Report of beamline review panel on BM32

General
The committee was impressed by the broad range and quality of the research, the staff and the instrumentation of beamline BM32. Several modifications have been made in the review period, and still the beamline has continued to produce many excellent papers. The committee congratulates the staff with these efforts.

BM32 is operated in a special way, because there is a strong team of senior scientists that is embedded in local institutions (CNRS and CEA in particular). Each of these scientists is formally connected to the beamline only for a limited fraction of his/her time. This mode of operation has allowed on the one hand a broad range of topics to be covered, but has on the other hand the danger that there is only limited coherence between the various topics. Gilles Renaud has been a strong leader of BM32 and, together with the other members, deserves praise for this crucial role. Renaud has become the undisputed leader in the field of (UHV) GISAXS and has several high-impact papers in this field.

In a CRG beamline in general, and BM32 in particular, it is difficult to separate the research from the users from that of the staff. In most cases, the research in the ESRF public beamtime still involves the people and laboratories of the beamline. Clear scientific highlights are the shape changes of Rh nanoparticles during oxidation and reduction (published in Science in 2008), the supercooling in AuSi eutectic droplets (published only weeks ago in Nature), the results on epitaxial InAs/InP nanowires (published in Nano Letters, 2007) and the interface structure after wafer bonding (e.g. Applied Physics Letters 2009).

Beamline instrumentation
Since the last review, two major improvements have been made. The first one is the beamline optics that was renewed in 2006. The committee was impressed by the excellent performance of the new optics, in which the flux is exactly what is theoretically calculated and in which the full 2 mrad acceptance of the front-end is used. The optics delivers a stable beam, with very little harmonics and the users are satisfied. The second improvement was the enlargement of the hutch with the UHV system. This major overhaul was done efficiently and has allowed new techniques and equipment to be combined with the existing set-up.

Microdiffraction
The involvement of staff in instrumental development is of the highest level. In addition, a stronger scientific interaction with beamline users is encouraged. The user community shows very promising results given the novelty of the technique, a further extension of the user base should be promoted.

The committee encourages the beamline scientists to further connect with other facilities and their users with the aim to contribute to establishing an international community. The committee strongly supports the further promotion of the aimed 3D-microdiffraction techniques in the material science community to establish excellence in scientific cases.

The committee is strongly impressed by the quality of the micro-diffraction instrumentation, specifically with regards to methods to determine the lattice parameter, 3D-strain microscopy and their contribution to analyzing software. Applications in 3D-Laue techniques will critically depend on improved acquisition speed which should be a high priority target of beamline development.

In situ nanostructures and surface (INS) station
Many achievements have been obtained using the joint facility of collecting in-situ data from GIXD and GISAXS, as an example the work on size and composition influence of CoPt nanoparticles morphology (PRL 100 (2008) 115502 . Outstanding results have been achieved on studies of substrate enhanced supercooling of eutectic droplets (Nature, 464 (2010) 1174). This topic will be developed in the future with the implementation of gas sources MBE. The whole series of experiments on Ge/Si(100) going from wetting layer to 3D growth include in-situ studies of state of the art surface diffraction, GISAXS and anomalous grazing incidence diffraction. Results on ultrathin metallic alloys are of interest for their magnetic properties. An in-situ control of these properties would be a plus.

The goniometer does not match the quality of the growth facilities and should be replaced.
The review panel acknowledges the effort in implementing the gas source MBE. Sufficient beamtime for commissioning the new equipment, which will be opened to users, should be provided. The MOKE project will enhance the quality of information on magnetic systems, it should be operated with minimal losses of beamtime use.

The number of topics currently pursued is very wide and seems to be more than the present staff can handle in the long run. We recommend concentrating on gas source MBE and magnetic systems and strengthening collaborations with expert groups in these fields. We recommend hiring one more person for running the gas source MBE to guarantee continuity of expertise.

Catalysis
The beamline is highly suitable for detailed investigations of model catalysts. An example of outstanding work in this field is the publication by Nolte *et al.* (Science **321** 1654, 2008) using the INS instrument. It is this type of detailed *operando* information that will lead to a full understanding of the structure and working mechanisms of 'real' catalysts.

The special setup constructed by Saint-Lager (CNRS, Grenoble) enables the investigation of model catalysts under the full pressure range, thus also beyond the pressure gap. The field of atomic- and molecular-scale catalysis research is rapidly moving away from flat surfaces to nanoparticles and from ultrahigh vacuum or low-pressure and low-temperature conditions to realistic reaction conditions.

The available diffraction techniques, dedicated instrumentation and expertise make BM32 extremely well-positioned to play a decisive role in these important and highly relevant developments. Therefore, the review panel suggests that the effort on catalysis at BM32 is strengthened, for example by actively searching further collaboration with expert groups in the field and, if possible, by providing access for other users also to Saint-Lager's setup.

Summary of recommendations
- Further promote interaction with leading groups in important scientific areas, in particular microdiffraction, gas source MBE and catalysis.
- Purchase new diffractometer for INS set-up.
- Develop fast data acquisition for 3D microdiffraction.
- Exploit fully the capabilities of new pixel detector for all techniques involved.
- Make sure the permanent staff is proportional to the number of topics pursued.
- Hire permanent scientist to do gas source MBE to ensure continuity of expertise.

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