New strategies in nuclear human decorporation using macromolecular systems

F. Lahrouch[a,$], L. Leost[a], B. Siberchicot[b], J. Roques[c], A. Van Der Meeren[d], J. Aupiais[b], C. Hennig[e], C. Di Giorgio*[a], C. Den Auwer*[a]
[a]Université Côte d'Azur, Institut de Chimie de Nice, UMR7272, 06108 Nice, France
$ now at Sorbonne Université, IMPMC UMR 7590, Paris, France
[b]CEA, DAM, DIF, 91680 Bruyères le Châtel, France
[c] Université Paris-Saclay, Institut de Physique Nucléaire, IN2P3-CNRS, 91406 Orsay, France
[d]CEA, DRF, Laboratoire de RadioToxicologie, 91680 Bruyères le Châtel, France
[e]HZDR, Institute of Resource Ecology, 01314 Dresden, ESRF, 38043 Grenoble, France
christophe.denauwer@univ-cotedazur.fr

The use of uranium and plutonium as a fuel for nuclear energy production or as components in military applications is under increasing public pressure worldwide. Associated nuclear risks include chronic or acute contamination in the nuclear industry, exposure in case of major accident or military attack, chronic low (to very low) dose effects from naturally (uranium, thorium) or artificially contaminated backgrounds due to mining activities. In case of human exposition, chemical toxicity as well as radiological toxicity (depending on isotopy) may contribute to deleterious health effects. However, the counter measures currently available are either inefficient or not very selective. Today, the only decorporation drug used in France is DTPA (diethylenetriaminepentaacetic acid, calcium form) injected intravenously.[1] But it is only valid for removing actinide contamination from blood (mainly Pu), few minutes after contamination. In order to overcome these difficulties, news strategies must be elaborated. Macromolecular systems like biocompatible polymers or functionalized nanoparticles could represent an alternative strategy because of their tropism for specific target organs (bone, lungs, liver, kidneys...). For the skeleton for instance, we have recently explored the complexation properties of methylcarboxylated and methylphosphonated polyethyleneimine with uranium, thorium and plutonium.[2,3] For the pulmonary alveolar system in case of plutonium exposure, we have designed biocompatible chitosan nanoparticles that are able to release the decorporation agent directly into the macrophages.[4] For those macromolecular systems, the cation coordination site has been characterized with a combination of analytical and spectroscopic techniques, among which X-ray Absorption Spectroscopy plays a central role. Molecular dynamics and quantum chemical simulations have also been performed as a complement to better understand the atomic arrangement around the

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actinide cation. The physical chemical approach described here represents a necessary basic chemistry stage before envisioning further biological evaluations