The investigations of iron local environment in human brain tissue using XAFS technique.

S. Wojcik, M. Szczerbowska-Boruchowska, M. Lankosz, C. Kapusta[1], M. Borowiec[1], D. Adamek[2], K.V. Klementiev[3]

Department of Nuclear Methods, Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Al. Mickiewicza 30, Krakow, Poland

[1] – Department of Solid State Physics, Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Al. Mickiewicza 30, Krakow, Poland

[2] – Institute of Neurology, Collegium Medicum, Jagiellonian University, Botaniczna 3, Krakow, Poland

[3]– Hamburger Synchrotronstrahlungslabor HASYLAB at DESY, Notkestr. 85, Hamburg, Germany

Iron-mediated processes in human brain are subject of numerous studies. As is known this element may participate in some pathological mechanisms e.g. via production of free radicals in the Fenton's reaction. For this reason, studies of iron sites in human brain tissue are of great importance. One of the methods providing this kind of information is X-ray Absorption Fine Structure (XAFS) spectroscopy.

The investigation was carried out for sample taken during an autopsy from the area of substantia nigra (SN) of human brain. Sample was cut using cryomicrotome (20 μm thick), then placed on AP1 foil and afterwards freeze-dried (-20°C). Iron oxides FeO and Fe_2O_3 (powder samples) were used as experimental standards.

The preliminary measurements were performed at the bending magnet beamline E4 at HASYLAB equipped with two mirrors and a double-crystal Si(111) monochromator. The beam size was set to a size of 1.3 x 3.0 mm FWHM using a slit system. The experiment was carried out in the air. The absorption spectra near the Fe K-edge were measured in fluorescence mode in the energy range from 7050 to 7700 eV using 7 pixel Si(Li) detector (energy resolution 160 eV at 1000 cps, 12 mm beryllium window). The energy step increments were equal to: 2, 0.2, 0.5 and 0.818 eV for the energy ranges: 7050-7110 eV, 7110-7130 eV, 7130-7182 eV, and 7182-7700 eV respectively. The measurement time was equal to 2 s.

The spectra have been elaborated with the ATHENA/FEFF software. The Fourier transforms of the SN EXAFS functions is shown in Figure 1. First peak is mainly composed of Fe-O scattering path. In second one Fe-C has strong contribution, but also multiply scattering path Fe-O1-O2. The third peak in the spectrum is mainly due to multiply scattering paths, especially Fe-C-O2-C. See table 1 for fit results.

Total of nine independent variables was used (i.e. radial distances, amplitudes for Fe-O and Fe-C scattering paths, the Debey-Waller factors), all other were tied to these independent variables.

Further investigations are in progress.

Table 1. Fit results for the theoretical model applied to SN XAFS data.

Path	Coordination number	Radial distance (Δ)	D-W factor ($\cdot 10^{-3}$Δ)
Fe-O1	4.95 ± 1.25	2.32 ± 0.04	16 ± 4
Fe-O2	4.95 ± 1.25	2.50 ± 0.04	15 ± 4
Fe-C	3.56 ± 2.50	3.48 ± 0.05	19 ± 9

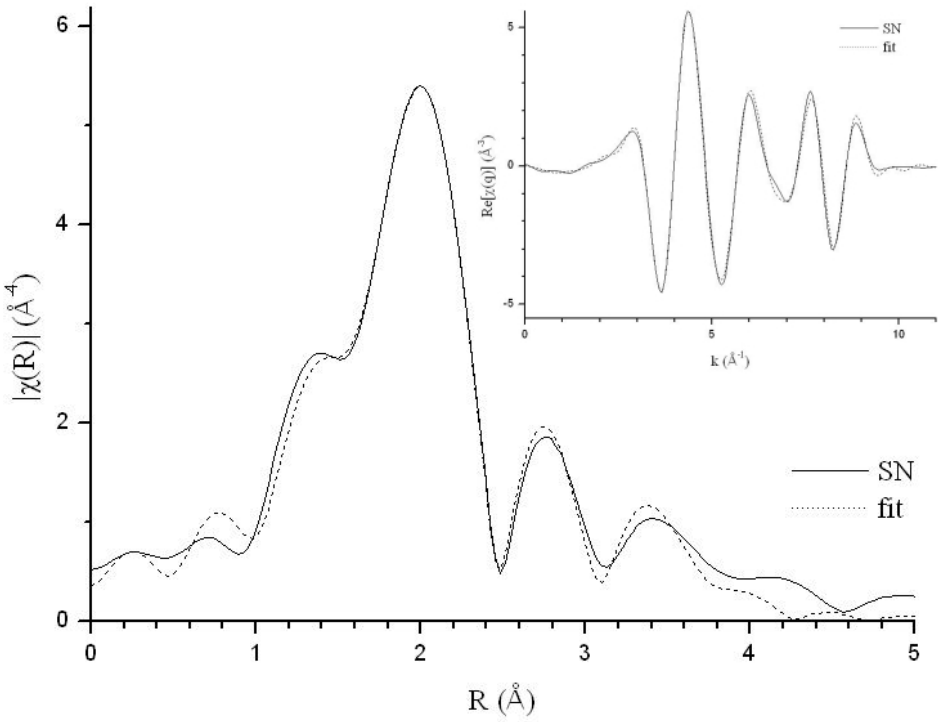

Figure 1. Magnitude of the Fourier transform, χ(R) as a function of a radial coordinate. Fourier Transform is over a k-space range of 3.0 – 9.1 Δ^{-1} (dk = 1) with Hanning window. Inverse Fourier transform over R-space range 1.0 – 3.85 Δ (dR = 0.2), Hanning window.

References

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