Fast EXAFS measurement in piezo-driven single-crystal monochromatization scheme

A.I. Protsenko[1,2], A.E. Blagov[1,2], A.V. Targonsky[1,2], I.A. Eliovich[1,2], A.V. Rogachev[1], S.N. Yakunin[1], M.V. Kovalchuk[1,2]

[1] NRC "Kurchatov Institute";
[2] FSRC "Crystallography and Photonics" RAS.

8xenderx8@gmail.com

At the “Langmuir” station of the Kurchatov Synchrotron-Neutron Research Complex, a single-crystal monochromator based on adaptive bending X-ray acoustic element [1] was implemented for X-ray beam energy fast tuning and for rapid recording K-edge absorption spectra (XANES-spectrum) of Bromine in NaBr powder sample.

To control beam parameters and record the absorption spectrum, Si single-crustal monochromator, driven by ultrasonic vibrations excitation in piezo-actuator, and monitoring system were used. Diffracted synchrotron beam was collimated by slits and recorded using a scintillation detector, connected with multi-channel analyzer. X-ray acoustic element was excited via the inverse piezoelectric effect by applying a AC electronic signal with first harmonic resonance frequency f_{rez} = 239 Hz. During the experiments, the beam intensity was recorded in relation to control signal phase, further converted into an absorption spectrum.

After data processing the results it was established that the position of absorption edge and the first coordination sphere radius coincided for X-ray acoustic and traditional mechanical scan. Achieved energy scan range was 13.25–13.65 keV (400 eV). Maximum time resolution available using the x-ray acoustic method is 2.1 ms, and actual time required to record qualitative spectrum, achieved in this experiment, was about 30 seconds and can be reduced by using detector with a higher dynamic range and counting rate, as well as optimizing X-ray optical scheme.

The developed scheme is promising for QEXAFS methods implementation, useful for chemical reactions kinetics study, for example, the Belousov-Zhabotinsky self-oscillation reaction [2], as well as the deformation processes kinetics research under external influences.

1. A.E. Blagov, A.S. Bykov et al. PTE, 2016, No. 5, p. 109

2. M Hagelstein, T Liu et al. // J. of Physics: Conference Series 430 (2013) 012123

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