Decontamination of radioactively contaminated materials using hydrogels

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The decontamination of radioactively contaminated material in nuclear facilities has continued to be a global problem since the operation of the first reactors in the 1940s. Current surface decontamination methods tend to rely on the use of liquid based decontaminating agents to remove highly mobile radionuclides but sequester large volumes of liquid waste which must then be processed. We propose a polymer hydrogel based solution which has shown decontamination of up to 90% of metal salts on laboratory substrates using only osmotic pressure as the mechanism of decontamination. Once dried the gels are able to retain the contaminants for treatment as solid waste. We present proof of concept, building to full decontamination measurements & surface characterisation.

I. Objective

To develop a less liquid intensive, more localised decontamination technique which reduces the mobility and volume of contaminated waste. The gels are based upon those used in fine art restoration[1,2,3,4] and are able to uptake high concentrations of deposited metal salts from substrates.

Published precedence of gels in nuclear decontamination is limited to viscous liquid gels commonly used as peelable coatings[5].

In depth uptake measurements using ICP-MS are planned for the immediate future (within several months) and full characterization of contaminated surfaces both before and after decontamination by GDOES and TOF-SIMS are also planned.

Further decontamination should be achievable by loading gels with components commonly used in liquid based decontamination formulations such as EDTA ligands, surfactants and nitric acid. The flexibility of loading, gel composition & size/shape will allow tailoring to specific applications and scenarios both common and unique.

II. Methods

Gels are formulated by a radically initiated crosslinking polymerization in water containing dissolved highly hydrophilic polymers of differing molecular weights. The mixture is stirred until homogenous, degassed and cured in an oven to form a solid gel which is them washed with copious volumes of water and soaked until saturated.

Substrate samples are artificially contaminated with metal salts and decontaminated using the application of gel samples over a controlled period of time. The uptake and decontamination of the highly UV active contaminant is measured using UV-vis spectrometry.

III. Results

Initial uptake measurements have shown viability of hydrogels as a decontamination technique on non-porous surfaces. Uptake has been shown to be >90% for optimized formulations.

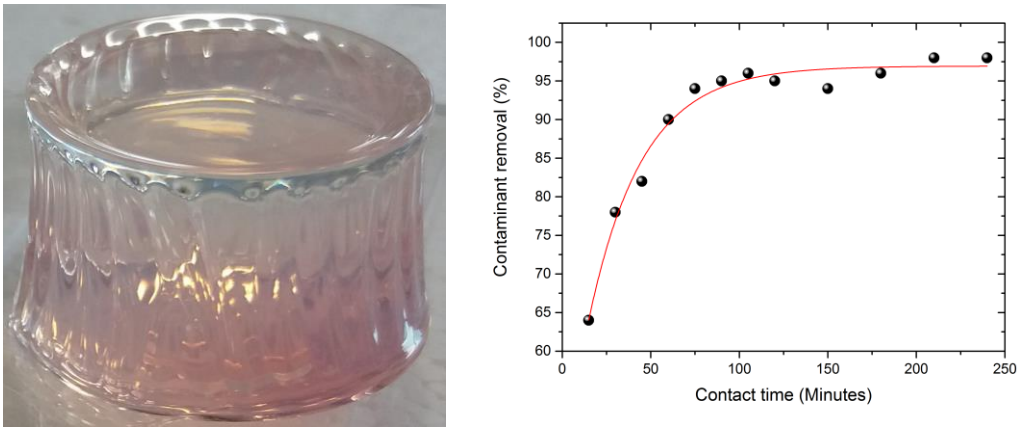

Fig.1. (L): Hydrogel "puck" after uptake of $CoCl_2$ from substrate. (R): Contaminant uptake over time from non-porous substrate

IV. CONCLUSIONS

Whilst still in the early stages the hydrogel decontamination technique has shown promise as an adaptable, simple and effective decontamination tool for non-porous surfaces. The reduction in liquid waste and ability to encapsulate contaminants in a solid form is highly valuable and can only be further enhanced by future planned further work.

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