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CANCEROUS TISSUES ANALYZED BY XANES AND SRIXE

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SRIXE (Synchrotron Radiation Induced X-ray Emission) analysis of trace element concentrations in cancer and healthy parts of tissues show significant differences between elemental concentrations. The use of SRIXE and X-ray Absorption Near Edge Structure (XANES) enabled obtaining additional information about the cancer the most dangerous disease of the recent days. The cancer tissue sections were obtained after radical removal of the organ from the patient's body. The samples were histologicaly examined and classified as well as the Gleason score was determined. An example of a prostate stained tissue section is presented in Figure 1. A 10 μm thick tissue sections cut on a cryo-microtome were placed on 3 μm thin Mylar foil and were irradiated with monochromatic X-ray beam of 16 μm × 14 μm size. The two-dimenssional scans on both cancerous and non-cancerous parts of the tissue were made in order to determine trace element concentrations and iron oxidation state.

The elemental concentration enable the calculation of correlation between the elements. The most interesting correlation has been found between copper and iron. In all samples one can easily observe positive correlation between those elements in all types of tissue. Figure 2 shows the results obtained along with the fitted trends for those data.

The differences in the lines slopes may result from different erytrocytes (Fe) / plasma (Cu) ratios caused by exovasation of blood and plasma formatioon of crystals containg Fe atoms. The results obtained show the difference in concentrations of several elements. Copper is increasing along with iron while zinc is decreasing. These shows the negative correlation between Cu and Zn levels. In cancerous parts of the tissues iron appears mostly on 3rd oxidation state while the non-cancerous parts contain iron mostly on 2nd oxidation state.

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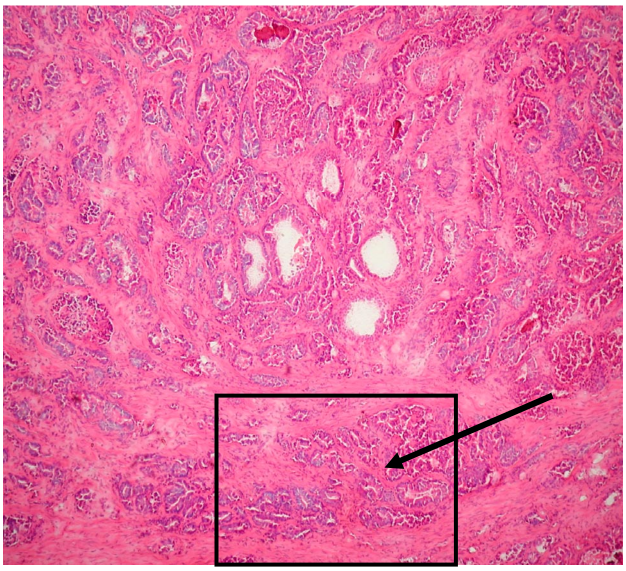

Figure 1.

Histological view of a prostate tissue sample with marked area of the measurements. The arrow points to the cancerous cells.

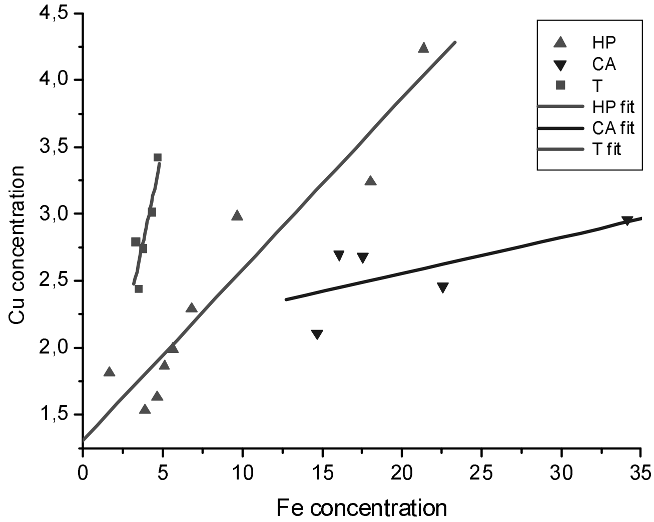

Figure 2.

Correlation between Cu and Fe concentration in ppm for different type of samples where HP – stands for hyperplasia, CA – stands for cancer, and T – stands for adenocarcinoma.

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IRON STUDIES IN CANCEROUS AND NON-CANCEROUS PROSTATE TISSUES

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The cancer and cancerogenesis as a process has been the subject of enormous number of studies: clinical and experimental, based on different philosophy and technical approaches. Although at present genetics and immunology on the other hand (both assisted by biochemistry) seem to be leading approach, the methods of nuclear physics offer also some valuable possibilities.

SRIXE and XANES analysis of trace element concentration in healthy and cancer parts of prostate tissues is a continuation of the last year's study [1]. On selected samples a one-dimensional scans across the sections were performed in order to obtain full range of X-ray spectrum from different tissue structures. Then two-dimensional mappings (up to 100 × 100 μm^2) were made to determine the elemental distribution in the tissue structure. Figure 1a shows a histological view of a prostate tissue whereas Figure 1b presents distribution of Fe concentration in the same area of the tissue.

The on-line analysis of the two-dimensional mapping indicated the areas with high concentration of iron. Those areas were re-measured by means of XANES with the beam energy scanned over the range of 7090 eV-7140 eV in order to measure the absorption edge of iron existing in the sample.

Figure 2 shows an example of iron XANES spectra taken on highly concentrated iron points in the investigated tissues.

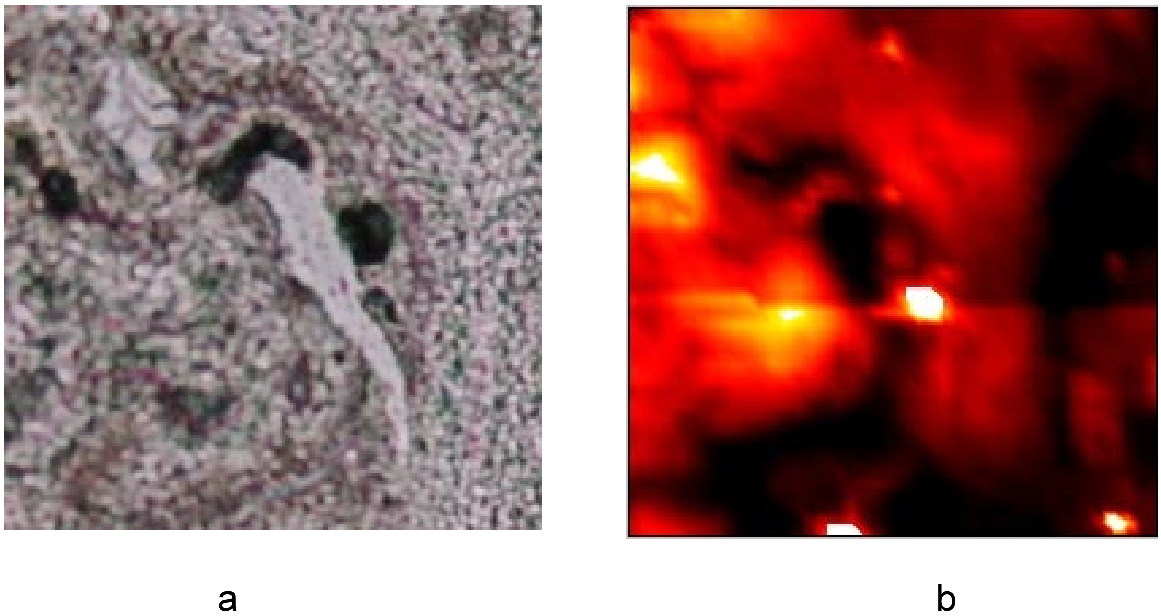

Figure 1. Histological view of a prostate tissue (a) and distribution of Fe concentration (b).

Almost all elements detected in the cancerous tissues were found at higher concentration levels in comparison to non-cancerous tissues, this relation is especially valid for iron. The XANES spectra analysis proved the domination of iron appearance on 3rd oxidation state in cancerous tissues and on 2nd oxidation state in healthy part of tissues.

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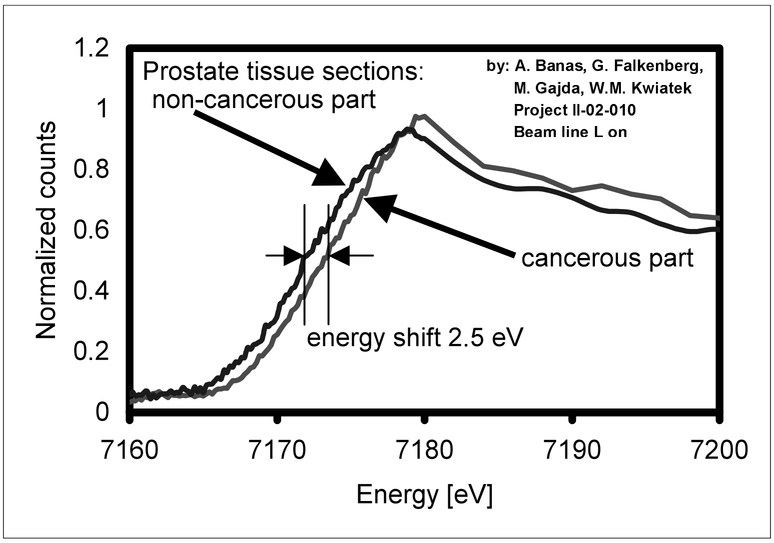

Figure 2. Iron XANES spectra taken on highly concentrated iron points in the cancerous and non-cancerous tissues.