Gamma irradiation induced defects in different types of fused silica

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Fused silica is a key element for optical diagnostic and remote handling components to be used for the safety and control systems in ITER, as well as in the final focusing of lasers in inertial fusion devices. All these components will suffer significant neutron and gamma irradiation which will affect their optical transmission properties, and hence the component lifetime. Gamma radiation (ionizing) effects in fused silica show a strong dependence on the precursors (defects/impurities) present in the material before irradiation. Hence radiation induced optical absorption depends on the material grade. In contrast the observed behaviour after neutron irradiation ($\geq 10^{-4}$ dpa) is very similar for all grades. This means that during the initial period of operation the optical degradation of the silica will be determined by the grade.

In the case of ITER, KU1 and KS-4V silicas provided by the Russian Federation, are being considered as the main candidate materials. Hence a detailed knowledge of the effect of ionizing radiation and dose accumulation in these grades under irradiation is required. In this work to understand the origin of the defects induced and the relevance of the precursors present in the silica before irradiation, KU1 and KS-4V have been irradiated under identical conditions together with six commercial types of silica with different OH and impurity contents. The effect of gamma irradiation at doses from 10 kGy up to 28 MGy on the optical properties of these different silicas has been studied. After each irradiation the optical absorption of the different grades has been obtained, and the concentration evolution of the different defects observed for each type of silica has been compared. These results will enable one to predict the behaviour of the transmission properties for different types of silicas from the onset of operation of ITER.