# **Supporting Information**

## ***X-Ray Diffraction***

The XRD peaks for the non-irradiated and 8 kGy samples are shown in Figure S7 to Figure S11.



Figure S7: XRD diffraction pattern for Cr2O3 for non-irradiated and 8 kGy dose of γ-irradiation.



Figure S8: XRD diffraction pattern for Fe2O3 for non-irradiated and 8 kGy dose of γ-irradiation.



Figure S9: XRD diffraction pattern for Fe3O4 for non-irradiated and 8 kGy dose of γ-irradiation.



Figure S10: XRD diffraction pattern for NiFe2O4 for non-irradiated and 8 kGy dose of γ-irradiation.



Figure S11: XRD diffraction pattern for ZrO2 for non-irradiated and 8 kGy dose of γ-irradiation.

## ***Raman Spectroscopy***

The Raman spectra for the oxides at irradiated with various doses are shown in Figure S12 to Figure S16.



Figure S12: Raman spectra of Cr2O3 – non-irradiated (black), 2 kGy (red), 4 kGy (blue), 6 kGy (green), 8 kGy (purple).



Figure S13: Raman spectra of Fe2O3 – non-irradiated (black), 2 kGy (red), 4 kGy (blue), 6 kGy (green), 8 kGy (purple).



Figure S14: Raman spectra of Fe3O4 – non-irradiated (black), 2 kGy (red), 4 kGy (blue), 6 kGy (green), 8 kGy (purple).



Figure S15: Raman spectra of NiFe2O4 – non-irradiated (black), 2 kGy (red), 4 kGy (blue), 6 kGy (green), 8 kGy (purple).



Figure S16: Raman spectra of ZrO2 – non-irradiated (black), 2 kGy (red), 4 kGy (blue), 6 kGy (green), 8 kGy (purple).

***H2 Production Analysis***

The amount of hydrogen produced in the oxide mixtures under γ-radiation along with pure water are provided in Figure S17.



Figure S17: The concentration of H2 produced from the metal oxide/water mixtures as a function of dose.