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Micro-X-Ray fluorescence spectrometer with X-ray single bounce metallic capillary optics for light element analysis

R. Mroczka[1]*, A. Sykuła[1], E. A.Stefaniak[1,2]

[1] *Laboratory of X-ray Optics, Centre for Interdisciplinary Research, The John Paul II Catholic University of Lublin, Konstantynów 1, 20-708 Lublin, Poland,*
[2] *Department of Chemistry, The John Paul II Catholic University of Lublin, Konstantynów 1, 20-708 Lublin, Poland,*

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*e-mail: rmroczka@kul.pl

In the last 20 years, due to the rapid development of X-ray optics, micro X-ray fluorescence spectrometry (micro-XRF) has become a powerful tool to determine the spatial distribution of major, minor, and trace elements within a sample.

Micro-X-ray fluorescence (micro-XRF) spectrometers for light element analysis ($6 \leq Z \leq 14$) using glass polycapillary optics are usually designed and applied to confocal geometry. Two such X-ray optics systems are used in this setup. The first one focuses the primary beam on the sample; the second restricts the field of view of the detector. In order to be able to analyze a wider range of elements especialy with ($6 \leq Z \leq 14$), both sample and detector are under vacuum. Depth resolution varies between 100 μm at 1 keV fluorescence energy (Na-Kα) and 30 μm for 17.5 keV (Mo-Kα) [1,2].

In order to improve resolution at energies below 9 keV, our group designed similar spectrometer (in cooperation with PREVAC) but instead of primary polycapillary optics we applied single bounce metallic capillaries optics, designed and manufactured in our Laboratory. The vacuum chumber is currently under construction and is expected to be fully operational in September this year.

Single bounce gold capillaries with elliptic internal shape have recently been redesigned and developed in our Laboratory. Surface roughness was reduced up to 0.5 nm and slope error to 0.3 mrad. For these capillaries an expected depth resolution varies from 3 μm (1 keV) and 10 μm for 9 keV (Cu-Kα).

The spectrometer equipped with gold capillaries offers the possibility of elemental analysis with better depth resolution than is offerred by glass polycapillaries at energies below 9 keV.

To further extend analytical capabilities of single bounce metallic capillaries, we will present a design of a micro-XRF spectrometer using synchrotron radiation (SR). Capillaries with parabolic shape will be applied in order to focus SR. This proposal can be considered as a part of our Polish Synchrotron SOLARIS.

Furthermore, we will compare the capabilities and limitations of this spectrometer with others, that use laboratory and/or synchrotron sources.

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