The M-Branch, a new UNILAC irradiation facility with in-situ analytical techniques for materials research

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The new M-Branch is installed in the former Z1 area of the UNILAC experimental hall and has three new beamlines which are presently in the commissioning phase. The M-Branch will provide ion beams up to 11.4 MeV/u specific energy for materials research and will partially compensate the former access to ion beams at the Ionenstrahllabor (ISL) existing until the end of 2006 at the Hahn-Meitner-Institut (HMI). The facility with state-of-the-art in-situ instrumentation and analytical tools was financed by combining funds from partially transferred research budget of ISL and from the GSI, the Helmholtz Association (Impuls- und Vernetzungsfond), and a BMBF project of several German universities (Verbundprojekt "Hochauflösende in-situ Charakterisierung struktureller Veränderungen in Festkörpern induziert durch hochenergetische Schwerionenstrahlung").

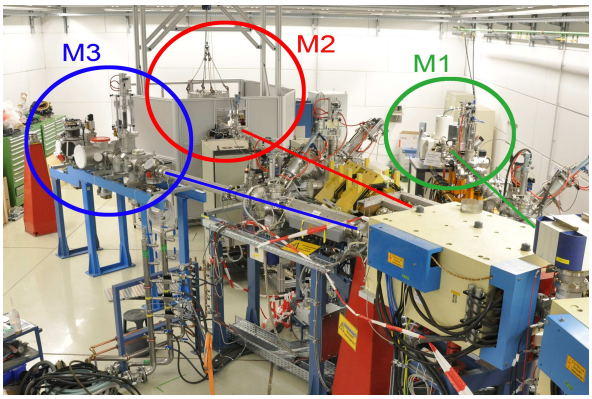

Figure 1: New M-Branch with beamlines M1, M2, and M3 equipped with different in-situ analytical tools such as scanning electron microscopy (M1), x-ray diffractometry (M2), and spectroscopy (M3).

M1 Beamline – Scanning electron microscope

Beamline M1 is connected to a high-resolution scanning electron microscope (HRSEM) installed and operated by the University of Stuttgart (W. Bolse). The HRSEM (Zeiss, SUPRA 40, 30 kV, magnification 12 – 900000×) is equipped with a thermal field-emission cathode and a secondary electron detector. It also houses a 5-axes motorised eucentric sample stage permitting the irradiation under tilted ion beam incidence or of a rotating specimen. For imaging, the stage is tilted into the electron beam without exposing the irradiated sample to air. The facility offers in-situ investigations of surface modification such as the formation of nanocracks, surface defects, and nanostructures.

M2 Beamline – X-Ray diffractometer

Beamline M2 is equipped with a standard 4-circle x-ray diffractometer (Cu-K_α) which was transferred from ISL (S. Klaumünzer). The instrument operates in vacuum and is equipped with a position sensitive detector (simultaneous measurement of $2\theta = 2°$). Investigation under any angle of incidence enables the quantitative analysis of structural modifications such as amorphisation or other phase transitions, internal stresses, and textural changes.

M3 Beamline – In-situ spectroscopy

Beamline M3 is equipped with two irradiation chambers. The first one houses a high-temperature stage (up to 900°C) installed by the University of Göttingen (H. Hofsäss). The second chamber is equipped with a closed-cycle He-cryostat and with several state-of-the-art analytical techniques. The combination of the cryostage, a residual gas analyser, and a gas flow controller allows irradiations under controlled temperature and gas atmosphere conditions. The set-up is important, e.g., when measuring outgassing yields of ion-bombarded polymers. The chamber is also equipped with an infrared spectrometer (TU Darmstadt, W. Ensinger) and an UV/Vis spectrometer (University of Heidelberg, U. Glasmacher) and will allow in-situ monitoring of optical absorption indicating e.g. degradation of organic insulators or creation of color centers as a function of irradiation fluence. Furthermore, the facility houses a luminescence spectrometer (University Dresden, J. Weber) to investigate time, temperature, and wavelength-resolved ion-stimulated luminescence for instance of semiconductors. In-situ observation of stress will be possible by means of curvature measurement using laser reflection in combination with an on-line long-distance microscope (University of Jena, W. Wesch).

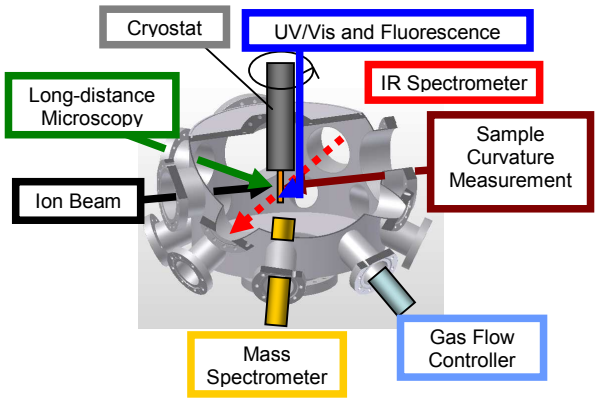

Figure 2: Scheme of the M3 multi-purpose chamber housing a large variety of in-situ analytical methods.