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Sample housing for high-energy Compton measurements

Ch. Bellin, J. Frouin and G. Loupias

Laboratoire de Minéralogie-Cristallographie, Université Pierre et Marie Curie, Case 115, 4 place Jussieu, 75252 Paris CEDEX 05, France, and LURE, Université Paris Sud, Bâtiment 209D, 91405 Orsay CEDEX, France

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In order to obtain reliable Compton spectra using high-energy photons, the scattered beam must be free of parasitic photons, because of the weakness of the double-differential inelastic cross section. The purpose of the device presented in this paper is to remove photons scattered by air, the sample holder or any other stopper. It has been tested on ESRF beamline 2, which is devoted to materials science.

Keywords: inelastic scattering; high-resolution spectrometer; low noise; Compton scattering; sample housing.

1. Introduction

Inelastic scattering of photons is a powerful tool for investigating the electron densities of solids (Cooper, 1985; Platzman, 1989). The Compton profile is easily related to the double-differential cross section of scattered photons (energy and direction analysis). Nevertheless, photoelectric absorption strongly competes with inelastic scattering (Evans, 1955) in samples with large Z. Therefore, the first high-resolution Compton spectrometer using synchrotron radiation (Loupias & Petiau, 1980) was limited to the study of light elements owing to the low critical energy (roughly 8 keV) of the superconducting wiggler of LURE/DCI (Orsay, France). For inelastic scattering experiments, a major improvement to the new generation of synchrotrons, such as the ESRF, is the increase in photon energy, mainly as a result of the high electron energy in the ring and the use of wigglers as insertion devices. A typical energy of 29 keV is delivered by the wiggler of ID 11. Furthermore, the optics of beamline 2 are designed in order to obtain a small spot size of $0.2 \times 0.2\,mm^2$ on the sample. As a consequence, a large range of materials (with large Z and small crystal size) may be studied as long as a dispersive analysing device is installed on the main arm of the κ diffractometer (Kvick, 1994).

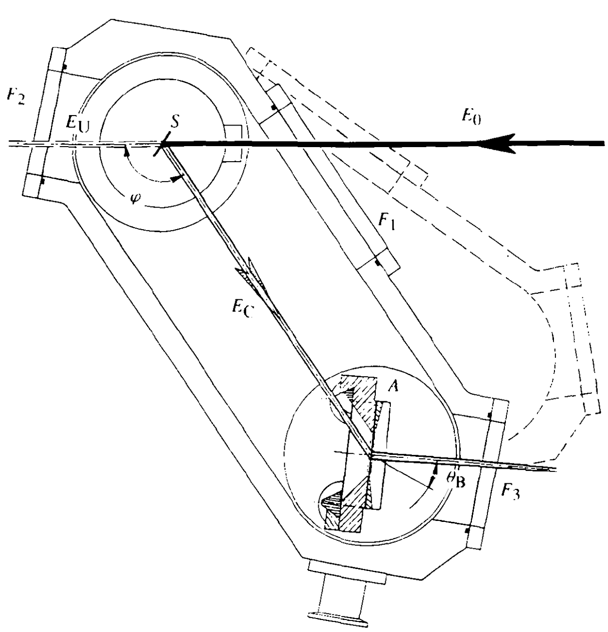

Figure 1
Sample and analyser housing.

2. Description

Using such a set-up, the photons, scattered by the sample S at an angle φ of between 125 and 145°, are energy analyzed and focused by a Cauchois curved crystal A (Cauchois, 1932) on a position-sensitive detector (image plate or gas detector).

At high energies, the system is very sensitive to parasitic photons scattered by air and any material in the beam paths. Such photons are also energy analysed by the crystal analyser and give a contribution to the Compton profile of interest. A special housing for the sample and analyser has been designed in order to refine experimental conditions, fulfilling the following conditions:

(1) The sample and analyser are under vacuum in order to avoid the parasitic contribution of air-scattered photons.

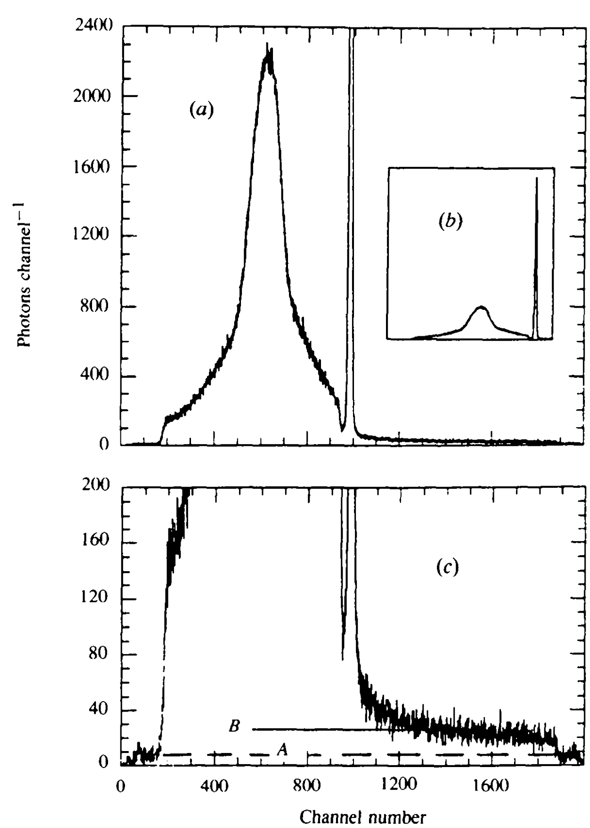

Figure 2
(*a*) Compton peak of the silicon direction [111] with the thermal peak on right side, (*b*) full-scale Compton and thermal peaks, and (*c*) expanded view of (*a*) showing details of backgrounds (*A* and *B*).

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(2) The monochromatized beam is prevented from hitting any stopper after having crossed the sample. Because of the non-directionality of the inelastic scattering, if such a stopper was close to the sample, the scattered photons could be seen by the analyser and consequently detected.

(3) The device has a minimum requirement of being capable of adopting different geometries for use in the Compton experiments.

In Fig. 1, one can see the incident monochromatized beam (E_0, bold line) entering the sample and analyser housing at the kapton window F_1. Photons E_C, scattered at angle φ (here equal to 125°), are energy analysed (curvature of the analyser A is obtained by squeezing) and then leave *via* the kapton window F_3. As a result of both the small size of the sample and the high energy of the photons, the incoming photons are not fully absorbed by the sample S. Therefore, a kapton window F_2 is utilized to allow the unstopped beam E_U to exit. The housing, rotated to reach a scattering angle φ of 145°, is drawn as a dashed line.

3. Concluding remarks

The Compton spectrum of silicon, obtained with the device described above, is shown in Fig. 2(*a*). The channel number increases with respect to energy. The narrow line (Fig. 2*b*), resulting from thermal scattering by the sample, is indicative of the experimental resolution of our set-up (six channels corresponding to 0.15 atomic units of momentum). From Fig. 2(*a*), the background, visible on the right-hand side of the spectrum, is very flat, whereas the Compton signal is still present on the left-hand side but has been cut by the geometrical conditions used for the low energies. In Fig. 2(*c*), the dashed line A shows the electronic noise, and line B the full background leading to a signal/noise ratio equal to 10^2 at the Compton peak and up to 6×10^2 at the thermal line. The flatness of the background measurement makes its removal easier.

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References

Cauchois, Y. (1932). *J. Phys. (Paris)*, **3**, 320–335.
Cooper, M. J. (1985). *Rep. Prog. Phys.* **48**, 415–481.
Evans, R. D. (1955). *The Atomic Nucleus*, pp. 972–1011. New York: McGraw-Hill.
Kvick, Å. (1994). *ESRF Beamline Handbook*, pp. 61–65. ESRF, Grenoble, France.
Loupias, G. & Petiau, J. (1980). *J. Phys. (Paris)*, pp. 265–271.
Platzman, P. M. (1989). *Momentum Distribution*, pp. 249–260. New York: Plenum Press.

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