UNIVERSITI TEKNOLOGI MARA

QUASI-DISTRIBUTED OXYGEN SENSOR BASED ON EVANESCENT WAVE SCATTERING IN OPTICAL FIBER

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of the requirements for the degree of
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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

This thesis deliberates the development and characterization of a multipoint quasi-distributed optical fiber sensor for oxygen measurement based on luminescence quenching. Current sensing devices such as the Clark cell or the luminescent probes located at distinct points in the water column are incapable of providing the dissolved oxygen measurement for the entire area of the pond in toto. Hence there is a need for the development of a new technique which measures the level of oxygen in the water at various depths and locations within a single optical fiber line. Towards this objective the new technique developed is based on luminescence quenching which reflect the overall oxygen concentration in aquaculture ponds. The research focuses on the development of a sensing mechanism which could be applied to optical fiber cladding/core region to produce optical fiber oxygen sensor in quasi-distributed arrangement and subsequently characterized using a suitable test method under laboratory conditions. The system is based on 1 mm core diameter plastic optical fiber where three sections of cladding have been etched using acetone resulting in a parabolic shaped cavity characteristic of the refractive index profile of the fiber. These cavities were then filled with sol-gel derived silica doped with the oxygen-sensitive dye. In this study ruthenium complex Tris(4,7-diphenyl-1,10-phenanthroline) ruthenium(II) dichloride complex($Ru(dpp)_3^{2+}$), platinum octaethylporphyrin (PtOEP) and palladium(II)-5,10,15,20-tetrakis-(2,3,4,5,6-pentafluorophenyl)-porphyrin (PdTFPP) were the dyes chosen, immobilized in a microporous glass produced by the low temperature sol-gel process to form the various sensing locations. Each of the luminophores had different emission wavelengths resulting in individual spectral peaks associated with each of the sensing points. Advantages of using this method of reagent capture are discussed and the sensor fabrication steps deliberated. Interrogation of the optical sensor system was through a fiber optic spectrometer incorporating narrow bandpass emission optical filter. Experimental characterization for the quasi-distributed optical fiber oxygen sensor in both gas and water were detailed. Results from the present study showed that the proposed sensors exhibited comparable sensitivity and repeatability as well as fast response and recovery towards oxygen. I_0/I_{100} among the three films for both gaseous and dissolved oxygen were $Ru(dpp)_3^{2+} <$ PtOEP < PdTFPP.

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