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Synthesis of Hybrid Polymer and Its Application as Distributed Feedback Laser

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R.E. Siregar

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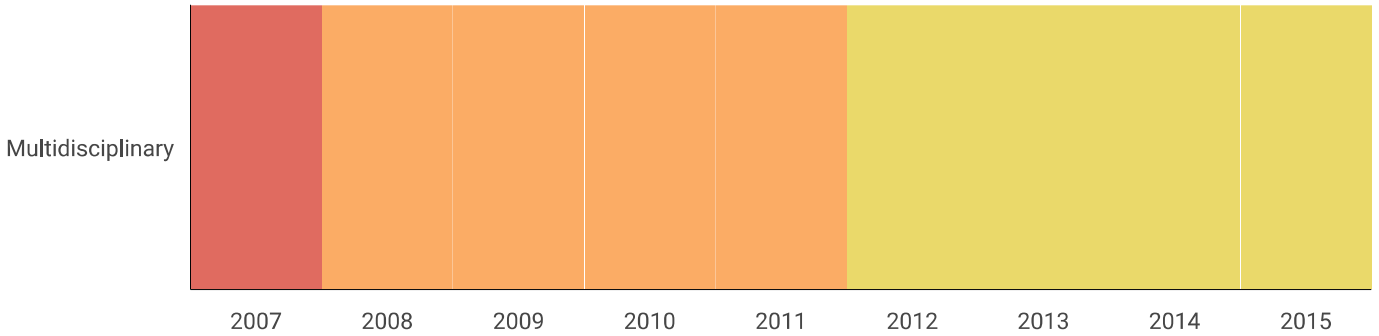

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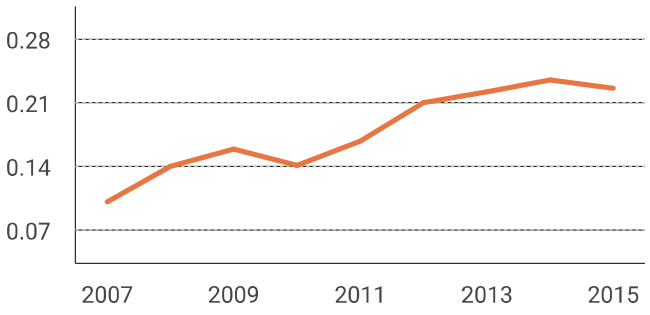

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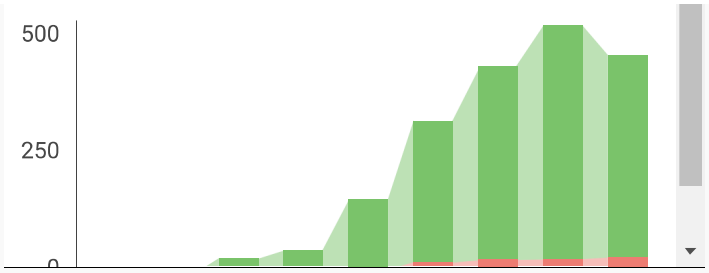

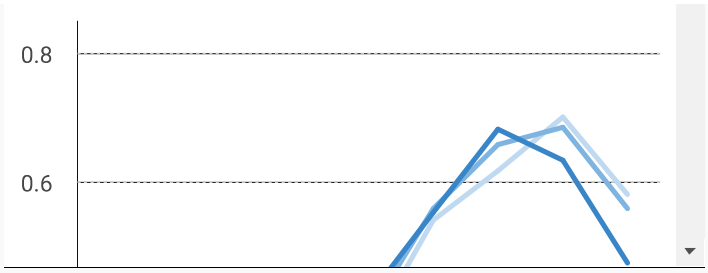

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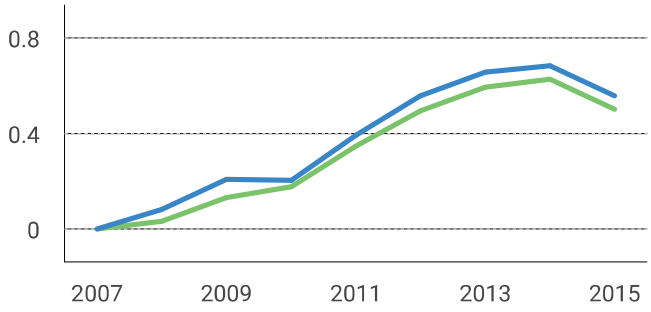

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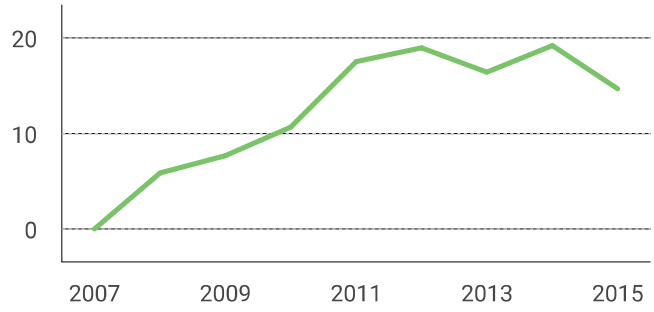

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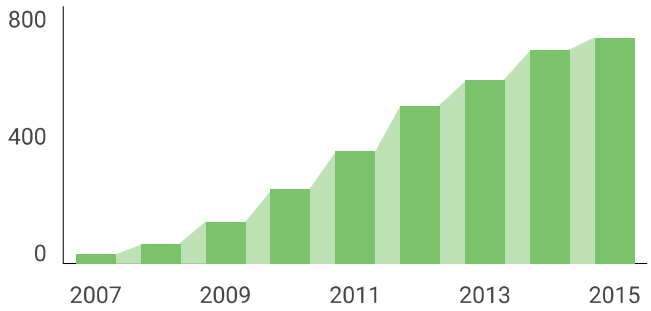

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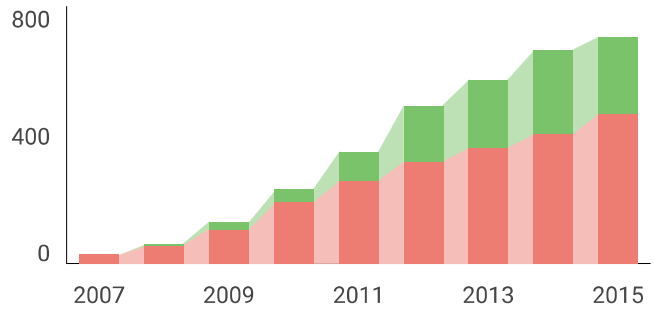

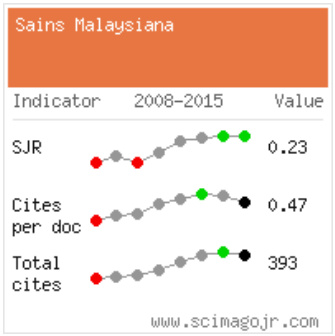

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Sains Malaysiana 42(4)(2013): 521–527

Synthesis of Hybrid Polymer and Its Application as Distributed Feedback Laser

(Sintesis Polimer Hibrid dan Aplikasinya Sebagai Laser Suap Balik Tertabur)

SAHRUL HIDAYAT*, R. HIDAYAT, FITRILAWATI, A. BAHTIAR & R.E. SIREGAR

ABSTRACT

The hybrid inorganic-organic polymer was synthesized by sol-gel method from TMSPMA. Organic dye laser of DCM was added into hybrid polymer host matrices by means of solution method at room temperature. The distributed feedback (DFB) laser was fabricated from hybrid polymer-DCM film using Lloyd Mirror interference technique. The surface profile of device was observed using AFM. From the AFM image, we obtained that the grating period was about 385 nm and the depth of corrugation was about 60 nm. The characteristics of DFB laser was investigated by optical pumping using SHG Nd-YAG (λ=532 nm). The laser emission has been demonstrated at 582 nm with the spectral width (FWHM) less than 2 nm at pumping power of 14.00 mJ/pulse cm². The experimental results have been confirmed by the theoretical model using coupled mode theory. The confirmation of experimental works by the theoretical model has a good result.

Keywords: Coupled mode theory; DFB laser; hybrid polymer; sol-gel method

ABSTRAK

Polimer hibrid telah disintesis dengan kaedah sol-gel daripada TMSPMA. Laser dai organik DCM telah ditambahkan ke dalam matriks polimer hibrid dengan menggunakan kaedah larutan pada suhu bilik. Laser Suap Balik Tertabur (DFB) telah difabrikasi daripada filem polimer hibrid-DCM menggunakan teknik pembelauan Lloyd Mirror. Profil pada permukaan daripada peranti laser diamati menggunakan AFM. Daripada imej AFM, kita boleh mengukur kala parutan ~385 nm dan kedalaman kerut ~60 nm. Ciri laser DFB telah dikaji dengan pam optik menggunakan SHG Nd-YAG (λ = 532 nm). Pemancaran laser telah ditunjukkan pada 582 nm dengan lebar spektrum (FWHM) kurang daripada 2 nm untuk daya pam 1400 mJ/denyut cm². Hasil eksperimen telah disahkan oleh model teori menggunakan teori mod terganding. Pengesahan hasil kerja eksperimen dengan model teori mempunyai hasil yang baik.

Kata kunci: Kaedah sol-gel; laser DFB; polimer hibrid; teori mod terganding

INTRODUCTION

In the last decades, the miniaturization technologies of devices has attracted much attention in many fields, such as optics, electronics, materials sciences and biomedical engineering (Cheng et al. 2012; Vyawahare et al. 2010). Besides, there is also a market demand for a low processing cost for fabrication such devices. Both factors have encouraged many scientists to continue their research for new materials. Hybrid inorganic-organic polymers are good candidate for application in micro-size devices since the hybrid polymer can be fabricated as micro-planar devices with a simple fabrication method, such as spin-coating followed by Ultra Violet (UV) patterning (Darracq et al. 1998; Hidayat et al. 2010).

Polymers are widely used for optical devices, such as a host matrix for dye laser in lasing application (Hidayat et al. 2010). Yurista et al. (2001) have reported fabrication of DFB grating using photoresist with UV holographic method. The gain medium consists of disperse-red-one chromophore side chain polymethyl methacrylate (DR1-MMA) deposited on Si substrate. The lasing emission can be tuned in various wavelengths from gain medium layer up-covered with photoresist grating (Yurista et al. 2001). Although offering advantage of simplicity in processing, but the polymer based optical system faced many problems due to its low thermal stability (Paquet & Kumacheva 2008). That has encouraged scientists to used hybrid inorganic-organic polymer instead of conventional organic polymer.

In recent years, there have been many reports on application of hybrid inorganic-organic polymer materials for optical devices (Hidayat et al. 2010), that is related to excellent optical properties and a high thermal stability of hybrid inorganic-organic polymer in comparison with conventional polymers. Moreover, hybrid polymers exhibit a good transparency in optical region, can be customized by adding some functional material and have several advantages such as easy in synthesizing and patterning process (Soppera et al. 2002).

In this paper, we synthesized hybrid inorganic-organic polymer of poly(3-(trimethoxysilyl) propyl methacrylate) (TMSPMA), modified the material using organic dye laser of 4-dicyanomethylene-2 -methyl-6-p-dimethylamino -styryl-4H- pyran) (DCM) and further using the material we fabricate 1D grating as laser resonator using Lloyd mirror interference technique. The DFB grating was characterized