Beamline Review Panel BM32

General

BM32 is a successful CRG that found complementary synergies between different techniques in a single beamline. What brings together these three different techniques is the ability to study material properties at different scale ranging from microns down to nanometers. The specific strength of the beamline lies in the capability to investigate buried interfaces and to perform *in situ* studies.

The committee is impressed by the high-quality scientific output from the beamline. A broad range of scientific problems in materials science has been addressed and disseminated in international peer reviewed high impact journals. The user-friendliness of the beamline and its software provision have evidently been improved over the last years.

The committee is of the opinion that the present number of staff on the beamline is below critical, considering the number and complexity of techniques supported, and the service aspect of user operation. The many commitments and demands on beamline staff's time are such that they prevent them from realising the full potential of the cumulated expertise available. The committee were very favourably impressed with the in-house research quality, but felt that what was missing was the 'multiplication factor' that only a very broad and active user community can bring.

The beamline features three end stations:

1. Micro-beam Laue

The locally developed open source Laue analysis software is continuously being adapted to user needs. The stability of the set-up has been significantly improved, and motorised vertical translation of the detector has been introduced. A significant step forward in determining the otherwise invisible dilatational strain component has been made by the development of the diamond rainbow filter technique. In addition, a new analysis method of deviatoric strain changes using DIC applied to Laue patterns has been developed, and provides a unique distinguishing feature of BM32 work in this field. This has salutary consequences both for strain precision (and order of magnitude improvement) and analysis speed, and is particularly useful for the analysis of plastically deformed materials.

Highlights micro Laue: 1. Diamond rainbow filter. 2. The Laue-DIC (Digital Image Correlation).

Recommendations micro Laue: The capability to extract 3D information is **essential** to stay competitive with respect to other beamlines and electron diffraction based techniques. In particular 3D Laue micro diffraction of buried structures should be developed to become a unique strength of the beamline. This needs high flux, fast detector(s), rapid interpretation and automated knife edge Differential Aperture X-ray Microscopy (DAXM) for 3D analysis.

2. INS

We congratulate the beamline staff on having implemented all the recommendations of the previous BLRP to expand the growth capabilities by introducing the in situ CVD and concurrent diffraction studies of Si nanowires. Moreover, in accordance with the recommendation of the previous BLRP, the INS is currently being completely refurbished with a new diffractometer and UHV/INS chamber. A great effort has been made to reduce the background noise, important for surface structural investigations of low-Z materials. We believe that the detailed structural characterization carried out on BM32 is making an important contribution to understanding the properties of magnetic thin films.

Highlights: 1. In situ de-wetting of Ge on SiO_2. 2. Full structural determination and thermal expansion of graphene on Ir(111).

Recommendations: 1. The in situ growth studies of Si nanowires using CVD should be continued and promoted. We recommend the staff not only to realize these new capabilities, but also to make them readily

accessible to the users. Furthermore, the installation of a cryostat at the INS should be pursued, to reduce beam damage of molecular structures and to follow possible structural temperature-dependent transitions in magnetic thin films. The experience gained at BM32 in reducing the background noise will be useful to other beamlines.

3. GMT:

A new *in operando* cell has been developed for solid state electrochemistry. Very interesting results emerged from the analysis of interfacial wafer bonding as a function of surface roughness and treatment process.
Highlights: 1. The design and implementation of cells for *in situ* electrochemistry 2. The successful investigation of buried interfaces in wafer bonded structures.

Recommendations: Make use of the distinctive high energy x-rays available on BM32 to study buried interfaces *in situ*, in particular in the context of electrochemistry-related research.

Upgrade:

The phase II upgrade programme has the potential to increase the flux and decrease the emittance significantly. Since the key strength of the beamline lies in the ability to conduct *in situ* measurements and to probe buried interfaces, the upgrade could make previously unattainable timescales and structures accessible. However, to fully utilize the properties of the source, adaptations of the primary optics are necessary.

Recommendations: Consequently the committee recommends the staff to formulate a strong case for support to fund improved optics that would make full use of the new source characteristics. For this purpose, the beamline staff should interact as soon as possible with the ESRF optics group to identify the needs and the solutions available.

Since phase II upgrade will lead to an interruption in beamline operation of approximately 18 months, this will present an excellent opportunity to devote focused efforts to upgrading not only the station hardware, but also to advance the level of sophistication and robustness of the proprietary software that makes the beamline stand out from the international competition.

General recommendations:

- Focus research on core-competence: *in situ* measurements and measurements on buried interfaces.
- Expand the user community beyond the present community by advertisements at user meetings and workshops. For example, intensified contacts should be made with the Mecano GDRi network, and possibly with experts in electrochemistry.
- Fully utilize the upgrade potential.
- The beamline should strive towards real-time data analysis in a five year time span.
- Re-establish the continuous funding of a postdoc position to assist staff in user operation and beamline development.

Signatures:

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