Effects of oxygen loading on the red-luminescence of non-bridging oxygen hole centers in γ-irradiated silica glasses

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Streszczenie

Ultra-high purity Corning 7980 and Corning 7979 silica glasses, respectively with high and low contents of hydroxyl and hydrogen, were specifically selected to investigate the effects of O_2 loading on the 1.9 eV red luminescence of the gamma-ray induced non-bridging oxygen hole center (NBOHC), whose luminescence intensity is beneficial not only to predict the laser damage of silica but also to the targeted improvements in the preparation-treatment processes of silica. The UV trasmittance spectra, the UV excitation spectra, the visible emission spectra and the red emission lifetime decay curves were determined for these two types of the gamma-ray irradiated silica glasses before and after O_2 loading. The content ratios of Si dangling bond (Si-E′) to NBOHC in silica glasses before and after O_2 loading are estimated. The formation precursors and other related defects for NBOHC, such as Si-E′, Si-O-Si bond, Si-O-H bond, peroxy radical and linkage, oxygen-deficient centers ODC(I) and ODC(II), etc, are discussed. The bandwidths of the excitation and emission spectra before and after O_2 loading are compared at the lower energy side of the spectra. The average emission lifetimes and especially the decay curves of the red luminescence before and after O_2 loading are analyzed. There appear two types of NBOHCs with and without neighbouring hydrogen interaction at room temperature, respectively corresponding to the shorter and longer lifetime components. After O_2 loading, the shorter lifetime component disappears and becomes the longer one, indicating that the hydrogen-bonded NBOHC is altered into the non-bonded. It is suggested that the analysis of the shorter and longer lifetime components of the red luminescence can be utilized in the laser damage prediction as well as the preparation and treatment processes of silica.

Słowa kluczowe

Fused silica, Oxygen loading, Non-bridging oxygen hole center, Hydrogen-bonded, Red luminescence, Emission lifetime components

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