Analysis of levels, speciations and chemical environments of selected elements in brain gliomas

M. Szczerbowska-Boruchowska, A. Wandzilak, M. Czyzycki, Z. Stegowski, D. Adamek[1], E. Radwanska[1], D. Zajac[2], and M. Lankosz

AGH-University of Science and Technology, Faculty of Physics and Applied Computer Science, Al. Mickiewicza 30, 30-059 Kraków, Poland

[1] Department of Pathomorphology, Collegium Medicum, Jagiellonian University, Krakow, Poland

[2] HASYLAB-DESY, Notkestrasse 85, 22603 Hamburg, Germany

The brain gliomas are the most common major histological type of brain cancer and account for more than 40% of all neoplasms of central nervous system. In spite of such frequency of occurrence the knowledge of this type of cancer is still very poor. The biomodulators causing unrestrained growth of brain tumor cells are not well known and current therapies are relatively ineffective. The complex chemical analysis of Fe, Cu and Zn in tumor tissue is particularly essential considering biochemical processes that may participate in pathogenesis of the brain gliomas [1]. These studies would to shed new light on cancerogenesis of brain gliomas

The techniques based on synchrotron radiation were previously applied by our group for investigation of brain gliomas in the frame of experiments performed at HASYLAB [2]. In our investigations we used tissues lyophilized at temperature -20^0 C and stored at room temperature in air atmosphere. It could cause, that speciation and local environment of measured elements would be affected by chemical processes caused by air. Preliminary research with the use of X-ray absorption spectroscopy technique was carried out for tissue samples taken intraoperatively from patients with different grades of brain gliomas. X-ray absorption near edge structure (XANES) was used for investigation of Fe and Zn oxidation state. The extended X-ray absorption fine structure (EXAFS) was used for investigation of Fe and Zn local environment. The specimens were taken during the tumorectomia and immediately frozen at temperature about –80 °C. The samples were transported to HASYLAB in liquid nitrogen (LN) cryostat. Before measurements the frozen samples having mass about 1 g each were encapsulated in Ultralene foil. Two samples of glioma with tumor grade III and with tumor grade IV were used in measurements. As standards: Fe(II) - $FeSO_4$*$7H_2O$, Fe(III) - $Fe_2(SO_4)_3$*nH_2O***;*** Zn(0)-powdered metallic Zn and Zn(II)- ZnS were used. The measurements were performed at the bending magnet beam line C at HASYLAB equipped with two mirrors and a double-crystal Si(111) monochromator, LN cryostat with sample holder located in vacuum chamber and seven pixels Si(Li) detector. The measurements were performed at temperature about –184 °C. The absorption spectra were measured at the Fe K-edge and the Zn-K-edge in the fluorescence mode in the energy range from 7050 to 7700 eV for Fe and from 9650 to 10150 eV for Zn, respectively. The collected spectra were evaluated using ATHENA program. In the measured gliomas Fe is in the oxidation state between 2^+ and 3^+, and Zn is on oxidation state between 0 and 2^+ (Fig. 1). No significant differences in the position of Fe edges were observed for measured samples. The shift towards higher oxidation state appears for Zn in glioma with grade IV. The influence of the sample temperature on the Fe oxidation state and Fe local environment were investigated. One of the sample was warmed, stored for 30 minutes at room temperature (about 23°C) and refrozen in LN before measurements. No difference in position of Fe absorption edge for frozen and refrozen sample was detected. The Fourier transforms of the tumor tissue EXAFS functions (Fig. 2) indicating differences in the paths of scattering for gliomas having III and IV WHO grades.

Further investigations on other cases of human brain gliomas to achieve a statistically reliable number of samples, and in consequence statistically significant results are necessary.

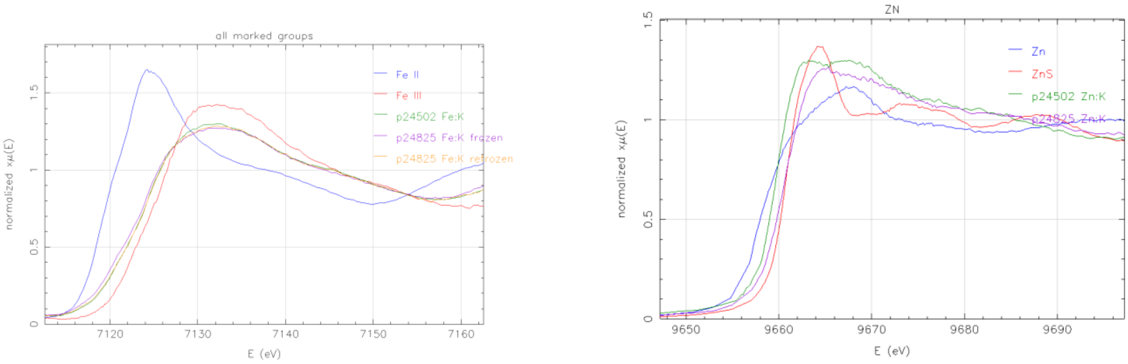

Figure 1: The example of Fe (a) and Zn (b) XANES spectra in gliomas (p24502- III grade, p24825-IV grade)

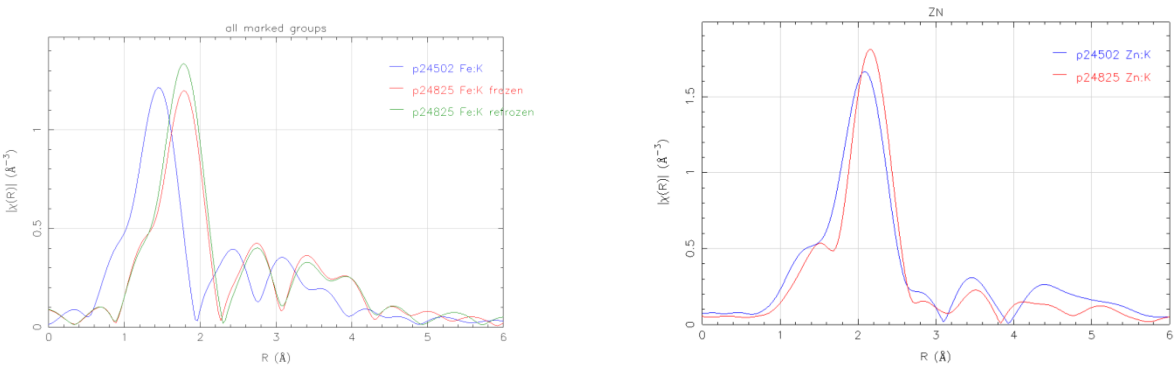

Figure 2: Magnitude of the Fourier transform, χ(R) as a function of a radial coordinate. The example represents a measurement of Fe (a) and Zn (b) EXAFS in samples of gliomas (p24502- III grade, p24825-IV grade)

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References

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