

UNIVERSITI TEKNOLOGI MARA

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

**NURUL IZZATI ZAFIRAH
BINTI ZULFIKRI**

Thesis submitted in fulfillment
of the requirements for the degree of
**Master of Science
(Applied Physics)**

Faculty of Applied Sciences

June 2023

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 $(100-x)\text{SiO}_2-(x)\text{HfO}_2$, 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 $\text{SiO}_2:\text{HfO}_2$ 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 $(100-x)\text{SiO}_2-(x)\text{HfO}_2$ is maybe suitable to be used for photonic applications, especially for laser and optical amplifier.

ACKNOWLEDGEMENT

Alhamdulillah, all praises to Allah, The Most Beneficent and The Most Merciful, for giving me the strength in completing my master research project especially during this hard times. It is most humbleness and gratitude that this study has finally completed with His Blessings.

I would like to record my sincere appreciation to my supervisor, Dr. Suraya Ahmad Kamil, for her patience, continuous guidance, advices and constant support in helping me completing my research project. I have been extremely lucky to have a supervisor who cared so much about my work, and who responded to my questions and queries so promptly. My special thanks and appreciation also goes to my co-supervisors, Dr. Abdel-Baset M. A. Ibrahim and Dr. Amalina Mustaffa, for their immense help and warm cooperation in accomplishing my research study and all other details pertaining to it.

I would also like to express my gratitude towards my family, especially my parents, Zaharah Hashim and Zulfikri Yahya, who gave me the encouragement I needed throughout this research project.

My thanks and appreciation also goes to my fellow friends and lab-mates, especially my senior, Nurul Iznie Razaki, who has willingly helped me out with her knowledge and abilities.

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