• Excluding SOT contribution  
 • Different strain distribution at higher  $j$

## $d_{CoO}$ dependence switching



➤ Switching could be observed in ultra-thin CoO film.

➤ Switching polarity are the same for different CoO thickness.



## Summary

### Imaging current switching of AFM domains in CoO/Pt

- AFM domain switching was observed with different  $T$  and  $d_{CoO}$ .
- Magnetoelastic effect dominates the domain switching.
- Switching polarity could be modulated by changing current density.

Tong Wu, et al., Phys. Rev. Appl. 21, 044054 (2024)