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Designing metal oxide-based stationary phases for the separation of Ac-225 and Bi-213 for biomedical applications

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Cancer is a disease that still kills nearly 10 million people every year [1] despite the countless existing treatments. The amount of novel therapies is growing every day and targeted alpha therapy is one of them. Herein, the patient is treated with a radiopharmaceutical that binds to the cancer cell and emits ionizing radiation to induce cell damage. Since alpha radiation has a very short range (only a few cell diameters), the healthy cells around the tumor are spared. Amongst a number of radioactive isotopes that can be used for this purpose, Bi-213 is a promising candidate because of its suitable half-life and well-known chelation chemistry. Clinical trials with this isotope have already been performed in the past and results are very promising [2]. The biggest hurdle, however, is the Bi-213 production, which is now far from sufficient to implement this isotope in targeted alpha therapy on a large scale.

The most commonly used generator for the separation of Ac-225 and Bi-213 is based on AG MP-50. This is a macroporous strong acid cation exchange resin composed of sulphonic acid groups attached to a styrene divinylbenzene copolymer backbone. The AG MP-50 generator has a high yield (>76% Bi-213), a very low breakthrough of Ac-225 (<2*10-5 %) and the Bi-213 elution is very fast (2-3 min). Despite these great advantages, the main disadvantage is its low radiation stability. The organic backbone and especially the link with the functional group is very susceptible to radiation damage, such that in normal operation conditions the performance of the generator will substantially decrease [3].

On the other hand, inorganic materials are known to be more resistant against radiation. Therefore, this contribution presents the study of surface modified inorganic materials and their performance towards Ac-225/Bi-213 separation. The materials under investigation are titania and zirconia, which are modified with phosphoric acid groups. Different analytical techniques such as zeta potential and ICP-MS are utilized to characterize the surface modification of the inorganic materials. Furthermore, the modified materials are subjected to a so-called 'cold sorption'test. Via this method, sorption properties such as separation efficiency, leaching stability and sorption capacity are evaluated by means of non-radioactive solutions of La and Bi. Ultimately, the actual Ac-225/Bi-213 sorption properties of the phosphoric acid-modified materials will be tested in a radiochemical laboratory.

The final goal of this research is to develop an improved direct Ac-225/Bi-213 generator material with high radiation stability and increased Bi-213 yield and purity to make targeted alpha therapy more available and to give cancer patients new hope for a better future.

Bibliography

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