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

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In the last 20 years rapid development of X-ray optics was found application in micro X-ray fluorescence spectrometry (micro-XRF) and 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. The first capillary 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 especially with ($6 \leq Z \leq 14$), both sample and detector are operated 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 lateral and depth resolution, our group designed similar spectrometer (in cooperation with PREVAC) but instead of primary polycapillary optics we applied single bounce metallic capillaries optics, designed, manufactured. For single bounce capillaries the second capillary normally mounted in the front of detector is not needed. As a source, X-ray tube with microspot (40μm) was applied, similar as it was used in other spectrometer [1]. Our spectrometer was installed on December 2015 in our Laboratory.

Single bounce gold capillaries with elliptic internal shape have recently been redesigned and developed in our Laboratory. Surface roughness internal reflectivity layer was reduced up to 0.3 nm and slope error to ~ 0.1 mrad. Because capillaries are produced by electroforming method, X-ray reflectivity internal layer is not only limited to gold but other metals and multilayers are also possible. The spectrometer equipped with gold capillaries offers the possibility of elemental analysis with better lateral and depth resolution than is offered by glass polycapillaries at energies 9 keV (Cu, Kalpha) and 17.4 (Mo, K,alpha) 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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