Effect of Gadolinium Oxide on Structure and Chemical Stability of Borosilicate Glass with Simulated Nuclear Power Plants HLLW

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Due to the high radioactivity, high corrosiveness, high toxicity, and high heat release rate, safe and proper treatment of high-level radioactive waste is always the important point in waste management. In order to properly handle the high-level liquid waste generated from the post-treatment of spent fuel in power reactors, this article focuses on the molar ratio of SiO_2:B_2O_3: Na_2O=1:0.23:0.54 type borosilicate basic glass, studied on its performance on the structure and chemical durability with containing 20 wt.% the simulated 33GW·d/tU spent fuel HLW and the addition of gadolinium oxide (with amounts of 0, 2, 4, 6, 8, and 10 wt.%). XRD analysis shows that the glass samples exhibit stable amorphous glass states. Raman analysis results show that as the increase of Gadolinium(III) oxide addition, the Q^3 structures of Si-O in the glass structure tend to move to the low frequency region. At same time, the nuclear magnetic resonance analysis results show that the proportion of Q^3 (B) structure shows a trend of first decreasing and then gradually increasing, while the proportion of Q^4 (B) structure shows first increases and then gradually decreases. As regard the chemical stability, the PCT results show that as the addition of Gadolinium(III) oxide, the leaching amount of Si, B, Na and other elements in the glass solidified sample decreases significantly, the chemical stability of those glass samples is significantly improved.