New research improvements on the CRG-FAME XAS beamline at ESRF

O. Proux,[1] V. Nassif,[2] H. Palancher,[3] E. Lahera,[1] A. Prat,[4] A. Braillard,[4] J.-L. Hazemann,[4]

[1] *Lab. de Géophysique Interne et Tectonophysique, UMR CNRS - UJF, Saint-Martin-D'Hères, France,* [2] *SP2M/NRS, CEA, Grenoble, France,* [3] *DEN/DEC, CEA, Saint Paul lez Durance, France,* [4] *Lab. de Cristallographie, CNRS, Grenoble, France*

Introduction

FAME is the French Absorption spectroscopy beamline in Material and Environmental sciences at the ESRF (France), one of the four French Collaborating Research Group (CRG) beamlines, dedicated to X-ray Absorption Spectroscopy (XAS). The aim of this beamline is to cover a wide variety of common applications of XAS (EXAFS and XANES) in condensed matter physics, materials science, biophysics, chemistry and mainly in geochemistry sciences. We have concentrated our effort on the study of diluted systems and small samples. The stability requirements of such XAS spectra acquisitions and the operational simplicity of the instrument for the users were then the main leading factors in the design of the whole beamline [1] and especially the double-crystal monochromator, designed and realized by our team [2].

Monochromator design

The monochromator was designed keeping two points in mind: 1) having the maximum flux on the sample with 2) an optimal stability. To increase the flux on the sample, we choose to cryogenically cool the first crystal, to avoid any thermal bump. The second crystal is dynamically bent to focus the horizontal fan (2 mrad) on the sample. Finally, the automatic angular feedback of the angle between the two crystals leads to a permanent optimization of the monochromatic beam intensity during an energy scan (in the step-by-step or continuous mode).

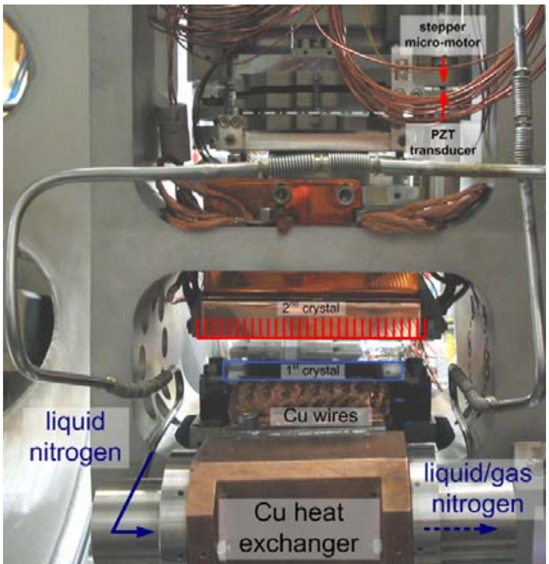

Fig. 1. First-crystal cooling device and 2nd crystal angular motion system via both PZT transducer and micro-motor

The monochromatic beam stability is achieved both in the short (noise) and the long ranges. The first crystal cooling process is performed *via* copper wires to damp the vibrations brought by the liquid nitrogen flow. Moreover, its temperature can be adjusted using two heating resistances, with a 1/100° accuracy. With this device, the 1st crystal temperature remains constant either during the decay of the current in the storage ring or during a refill process, *i.e.,* during slow or quick heat power variations.

The resulting absolute noise of the monochromatic beam intensity is then ~0.03% rms for a counting time equals to 1s/pt.

Actual developments

The actual and near future technological developments on the beamline go now in two directions: the decrease of the beam size and the improvement of the detection.

On one hand, a micro-focus apparatus in the so-called Kirkpatrick-Baez geometry will be soon operational. The aim is to have a small ($10\times10\mu m^2$ instead of the actual $300\times200\mu m^2$ HxV size) and stable spot, with a reasonable flux, to perform an EXAFS scan (1keV range) for energies ranging from 4 to 22 keV. A first set of tests has been performed with one mirror (size of the beam: $300\times15\mu m^2$ HxV) at the U L_3- and Mo K-edges [3] and a second with the complete set-up, at the Cu K-edge on vapor-phase fluid inclusions (size of the beam: $10\times10\mu m^2$ HxV). These experiments have allowed i) to precise the design of our new set-up (mainly the best way to define the secondary source by the actual optic elements), ii) to measure the size of the micro-focused beam and finally iii) to check if the stability of the optic elements allows to maintain the position of this micro-focused spot constant when the energy changes.

On the other hand, a crystal analyser device is under designed, to improve i) the fluorescence detection in some particular cases and/or ii) the energy resolution in the XANES area. First experiments have been already performed at the Cu K-edge [4].

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