Radon diffusion through tissue*

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For a better understanding of the molecular mechanism of its anti-inflammatory effects we want to investigate the radon diffusion through tissue. In parallel work we measured the primary radon uptake via γ-spectroscopy of the short living radon daughter nuclei Pb-214 and Bi-214 [1]. However, in such experiments the diffusion of radon through tissue cannot be measured directly. Here we report preliminary results on the radon diffusion using alpha spectroscopy.

Experimental Setup

In the diffusion chamber (fig. 1) biological samples like muscle, fat or cartilage can be inserted and exposed to radon at different concentrations when placed inside the larger radon chamber [2]. The diffusion chamber consists of an upper and a lower part which can be screwed together and holds the various samples in between. In the lower section a silicon-detector is used to detect alpha-particles from Rn-222 (half-life 3.8 d) and its decay daughters Po-218 (3.05 min.) and Po-214 (164 µs).
Radon gas can reach the small volume above the detector only by diffusion through the sample.

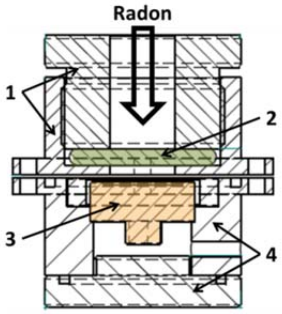

Fig. 1: Measurement setup, 1: upper part, 2: sample, 3: detector, 4: lower part

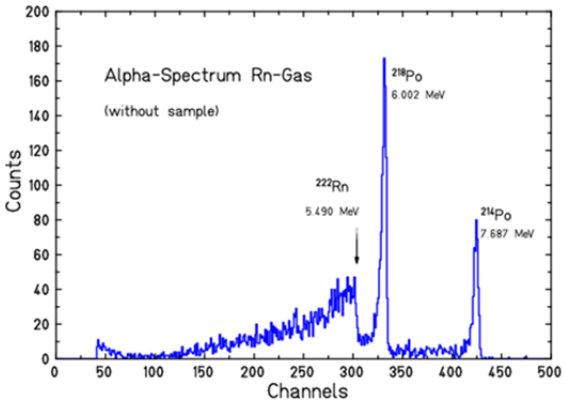

Fig. 2: Alpha spectrum recorded without sample. Acquisition time 2 hours

As a reference we measured spectra of Rn-222 and its daughter nuclei without sample (fig.2). An Am-241 alpha source placed in front of the detector was used for energy calibration. The spectrum shows a broad distribution for alpha particles emitted in Rn-222 decays (range in air 3.9 cm) in the gas volume above the detector, while the decays of the daughter products Po-214 and Po-218 seem to take place mainly at the detector surface (narrow peaks).

Results

In the measurements carried out so far different tissues were exposed with different Rn concentrations over 120 minutes and the corresponding alpha spectra were recorded in intervals of 10 minutes. In fig. 3 we show first results from cartilage tissue with a thickness of 2.5mm. The amount of Radon-222 obtained by integration of the alpha spectrum up to 5.49 MeV is plotted versus time. As expected, the curve for the higher radon concentration during exposure gives higher values than the lower radon-concentration. But the time until reaching saturation is for both samples nearly the same.

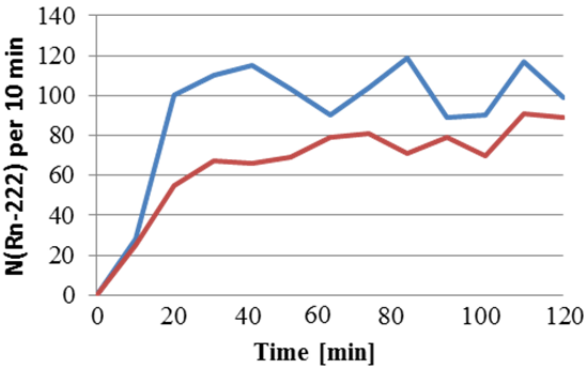

Fig. 3: Integrated amount of Radon-222 in cartilage with different radon concentration: upper curve: 394 ± 6 kBq/m^3, lower curve: 218 ± 5 kBq/m^3

Conclusion

In this work we developed a new method to measure the radon diffusion though various materials via alpha spectroscopy. In first measurements we demonstrated the feasibility of this method and obtained first results. In the future we plan systematic measurements with improved statistics and studies of different types of tissue with different thicknesses. Using this novel technique one can obtain quantitative results necessary to optimize our model for the radon diffusion in different tissues and the distribution of radon in the human body.

[1] A. Maier, P. van Beek, M. Durante, C. Fournier, J. Hellmund, G. Kraft, Radon solubility in different types of tissue, GSI Scientific report 2014
[2] C. Fournier, G. Kraft, A. Maier, Untersuchungen zum genetischen Risiko und zur entzündungshemmenden Wirkung von Radon, StrahlenschutzPRAXIS, 1/2014

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