

Ps in solutions - could be of help for PET and detection of carcinogens?

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It is known that the concentration of the dissolved oxygen in malignant tumors is much lower than in healthy tissues. Therefore, cancer cells permanently live in conditions of oxygen starvation. On the other hand, dissolved oxygen efficiently shortens the lifetime of the ortho-Ps atom. It takes place because, firstly, oxygen may oxidize Ps (taking away an electron from it and converting Ps into a “free” positron). Secondly, since the O₂ molecule is paramagnetic, it is able to induce the process of ortho-to-para Ps spin conversion. Both of these effects reduce the Ps lifetime in liquids. This means that the lifetime of the Ps in healthy tissues will be shorter than in malignant ones. This relationship between the ortho-Ps lifetime and the concentration of the dissolved O₂ can be used to develop a new, additional method for detecting tumors using modern positron emission tomographs [1, 2].

It is recognized that one of the main causes of cancer is chemical carcinogens. Physicochemical methods for determining the carcinogenic activity of substances are based on the fact that most of carcinogens are, in particular, effective electron scavengers. However, it is known that track electrons, generated by ionizing slowing down of the fast positrons when they pass through a medium, are the main precursors of the positronium atom (Ps). We have shown that the complete inhibition of the Ps formation in a cellular milieu by the test chemical compound can serve as an indication of its carcinogenic properties.

This approach is similar to what was done by G. Bakale using nanosecond pulsed radiolysis setup in 80's. The advantages of the positron approach over the Bakale's method are reduced to simplicity, speed and economic benefit.

The simplest model is proposed for interpretation of the carried out experiments on Ps inhibition, oxidation and ortho-para conversion.

[1] S.V. Stepanov, V.M. Byakov, P.S. Stepanov “Positronium in Biosystems and Medicine: A New Approach to Tumor Diagnostics Based on Correlation between Oxygenation of Tissues and Lifetime of the Positronium Atom” *Physics of Wave Phenomena*, V. 29(2), 174-179 (2021) DOI: 10.3103/S1541308X21020138

[2] P.S. Stepanov, F.A. Selim, S.V. Stepanov, A.V. Bokov, O.V. Ilyukhina, G. Duplatre, V.M. Byakov “Interaction of positronium with dissolved oxygen in liquids”, *Physical Chemistry Chemical Physics*, V. 22, 5123-5131 (2020) doi.org/10.1039/C9CP06105C

[3] Vsevolod M. Byakov, Sergey V. Stepanov “Detection of carcinogenic and anticarcinogenic properties of chemicals by means of the positron annihilation lifetime spectroscopy”. *RENSIT*, 12(1):115-128 (2020); DOI: 10.17725/rensit.2020.12.115

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