Department of Materials Science and Engineering

Iby and Aladar Fleischman Faculty of Engineering Tel Aviv University

הפקולטה להנדסה ע"ש איבי ואלדר פליישמן אוניברסיטת תל אביב

המחלקה למדע והנדסה של חומרים

You are cordially invited to attend this seminar to be held on

Sunday, June 4th, 10:00
Room 206, Wolfson Mechanical Engineering Building

Alternative Oxide Architectures for Ionic Memories and Neuromorphic Computing: Designing Defects and Carrier Motion

Prof. Dr. Jennifer L.M. Rupp, Electrochemical Materials Laboratory

Thomas Lord Assistant Professor of Materials Science and Engineering
Massachusetts Institute of Technology, MIT

Abstract

The next generation of information memories and neuromorphic computer logics in electronics rely largely on solving fundamental questions of mass and charge transport of oxygen ionic defects in materials and their structures. Here, understanding the defect kinetics in the solid state material building blocks and their interfaces with respect to lattice, charge carrier types and interfacial strains are the prerequisite to design new material properties beyond classic doping. Through this presentation basic theory[1] and model experiments for solid state oxides their impedances and memristance[2], electro-chemo-mechanics and lattice strain[3-5] modulations is being discussed as a new route for tuning material and properties in ionic conducting oxide film structures up to new device prototypes based on resistive switching. Central are the making of new oxide film materials components, and manipulation of the charge carrier transfer and defect chemistry (based on ionic, electronic and protonic carriers)[1-2, 5-6], which alter directly the resistive switching property and future computing performances. A careful study on the influence of microstructure and defect states vs. the materials` diffusion characteristics is in focus. For this, we suggest novel oxide heterostructure building blocks and show in-situ spectroscopic and microscopic techniques coupled with electrochemical micro-measurements to probe near order structural bond strength changes relative to ionic and electronic diffusion kinetics and the materials integration to new optimized device architectures and computing operation schemes.

[1)]Memristor Kinetics and Diffusion Characteristics for Mixed Anionic-Electronic $SrTiO_{3-\delta}$: The Memristor-based Cottrell Analysis Connecting Material to Device Performance
F Messerschmitt, M Kubicek, S Schweiger, JLM Rupp
Advanced Functional Materials, 24, 47, 7448 (2014)

[2)]Uncovering Two Competing Switching Mechanisms for Epitaxial and Ultra-Thin Strontium Titanate-based Resistive Switching Bits
M Kubicek, R Schmitt, F Messerschmitt, JLM Rupp
ACS Nano 9, 11, 10737 (2015)

[3)]Designing Strained Ionic Heterostructures for Resistive Swicthing Devices
S Schweiger, R Pfenninger, W Bowman, U Aschauer, JLM Rupp
Advanced Materials, in press (2016)

[4)] The Effect of Mechanical Twisting on Oxygen Ionic Transport in Solid State Energy Conversion Membranes
Y Shi, AH Bork, S Schweiger, JLM Rupp
Nature Materials, 14, 721 (2015)

[5)] A Micro-Dot Multilayer Oxide Device: Let's Tune the Strain-Ionic Transport Interaction
S. Schweiger, M. Kubicek, F. Messerschmitt, C. Murer, J.L.M. Rupp

ACS Nano, 8, 5, 5032 (2014)

[6)] How does Moisture affect the Physical propert of Memristance for Anionic-Electronic Resistive Switching Memories?
F Messerschmitt, M Kubicek, JLM Rupp
Advanced Functional Materials, 25, 32, 5117 (2015)

Short Bio

Prof. Jennifer Rupp is an Assistant Professor of Electrochemical Materials at the Department of Materials Science and Engineering at MIT. Prior she is a non-tenure track assistant professor at ETH Zurich Switzerland where she was holding two prestigeous externally funded career grants, namely an ERC Starting Grant (SNSF) and Swiss National Science Foundation (SNF) professorship from 2012 on.

She previously was affiliated as a visiting and senior scientist at the MIT (2012-2011), the National Institute of Materials Science (NIMS) in Tsukuba Japan (2011), and was working as a postdoc at ETH Zurich (2010-2006). Rupp team`s current research interests are on solid state material design and tuning of structure-property relations for novel energy and information devices and operation schemes. This ranges from alternative energy storage via batteries or catalytic convertor systems processing by smart material design solar light and CO2 to renewable synthetic fuels, or novel types of neuromorphic memories and computing logic entities for data storage and transfer beyond transistors. Here, her team goes the whole way from material design, novel processing techniques to make ceramics, cermets or glassy-type ceramic structures up to device prototypes, their operation and characteristics.

She has published more then 70 papers, holds 4 patents, and enjoy to be active discussing material tech trends on the theme of energy with the public, economists and policy makers being a frequent speaker and member of the World Economic Forum (2015-2017), or contirbuting with CNN and other television movies.

Rupp and team received several honors and awards such as keynote lecture at Nature Energy conference 2016, "Top 40 international scientist under the age of 40" by World Economic Forum 2015, Spark Award for the most innovative and economically important invention of the year 2014 at ETH Zurich, Gordon Research lecture 2014, the Kepler award "new materials in energy technology" by the European Academy of Science 2012 or Young Scientist Award by the Solid State Ionic Society.