XMLD Study of antiferromagnetic NiO Spin Order Manipulated by Strain

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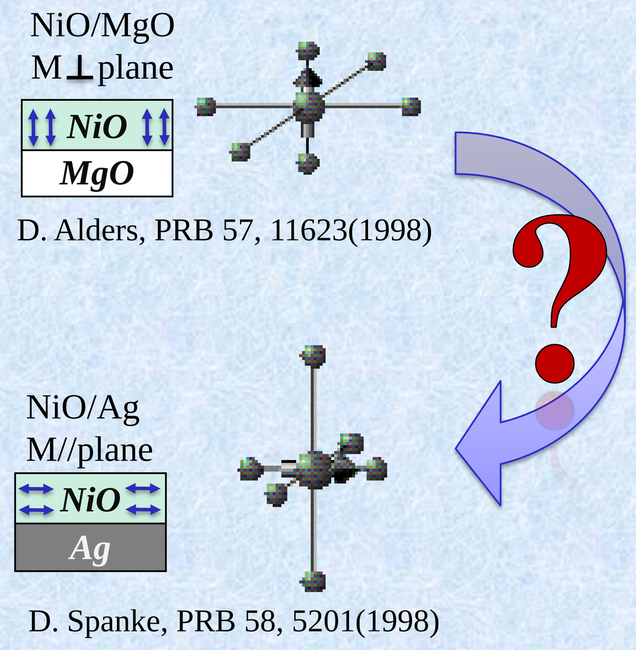
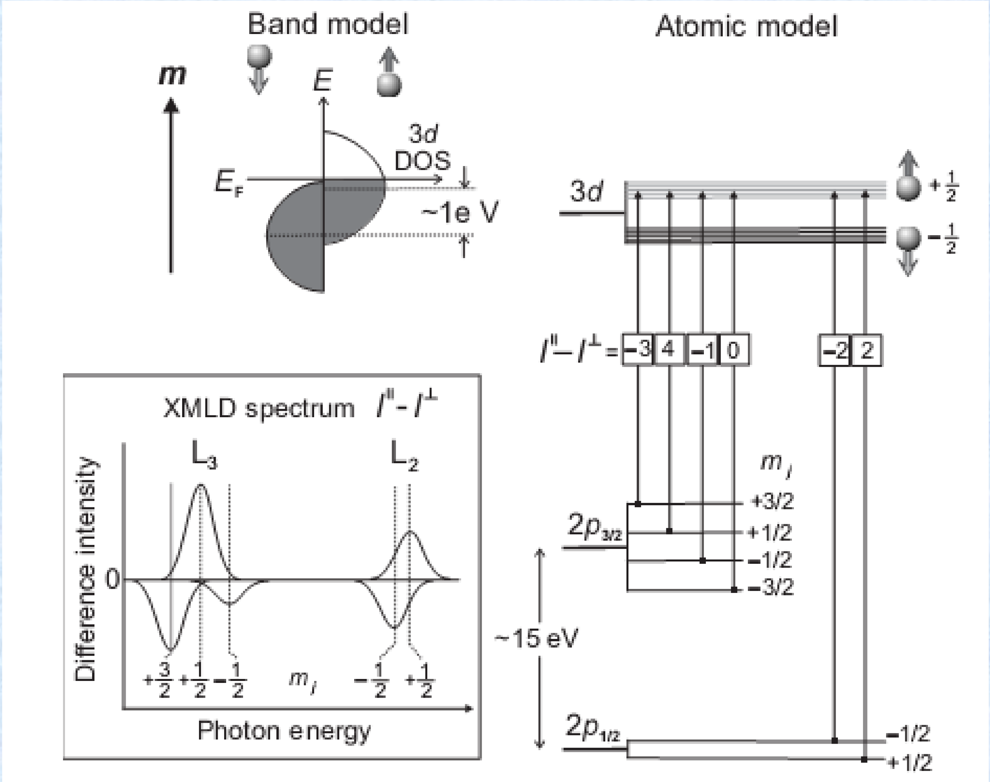
Introduction

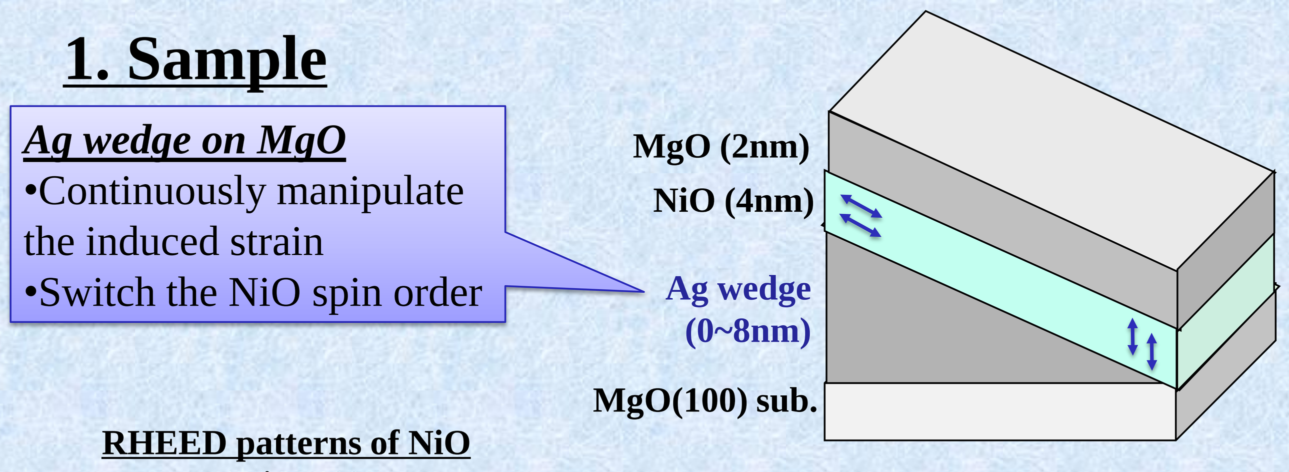
Antiferromagnetic (AFM) spin order is the key issue in the study of ferromagnetic/antiferromagnetic (FM/AFM) coupling. Strain plays an essential role in the determination of AFM spin direction. It has been found that AFM spin aligns in plane in NiO/Ag but perpendicular to plane in NiO/MgO due to the different strain from Ag and MgO substrates. However, it is still unclear how the AFM spin switch by continuously manipulated strain. X-ray Magnetic Linear Dichroism (XMLD) is a very effective way to directly detect the spin structure in AFM thin films. In this work, the spin structure of antiferromagnetic NiO film grown on strain continuously changed substrate is studied by XMLD.

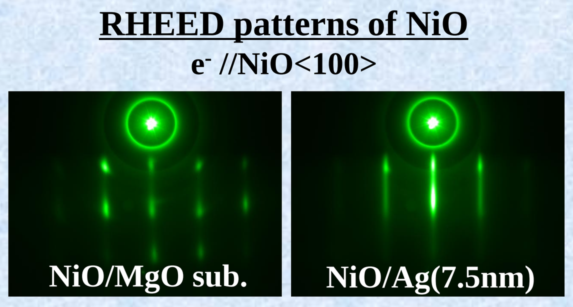




Experiment

1. Sample

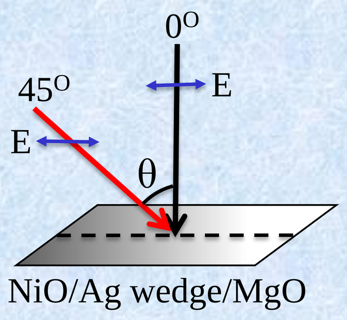




The RHEED patterns NiO show high quality of epitaxial growth of NiO single crystal film both on MgO and Ag.

2. Measurement

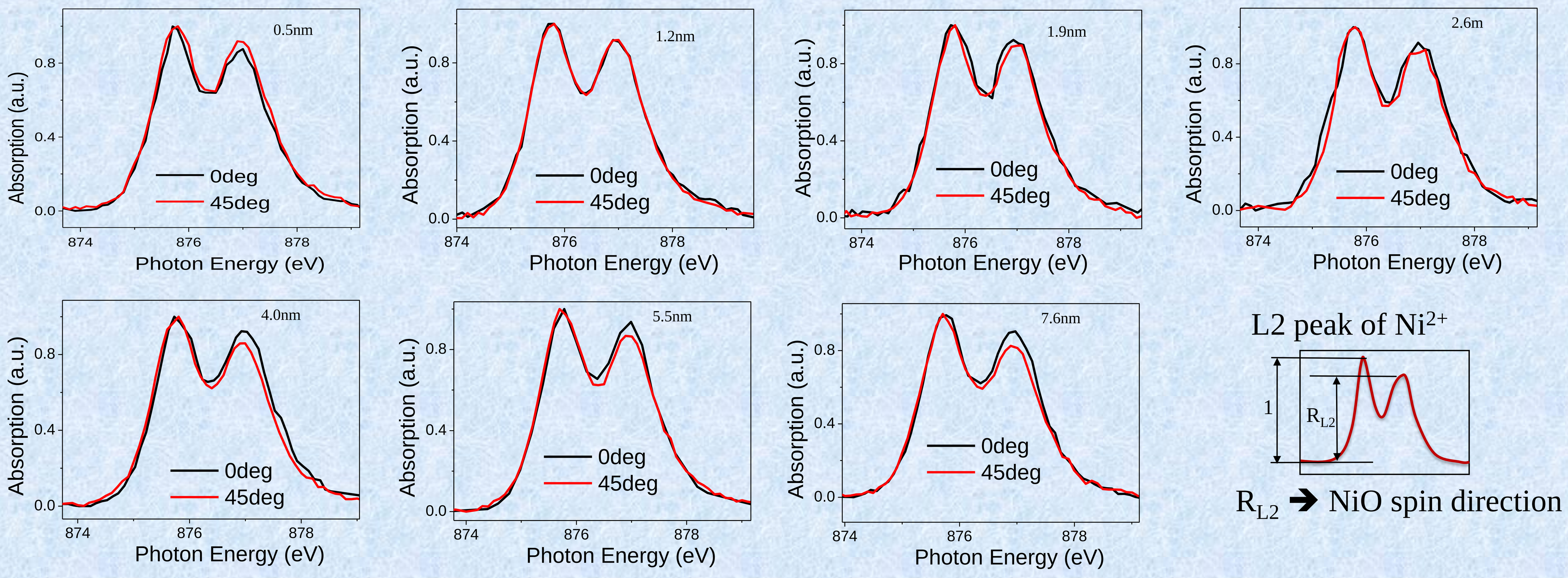
Beam line 08U, SSRF, Shanghai, China

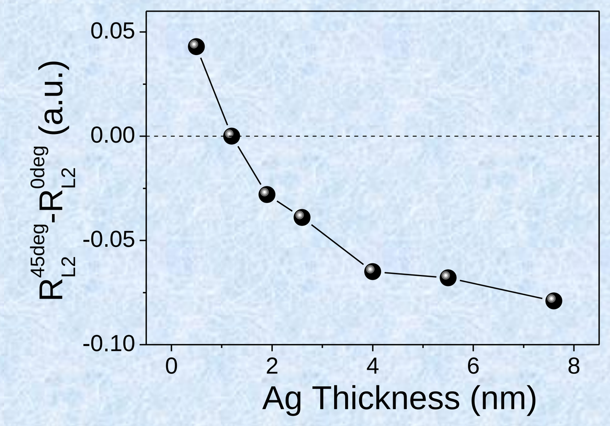


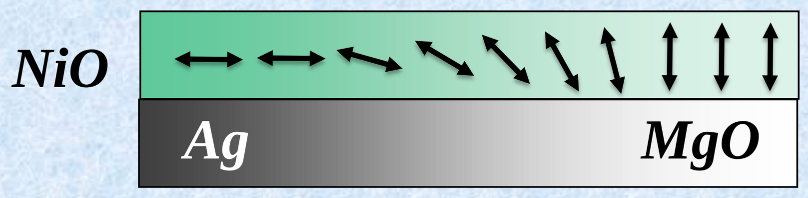
XMLD spectrum of NiO film was measured at different thickness of Ag. The measurement was in two different geometries : ① $\theta=0^O$ and ② $\theta=45^O$

Result

XMLD spectra of Ni^{2+} L2 peak of NiO film on different thickness of Ag







NiO AFM spin order undergoes a continuous rotation from in-plane to perpendicular-to-plane, as the substrate induced strain changes from compression to expanding.

Conclusion

We manipulated the antiferromagnetic spin structure of NiO by continuously control the strain from the substrate and studied the rotation process of NiO AFM spin. This result provides a method to control the FM/AFM coupling and also gives a good idea for spintronic device design.

More work to Do...

- Other antiferromagnetic materials such as CoO
- Crystal field contribution on XMLD signal
- Ferromagnetic/antiferromagnetic coupling in FM/AFM system where AFM spin rotates.

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