Masterarbeit: Spintro-Catalysis on RuO_2 (110)

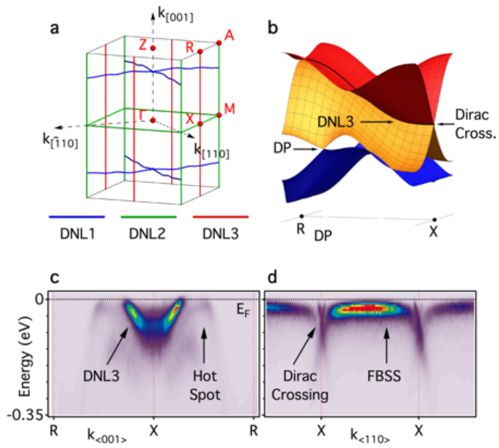

Fig 1: ARPES measurements on RuO_2 show Dirac Nodal Lines (DNL) und Flat band surface state (FBSS).

A new research area at the chair of EP IV at JMU aims at bridging the gap between the fundamental topological- and the applied catalytic properties of topological materials. A prime candidate of our active investigation is the Dirac semimetal RuO_2,[1] found to exhibit a series of unusual physical phenomena such as colinear antiferromagnetism,[2] the crystal Hall effect[3,4] and Dirac Nodal lines (DNL) along with a flat band surface state (FBSS) at the (110) surface.[1] The (110) surface of RuO_2, in particular, is known as the *gold standard* catalyst for the oxygen evolution reaction in electrolytic[5] and photocatalytic water splitting, the bottleneck reaction in the current quest of hydrogen based renewable energy.[6] Most interestingly, this exceptional catalytic activity is believed to directly relate to the fundamental electronic and magnetic properties of RuO_2,[7] which we seek to demonstrate in this project.

To this end, we have fully characterized the surface electronic structure of RuO_2[1] and are – in collaboration with collaborators in Dresden – about to characterize the fundamental magnetic and transport properties. Our successful epitaxial growth program (Philipp Kessler) reliably provides us with large scale atomically ordered and thickness controlled RuO_2 (110) films, perfectly suited for both the fundamental as well as applied questions at hand.

In this master, the student will **build and characterize a basic electrochemical testing setup** with **collaboration partners in New Zealand**, to systematically and controllably measure the overpotential in the anodic evolution of oxygen as a function of RuO_2 film crystallinity, thickness, stoichiometry, and crystalline orientation that the student will grow by **pulsed laser deposition (PLD)** and characterize by top notch **in- and ex-situ characterization methods (XPS, LEED, RHEED, XRD, STM).** Most importantly, we will build a novel type of **electrochemical hydrogen cell under externally applied magnetic field**, thereby controlling the antiferromagnetic Neel order in RuO_2, and according to predictions altering the catalytic overpotential.[7]

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Bei Interesse oder Fragen bitte E-Mail an:

Dr. Simon Moser (EP4), simon.moser@physik.uni-wuerzburg.de, Physikgebäude Raum C165