UNIVERSITI TEKNOLOGI MARA

MORPHOLOGICAL, STRUCTURAL AND OPTICAL STUDIES OF THULIUM-DOPED SILICA-HAFNIA WITH NANOFIBER/THIN-FILM MULTILAYER

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ABSTRACT

The inclusion of rare earth (RE) ions into sol-gel glass systems has prevalently been used in photonic applications due to its ability to produce emissions in UV-IR range. The desired characteristics of photonic devices are to have high emission intensity and broad spectral bandwidth. The type of host material and structure of the deposited RE doped layer influenced the broadness of spectral bandwidth. On the other hand, high amount of RE ions is required in order to obtain high emission intensity. However, this will lead to emission quenching due to the formation of RE ion clusters in the material. Thus, this study uses an alternate approach by combining nanofiber (NF) and thin film (TF) structures in a single substrate with an aim to produce enhanced photoluminescence emission intensity and spectral bandwidth as well as to determine the morphological, structural and optical properties of fabricated samples. Results shown that smooth and uniform electrospun nanofiber strands composed of 0.8 mol% Tm^{3+}-doped $(100–x)SiO_2–(x)HfO_2$, where x = 0–30 mol%, were successfully fabricated and the range of diameter size of nanofiber increases along with the amount of Hf content. For hybrid structure, the ratio of SiO_2:HfO_2 used for all sample was 90:10 with 0.8 mol% of Tm^{3+} ion and result shows enhanced PL emission intensity of about 10 times was attained by three-layered hybrid samples at wavelengths of about 457 nm (blue), 512 nm (green) and 634 nm (red). This significant enhancement is due to the increase amount of RE-doped ions and also the involvement of nanofiber that has high surface-to-volume ratio. A good agreement was achieved between the experimental and theoretical result of the optical properties, in terms of transmittance, absorbance and FWHM, and was retrieved from IMD software and the Voigt function. In conclusion, the experimental and theoretical result obtained from this study have shown that nanofiber/thin-film hybrid structure that composed of Tm^{3+}-doped $(100–x)SiO_2–(x)HfO_2$ is maybe suitable to be used for photonic applications, especially for laser and optical amplifier.

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