# From Repository Condition Behaviour to Advanced Functional Material Design: New Insights into the Reactivity of $IO_3^-$

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$^{129}$I, chemically as $IO_3^-$, resulting from an accident scenario involving spent nuclear fuel (SNF) presents serious concern due to its significant radiation hazard, ability to readily metabolize in the human body and its low interaction affinity with exchange based materials and minerals. Consequently we have embarked on an extensive systematic investigation of the solid state chemistry of $IO_3^-$ systems relevant to SNF and nuclear waste management.

The current consensus under an accident scenario, due to its mobility, $IO_3^-$ is expected towards the far-field of SNF where exchange materials such as layered double hydroxides are considered for application to prevent against biosphere interaction. However, we have recently demonstrated that the chemistry and topology of certain SNF secondary phases that occur in an accident scenario in the near-field will retard the transport of $IO_3^-$ via intercalation mechanisms. Particularly we show that under certain conditions an anionic species such as $IO_3^-$ can be prevalently incorporated into an anionic lattice (~ 40 w/w%) i.e exceedingly above trace level. This has profound consequences for the understanding of fission daughter species behaviour under a SNF accident scenario. The specific intercalating secondary phases, ramifications to SNF disposal, and also preliminary investigations of related intercalation of $SeO_3^{2-}$ will be discussed.

We extended our studies from the interaction of $IO_3^-$, towards understanding structure formation of uranyl-iodate systems under slow evaporative conditions with variable pH. These experiments unveiled the first example of an actinide polyiodate. Denoted UP-1, the structure possess remarkable properties towards application in non-linear optical (NLO), X-ray scintillation and proton conductor materials. Importantly this work reveals the synthesis conditions at which polymerisation of $IO_3^-$ be obtained in materials for NLO and scintillator applications.