In Search of Spin-Polarized Electrons Arising from Surface Chirality

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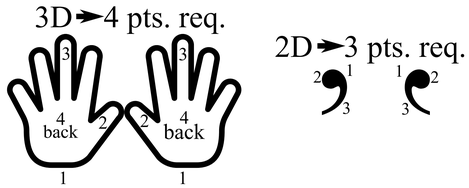
Motivation

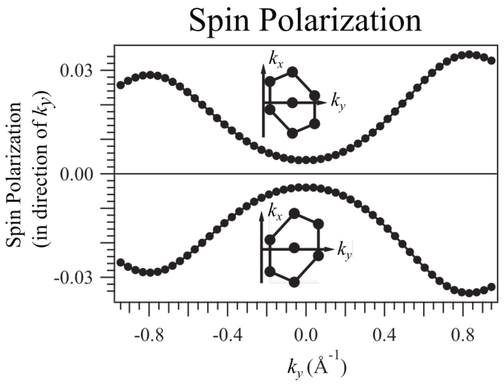
Electronics that utilize the electron's spin, or spintronics, show many potential benefits to increasing efficiency and speed in computers. This work investigates the possibility of using surface structure, specificically chirality, as a source of these bound spin polarized electrons.

Chirality



We have done theorerical work[1] indicating that electron polarization can arise from chirality.

Spin Polarization

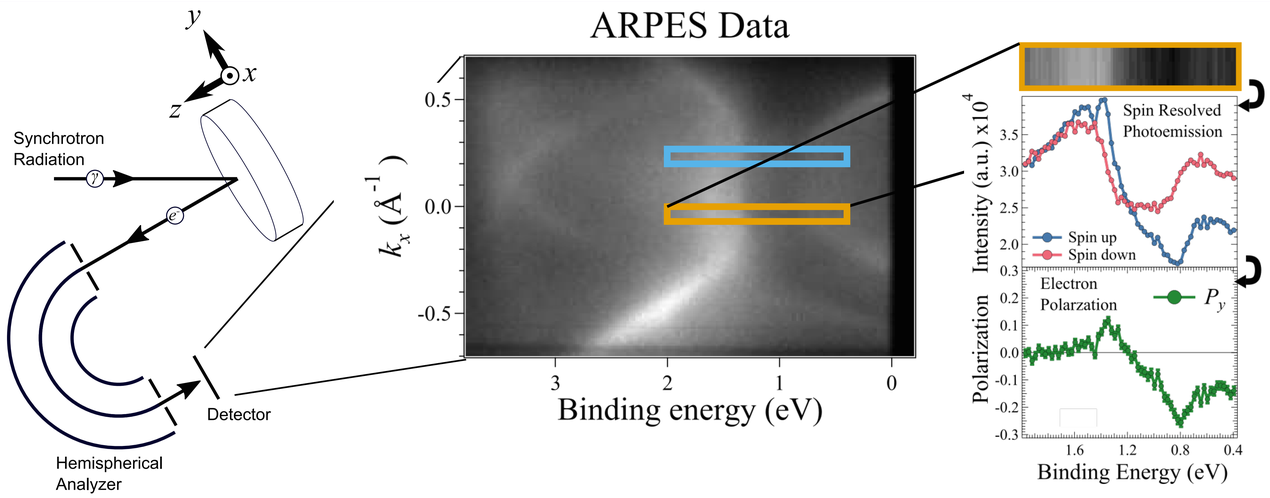


We used angle resolved photoemission spectroscopy (ARPES) to study the energy and momentum (k) of the electrons associated with these chiral surfaces.

The Experiment

- An interesting location in binding energy and k space is selected from ARPES data. Band splitting on the order of meV indicates spin splitting where we expect chiral effects.
- VLEED spin detectors measure the spin of the electrons in this location.
- Based on the electron spin intensities, we can calculate a value for the spin polarization of the electrons.

$$P_e = \frac{I_\uparrow - I_\downarrow}{I_\uparrow + I_\downarrow}$$



The Results

Expected: Equal polarizations, opposite signs at .6 or .8 binding energy.

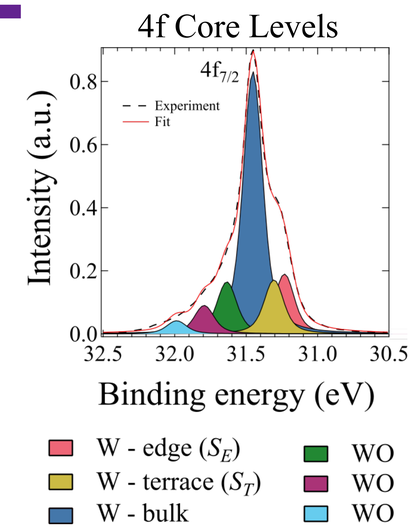
Obtained: Polarizations larger in magnitude than expected. Binding energy shift larger than theory.

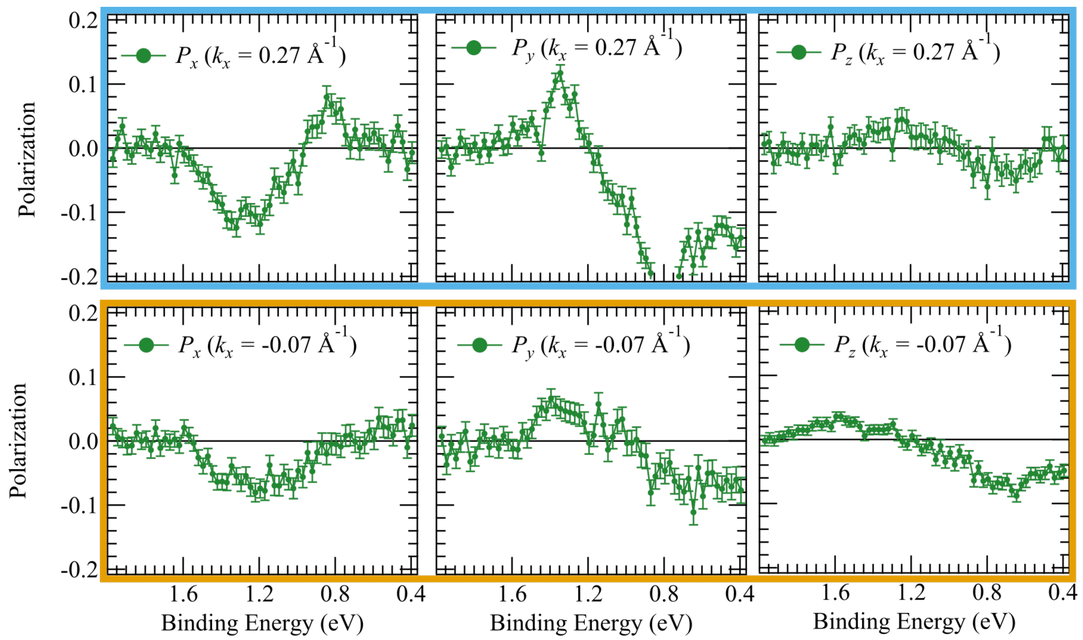
Need: Understanding of source of large polarization to isolate contribution of chirality to polarization.

Expected: Small WO peaks indicating a successful cleaning procedure[2].

Obtained: Evidence of surface core level shifts which are absent from the literature for W(321).

Need: Equivalent core levels for non-chiral surface using our cleaning method or cleaner surface to be able to identify core level shifts due to chirality.





Expected: P_X to change sign between top row (positive k) and bottom row (negative k).

Obtained: Identical signs between k values. Unexpected offset of center of energy band ($k_{x1} \neq -k_{x2}$).

Need: Theoretical model describing polarizations or sample rotation *in situ*.

Attribution

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References

[1]N. K. Lewis, P. J. Durham, W. R. Flavell, and E. A. Seddon, Physical Review B 97, (2018).
[2]Kh. Zakeri, T. R. F. Peixoto, Y. Zhang, J. Prokop, and J. Kirschner, Surface Science 604, L1 (2010).