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HESEB Soft X-ray Beamline at SESAME: Commissioning, First User Experiments, and Future Prospects

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The collaborative efforts between SESAME and a consortium of five Helmholtz Centers comprising DESY, FZJ, HZB, HZDR, and KIT have led to the successful design and installation of the Helmholtz-SESAME Beamline (HESEB), the first soft X-ray beamline at the SESAME synchrotron facility in the Middle East, Amman, Jordan. This initiative was funded by the Helmholtz Association over a four-year project cycle that commenced in January 2019. In February 2024, HESEB achieved another significant milestone by welcoming its first user groups. These groups focused their research efforts on various topics, including the investigation of metal-oxide-semiconductor thin films.

The HESEB soft X-ray beamline covers a photon energy range from about 90 eV to 1800 eV. An APPLE II type undulator (BESSYII/Model UE56) in addition to linearly polarized light produces circularly polarized light which is important for the magnetic material characterization. The Plane Grating Monochromator (PGM) has two different gratings, 400 and 1200 grooves/mm. At 400eV, the photon flux on the sample is 4.4×10^{12} photons/s and the energy resolution is 8500 (E/ Δ E). The spot size of the beam on the sample is $240 \times 25 \mu\text{m}^2$.

The compact UHV analysis chamber, attached to the end of the HESEB beamline, was designed for soft XAS techniques. A Bruker XFlash Silicon Drift for X-Ray Fluorescence (XRF) detection and a Keithley 6487 picoammeter for Total Electron Yield (TEY) monitoring are used for absorption measurements. The HESEB end station has a motorized manipulator, reproducible $1 \mu\text{m}$ lateral resolution, 4 degrees of freedom, transfer motion on the x, y, z axes, and rotation around the y axis to change the sample orientation relative to the incident X-ray beam. The receptacle unit has 3 slots for a) cooling b) magnetization and c) heating. In the cooling slot, the sample can be cooled by liquid nitrogen. In the magnetic slot, an electromagnet was placed to produce a field of 160mT perpendicular to the sample. In the heating slot, a button-type resistance heater is used to heat the sample up to 800°C.

One unique property of the HESEB end station is that measurements can be done in He atmosphere up to 1atm. This ability is e.g. important for vacuum-sensitive samples in cultural heritage research and for studies of catalysts under near ambient pressure conditions. This is achieved by using an optical capillary placed in to photon pathway. It has a minimum hole diameter of $20 \mu\text{m}$ and focuses the beam at 5 mm behind the capillary. Therefore it serves to maintain a high differential pressure allowing measurements in He atmosphere and by focusing the beam decreases the beam path length in the high-pressure He environment.

In brief, HESEB is SESAME's first Soft X-ray facility and its first undulator beamline which will notably expand SESAME's research capabilities. Equipped with a basic yet distinctive end station for absorption measurements, it has started to serve the user community.

I plan to submit also conference proceedings

Yes

Primary authors: ABBADI, Anas (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan); AL NAJDAWI, Mohammad (SESAME); ALZUBI, Mustafa (Synchrotron-light for Experimen-

tal Science and Applications in the Middle East, Allan, Jordan); ATTAL, Maher (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan); Dr BAHRDT, Johannes; DRUBE, Wolfgang (HASYLAB); EBERHARDT, Wolfgang (DESY); ESSER, Frank Martin (Forschungszentrum Jülich GmbH, Jülich, Germany); FOLLATH, Rolf (Deutsch); FROIDEVAL, Annick (Helmholtz-Zentrum Dresden-Rossendorf e.V., Dresden-Rossendorf, Germany); GENISEL, Mustafa Fatih (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan); GORBUNOV, Denis (Helmholtz-Zentrum Dresden-Rossendorf e.V., Dresden-Rossendorf, Germany); GROETSCH, Daniel (Institut für Optik und atomare Physik, TU-Berlin, Germany); HASONEH, Abdel Rahman (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan); HUTTEL, Erhard (Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany); KANGIESSER, Birgit (Technische Universität Berlin); KRUEGER, Ole (Deutsches Elektronen-Synchrotron, Hamburg, Germany); LAUSI, Andrea (SESAME); LEHNER, Frank (DIB (Direktoriumsbuero)); Prof. MESECK, Atoosa (Helmholtz Zentrum Berlin (HZB)); MOMANI, Yazeed (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan); ÖZTÜRK, Zeynep Reyhan (SESAME); RIAL, Ed (Helmholtz-Zentrum Berlin); ROSCHKA, Michael (Feinwerk und Messtechnik Berlin); SCHEER, Michael (Helmholtzzentrum Berlin); SCHRAMM, Barbara (Helmholtz-Zentrum Dresden-Rossendorf e.V., Dresden-Rossendorf, Germany); SCHUPPLER, Stefan (Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany); SHEHAB, Maher (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan); SIEWERT, Frank (Helmholtz Zentrum Berlin); SOLTNER, Helmut (Forschungszentrum Jülich GmbH, Jülich, Germany); TIEMANN, Christoph (Forschungszentrum Jülich GmbH, Jülich, Germany)

Presenter: GENISEL, Mustafa Fatih (Synchrotron-light for Experimental Science and Applications in the Middle East, Allan, Jordan)

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