OPTICAL TWEEZER INDUCED BY MICRORING RESONATOR

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This thesis is dedicated to my parents Abd Aziz Moin and Rosnani Sarmidi,

My beloved family, fiancé and friends,

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Optical tweezer technique for molecular trapping is becoming of increasing importance for numerous biological applications. The main objective of this study was to investigate the dynamical behavior of the optical tweezers signals in microring resonators (MRR). Operating system consists of modified nonlinear add-drop optical filter made of InGaAsP/InP integrated together with a series of nonlinear nanoring resonators. This particular form is known as a PANDA ring resonator. Different models of operating system were designed and optical transfer functions for each model were derived by using Z-transform method. Simulation results were obtained from MATLAB2010a program by using parameters of practical devices. Input signals in the form of dark soliton were generated at center wavelength 1.5 µm with peak intensity 1 W/µm² and pulse width 50 ps. Radii of rings were set to be R=34 µm, R₁=60 nm, R₂=60 nm, R₃=50 nm and R₄=50 nm respectively. Coupling coefficients of the system were chosen to be κ₁=0.15, κ₂=0.65, κ₃=0.5, κ₄=0.5, κ₅=0.5 and κ₆=0.50. Intense output signals in the form of potential well are generated at the intensity of 219.14 W/µm² and FWHM around 20 nm. Simulated results shows an optical force of 15.83 fN generated from intensity gradient associated with the output signal are calculated for particle of diameter 20 nm. Stiffness at the center of the trap was recorded at 2.23 fN nm⁻¹. This study shows that the model was able to control the dynamical behavior of optical tweezers. Analytical formulation of such system provides the underlying physics of dynamic optical tweezers generation within MRR.
ABSTRAK

Teknik penyepit optik untuk memerangkap molekul menjadi semakin penting bagi pelbagai aplikasi biologi. Objektif utama kajian ini adalah untuk menyelidik sifat dinamik isyarat penyepit optik di dalam pengalun cincin mikro (MRR). Sistem operasi terdiri daripada penapis optik menambah-lepaskan tak linear diubahsuai yang dibuat daripada InGaAsP/InP bersepadu dengan siri pengalun cincin nano yang tidak linear. Sistem ini dikenali sebagai pengalun cincin PANDA. Model sistem operasi yang berlainan telah direka dan fungsi pemindahan optik untuk setiap model diperoleh dengan menggunakan kaedah pemindahan-Z. Hasil simulasi telah diperoleh dengan menggunakan program MATLAB2010a berdasarkan nilai peranti praktikal yang sebenar. Isyarat input dalam bentuk soliton gelap yang dihasilkan pada gelombang yang berpusat pada 1.5 µm dengan keamatan puncak 1 W/µm² dan lebar denyut 50 ps. Jejari cincin ditetapkan pada R = 34 µm, R₁ = 60 nm, R₂ = 60 nm, R₃ = 50 nm dan R₄ = 50 nm. Pekali gandingan sistem telah dipilih pada κ₁=0.15, κ₂=0.65, κ₃=0.5, κ₄=0.5, κ₅=0.5 dan κ₆=0.50. Isyarat output dalam bentuk telaga keupayaan dihasilkan pada keamatan 219.14 W/µm² dan FWHM sekitar 20 nm. Keputusan simulasi menunjukkan daya optik 15.83 fN telah dijana daripada kecerunan keamatan output bagi zarah berdiameter 20 nm. Kekukuhan di pusat perangkap dicatatkan pada 2.23 fN nm⁻¹. Kajian ini menunjukkan bahawa model ini mampu untuk mengawal sifat dinamik isyarat penyepit optik. Formulasi analisis sistem tersebut dapat menyediakan pengetahuan asas fizik terhadap penghasilan penyepit optik dinamik di dalam MRR.