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► To cite this version:

Magaly Tribet, Hélène Arena, Caroline Marques, Sarah Mougnaud, Veronique Broudic, et al.. Alpha dose rate and decay dose impacts on the long-term alteration of HLW nuclear glasses. Plutonium Futures - The science 2022, Sep 2022, Avignon, France. 2022. cea-04666327

HAL Id: cea-04666327

<https://cea.hal.science/cea-04666327>

Submitted on 1 Aug 2024

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Alpha dose rate and decay dose impacts on the long-term alteration of HLW nuclear glasses

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Abstract

In the prospect of deep geological disposal, the long-term behavior of high-level nuclear glasses has to be investigated regarding alpha radiation induced by long-life minor actinides. The present study focuses on the effects of alpha radiation on the long-term chemical reactivity of R7T7-type glasses, by separately considering the alpha dose rate and the alpha decay dose. Old SON68 glasses doped with $^{238/239}\text{PuO}_2$ or $^{244}\text{CmO}_2$ were studied to simulate high alpha dose rates corresponding to an early water ingress and a high level of alpha decay doses corresponding to long-term disposal conditions. A part of the $^{238/239}\text{Pu}$ -doped glass block was annealed to fully recover the irradiation-induced damage accumulated since the glass was fabricated and to dissociate the effect of the alpha dose rate from that of the alpha decay dose. The glasses were then leached under static conditions at 90 °C for several years. The results showed that the residual alteration rate is not affected by the alpha dose rate over a wide range of dose rate values expected under disposal conditions: this glass remained relatively insensitive to the alpha radiolysis phenomena at the glass - water interface. However, over the duration of the experiments, the residual alteration rate of the damaged $^{238/239}\text{Pu}$ -doped glass was enhanced compared to that of the annealed glass (Figure 1). This result, underlying the role of the damaged glass structure on its macroscopic behavior, is in agreement with those obtained on previous studies on a ^{244}Cm -doped glass [1] and with leaching behavior of simplified externally irradiated glasses [2-3], indicating that the ballistic effects of the recoil nuclei are responsible for this increase in the residual alteration rate.

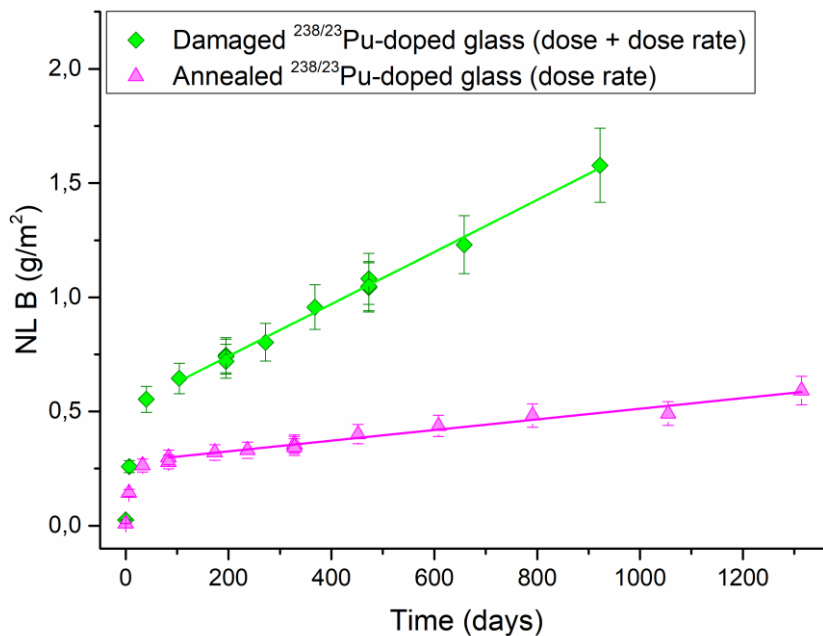


Figure 1: Boron normalized mass loss (NL B) versus time for annealed (pink triangles) and damaged (green diamonds) ^{238/239}Pu-doped glass leaching tests.

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