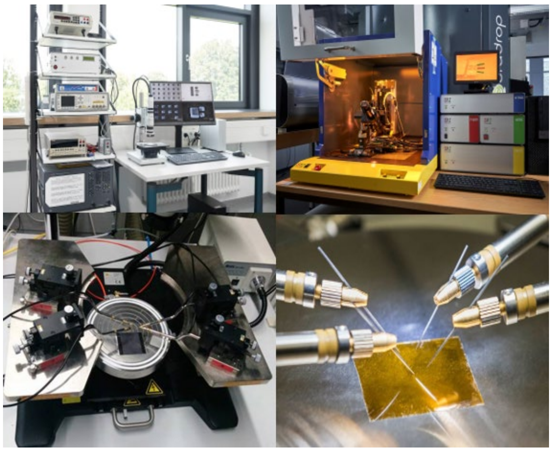
Master Thesis Proposal: Investigation of IGZO and High-Entropy Doped IGZO Films in Memristors and Electrolyte-Gated Transistors

Karlsruhe Institute of Technology
Institute of Nanotechnology



In recent years, there has been a surge of interest in the exploration of oxide semiconductors, particularly amorphous oxide semiconductors, due to their significant potential across many applications. Among the various oxide semiconductors are zinc oxide, indium zinc oxide (IZO), indium tin oxide (ITO), indium oxide, and indium gallium zinc oxide (IGZO). Notably, IGZO has emerged as a preferred material for displays, with ongoing research exploring its potential in other domains such as sensors, (non-volatile) memory, and memristors for neuromorphic applications. In addition to its high electron mobility, low threshold voltage, and low subthreshold swing, IGZO is well-suited for flexible thin-film transistors (TFTs). A key attribute that makes materials like IGZO noteworthy is their substantial bandgap, which provides transparency to visible light. In IGZO, indium, gallium, and zinc atoms bind in a manner that allows the orbitals relevant to the conduction band width to overlap, even in the amorphous phase, enabling high mobilities.

This project aims to introduce IGZO films into electrolyte-gated transistors or memristors, which are used for simple logic circuits or neuromorphic applications, respectively, depending on their electronic properties. Additionally, we aim to investigate the impact of high-entropy doping—doping with many different elements simultaneously, a novel concept reported recently—on the electronic performance of IGZO. For synthesis and doping, we will use a high-throughput synthesis robot with automated structural characterization capabilities. The prepared materials will be spin-coated and electronically characterized (e.g., via Hall-effect measurements) before being transferred into printed transistors or memristors.

Tasks:

- Synthesis of IGZO and doped IGZO using a high-throughput synthesis robot.
- Structural characterization of the developed materials using automated high-throughput methods (e.g., XRD).
- Preparation of thin films using spin coating or printing techniques.
- Electronic characterization of the developed materials (e.g., Hall-effect measurements).
- Integration of the developed materials into transistors or memristors.

Contacts:
Institute of Nanotechnology
Prof. Dr. Jasmin Aghassi-Hagmann, jasmin.aghassi@kit.edu
Dr. Ben Breitung, ben.breitung@kit.edu