The concept of using a microfocus X-ray source in combination with X-ray optics for diffraction experiments was first pioneered by U. Arndt in the early 90’s. Since then, there have been numerous research activities for finding suitable combinations of high-brilliant microfocusing sealed tube X-ray sources and X-ray optics (e.g. capillaries, TR mirrors). A major breakthrough was the development of graded multilayer mirrors by H. Goebel. Combining graded multilayer mirrors with a state-of-the-art high-brilliance microfocus sealed tube results in a new class of high-brilliant X-ray sources for the home lab. These sources are characterized by a high performance (high flux densities, high spatial resolution) and excellent beam stability together with low power consumption and low maintenance.

Third generation microfocusing sealed tube sources, such as the µS (Incoatec Microfocus Source), are now well established and give a performance beyond that of typical traditional X-ray sources - at power settings far below 1 kW. However, the past research work was focused, almost exclusively, on sources using Cu radiation. We will present selected results from single crystal diffraction experiments with the µS for Mo radiation. The flux density obtained from this source is about 1.5 times the flux density of a 5 kW rotating anode plus graphite monochromator on a 100 µm sample. In our experiments with very small crystals (< 50 µm), we have achieved gain factors of up to 3. Our results show that this source-optics-combination is very well suited for the structure determination on small crystals, as well as on medium sized samples.

Keywords: multilayer thin films, X-ray optics, powder and single crystal instrumentation

Optimizing signal-to-noise on a home X-ray source for the analysis of microcrystals

Daniel C Frankel1, Robert Lancaster1, Brian Michell1, Arjen Storm1, Rick Burkholder1, Frank von Delft2, James Murray2
1Bruker AXS Inc, Engineering, 5465 East Cheryl Parkway, Madison, Wisconsin, 53711, USA, 2Structural Genomics Consortium, Oxford UK, E-mail: dan.frankel@bruker-axs.com

Microfocus sources and multilayer optics have yielded enormous increases in flux for home X-ray sources. With these advances, optimization of signal to noise of the measured intensities has received little attention, despite the fundamental considerations being well understood and incorporated at synchrotron beamlines. We are developing a home X-ray system which allows easy experiment optimization in daily use. Some of the important considerations in this development include: A collimator assembly to allow real-time adjustable beam size and divergence which decreases noise by limiting exposure to the diffracting crystal; Minimize air scatter from the direct beam, but also allow measurement of very low resolution reflections through the use of collimator/beam stop/cold stream configurations; A noise-free photon counting detector (Axiom) to enable exposures required for tiny crystals with correspondingly tiny beam; High resolution imaging camera for accurate alignment and crystal quality assessment; Ice-free sample changer with semi-automated alignment protocols, to allow routine characterization of small crystals; Supporting software that exposes only true experimental considerations to the user, allowing even inexperienced users to routinely collect the best data possible. First versions of the system are intended to allow screening of extremely small crystals towards increasing efficiency of synchrotron beamtime. More ambitiously, we envisage that the system will allow routine collection of high quality datasets from small crystals that currently require synchrotrons. This is particularly pertinent in the context of Chemical Biology at the SGC, which requires large numbers of protein-ligand datasets, even from marginally diffracting crystals.

Keywords: microcrystal, homelab, microfocus

Transition radiation of relativistic electron from the superlattice of dielectric permittivity

Zohrab Amirkhanyan, Vahan Kocharyan, Artur Movsisyan, Gurgen Khachatryan
Institute of Applied Problems of Physics, National Academy of Sciences, Republic of Armenia, Coherent Processes, 25 Hr. Nersisyan str., Yerevan 375014, Republic of Armenia., Yerevan, Yerevan, 375014, Armenia, E-mail: zohrab@iapp.sci.am

The possibilities of formation of an intense source of monochromatic radiation in x-ray range [1], manageable in space and time are considered. It is based on the transition radiation of relativistic electrons from the superlattice of dielectric permittivity induced by electromagnetic field or double-walled nano-acoustic tube [2]. The experiments are carried out on the 20 MeV electron bunch. At the 1.2 GHz frequency of the electromagnetic field the superlattice - stack