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#10-189 Visible-Near Infrared Light Attenuation Measurements of Radiophotoluminescence FD7 Dosimeters irradiated with X-rays and Electrons at High Doses

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Protection of opto-electronics devices and components susceptible of radiation damage is of foremost importance in intense ionizing radiation environments like the ones produced by particle accelerators, radioisotopes production facilities nuclear infrastructures and waste. Monitoring such radiation levels using accurate dosimetry is accordingly necessary to prevent components'failure and maximize their lifetime. Few known dosimeters provide a reliable response dosimetry in kGy-MGy range, generally considered as high dose level. One of the emerging candidates are silver doped metaphosphate glasses commercially known as FD7 dosimeters. These are in the form of cylindrical rods (1.5mm×8mm) employed currently for medical and environmental radiation monitoring purposes. Radiation induces photoluminescent centers in this glass, that emit orange light as a result of their excitation with ultraviolet light. This phenomenon is referred to as Radiophotoluminescence (RPL), and it is the principle driving the dosimeter's response. The emitted light is proportional to absorbed dose (up to few hundreds of Gy) and it is exploited for dosimetry. Radiation induces additional point defects in dosimeters causing attenuation of the light transmitted through their volume (commonly termed as Radiation Induced Attenuation, RIA). The sensitivity range of the readout system can be increased by combining Radiophotoluminescence signal with transmitted light system. This system is in use at the European Organization for Nuclear Research (CERN) to passively measure doses absorbed in operation in several locations of interest of the accelerator complex. Limited knowledge on the behavior of FD7 glass material in different radiation fields, specifically at high doses, motivates us to further characterize their response. Reported experiments were conducted at the X-ray irradiation facilities of the Laboratoire Hubert Curien and at the SIRIUS irradiation (2.5 MeV electrons) facility of the Laboratoire des Solides Irradiés. For this purpose, a dedicated setup has been developed for online (during irradiation) and offline characterizations of the dosimeters in a free-space configuration. The setups allow to characterize the signal dependence on wavelength, dose, dose rate and previous thermal treatments, such as the ones performed for dosimeters regeneration. It also allows to measure the signal evolution after irradiation, the so-called recovery. Recent irradiation and testing campaigns targeted spectral Radiation Induced Attenuation measurements in the Near Infrared range at high doses ranging between 500 Gy and 100 MGy. Previous study focused on transmission in visible spectral range concluded that radiation induced attenuation starts saturating at doses ranging between 1 and 50 kGy due to glass darkening. On the other hand, light transmission in NIR range remains measureble up to several hundred kGy. For this reason, the present work focuses on Near Infrared analysis, with the goal of combining both visible and Near Infrared knowledge extend the detection range of FD7 dosimeters at high doses. Spectral analysis plays an important role in understanding the full potential of this dosimetry technique, as it could enhance sensitivity and accuracy at extreme dose levels. Recovery of radiation induced attenuation is recorded for at least 3 hours after irradiation conclusion, as it might impact passive radiation readout as well. The dependency of radiation induced attenuation and recovery on total absorbed dose, dose rate, wavelength and pre-irradiation thermal treatments will be discussed. Discussion with findings from prior works in visible spectrum will be presented. The results allow the current knowledge on optically active defects responsible for signal kinetics, overall not fully understood and debated in the community, to be integrated. This study reports data at doses higher than those typically investigated and describes a new type of spectral analysis in the Near Infrared range, which has not previously been explored for dosimetry purposes. These parametric investigations of the dosimeter response, so far largely unexplored at high doses, are crucial for deeper understanding of the response mechanisms exploited by the existing readout system to attribute the total absorbed dose. Successful radiation induced attenuation measurements encourage the possibility of using an adapted version of the current setup for time-resolved analysis of the Radiophotoluminescence light as well. Future studies will include the dependency of radiation induced attenuation, recovery and Radiophotoluminescence signal on dose rate, temperature and different configurations of samples.

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