ELECTRON PARAMAGNETIC RESONANCE FOR DOSIMETRY AND DATING

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Since the invention of Electron Paramagnetic Resonance (EPR) by E. Zavoisky in 1944 this method has rapidly found a number of applications in different fields of research. Also the EPR has been used as a proven method for dosimetry purposes. At the beginning, this was customized for high-dose measurements using alanine as the irradiation detector. Later on, the EPR technique was for the dose estimation on teeth enamel and bones using most stable free radicals originating in hydroxyapatite – the mineral part of biogenic calcified tissues. The EPR dosimetry using tooth enamel is based on the correlation between the intensity or amplitude of some of the radiation-induced signals and the dose absorbed in the enamel.

The use of EPR for radiation dose reconstruction is based on the fact that human tooth enamel is a natural detector of accumulated dose. The first study that demonstrated possibility to use enamel as a radiation detector was published in 1968 [9], and later on successfully applied for dose reconstruction for survivors of atomic bomb attacks in Japan, for Chernobyl's clean-up workers. The radiation dose received by their tooth enamel was determined from the EPR signal strength of the stable paramagnetic centres created by radiation. A dosimetric EPR signal is formed from carbonate impurities of hydroxyapatite, with the most stable being CO_2^{3-} that has a lifetime over several million years. One of the advantages of EPR technique for the dose reconstruction is its invasiveness, i.e. the signal evaluation could be repeated not affecting the primary dose information. Introduction of new sample preparation methods and careful separation of influencing factors have led to remarkable methodological progress in the EPR bio-dosimetry. Currently, EPR remains the only feasible method for dose reconstruction using tooth enamel, becoming an increasingly more recognized technique for retrospective dosimetry. In the near future, more sophisticated EPR techniques for human *in vivo* dose evaluation and local dose imaging is to be developed.

The EPR method has made a substantial contribution to the dating of geological and archaeological materials such as calcites, carbonates, silicates. The very long lifetime of the hydroxyapatite signals allows EPR to provide information on the early entire span of human evolution.

Also, we report results of investigations into the radiation influence on blood of patients examined at radio-isotope diagnostics (Tc99m), of Chernobyl clean-up workers, and of irradiated human blood (taken from our researcher) by linear accelerator (LINAC). We have chosen the EPR method to study the effect of radiation on blood since this method sensitive for detecting the valence state of transition metal ions. When an ion of Fe^{2+} in porphyrin ring of hemoglobin is binding the oxygen, no change of electronic state occurs but that of the spin state from high to low. The ion of iron has a high-spin state in dioxyhemoglobin (venous blood) and a low-spin state in oxyhemoglobin (arterial blood). Ionizing radiation change the valence of iron from Fe^{2+} to Fe^{3}. The EPR spectra for blood samples from Chernobyl's clean-up workers were also obtained. It is necessary to note that the obtained spectra have g-factors signals of 2.0 (dioxyhemoglobin), 4.3 (transfferin), 6.0 (dioxyhemoglobin). The overview [2] of reu obtained allow us to suggest that Chernobyl's clean-up workers contain methemoglobin (Fe^{3+} in high spin state) above the normal level. We hold to the opinion that the ion Fe^{2+} of hemoglobin is oxidized to the Fe^{3+} in heme by radiation, and we suppose that the sources of radiation are $^{90}Sr/^{90}Y$ radionuclide and other radionuclides were received and absorbed in tooth and bones during clean-up action in Chernobyl. We observed correlation between the EPR signal intensity of methemoglobin and the activity of the $^{90}Sr/^{90}Y$. It was found that one of the main radionuclides presented in the teeth is Sr-90 and its contribution is from 20% to 50% of the total absorbed dose [3, 4]. The EPR spectra of irradiated blood *in vitro* contain only methemoglobin in the low-spin state. Therefore, based on the results obtained, we can state that under ionizing radiation ion Fe^{2+} changes the valence to Fe^{3+} but do not change the spin state configuration [4].

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