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# List of Abbreviations

ALU	Arithmetic Logic Unit
BPM	Beam Propagation Method
CW	Continuous Wave
DC	Directional Coupler
DLSP	Dielectric Loaded Surface Plasmon Polariton
FWM	Four-wave Mixing
IGMPW	Index Guided Multimode Plasmonic Waveguide
MFOD	Multifunctional Optical Device
MIM	Metal-Insulator-Metal
MMI	Multimode Interference
MZ	Mach-Zehnder
MZ-MMI	Mach-Zehnder based Multimode Interference
NDCMMI	Nonlinear Directional Coupler based Multimode Interference
OTMI	Optically-controlled Two-mode Interference
PhCWG	Photonic Crystal Waveguide
SEIM	Simple Effective Index Method
SEIM- $x$	Simple Effective Index Method along $x$ -direction
SEIM- $y$	Simple Effective Index Method along $y$ -direction
SOA	Semiconductor Optical Amplifier
SPP	Surface Plasmon Polariton
SPTMI	Surface plasmonic Two-mode Interference
TE	Transverse Electric
TM	Transverse Magnetic
TMI	Two-mode Interference





# List of Symbols and Notations

$\alpha$	Bending loss coefficient
$\alpha_P$	Propagation loss coefficient
$\alpha_1$	Fraction of input power transferred to output access waveguide-3 in a optical power splitter
$\alpha_2$	Fraction of input power transferred to output access waveguide-4 in a optical power splitter
$\beta_m$	Propagation constant of $m$ th mode propagating in SPTMI coupler
$\beta_m(n_1, n_2(E), n_m)$	Propagation constant of $m$ th mode in SPTMI coupler as a function of refractive indices $n_1$ , $n_2(E)$ and $n_m$
$\beta_m(n_2(E))$	Propagation constant of $m$ th mode in SPTMI coupler when optical pulse of energy $E$ is applied
$\beta_m(n_2(0))$	Propagation constant of $m$ th mode in SPTMI coupler when no optical pulse is applied
$\beta_m^r$	Real part of propagation constant of $m$ th mode propagating in SPTMI coupler
$\beta_m^r(n_1, n_2(E), n_m)$	Real part of propagation constant of $m$ th mode in SPTMI coupler as a function of refractive indices $n_1$ , $n_2(E)$ and $n_m$
$\beta_m^r(n_2(E))$	Real part of propagation constant of $m$ th mode in SPTMI coupler when optical pulse of energy $E$ is applied
$\beta_m^r(n_2(0))$	Real part of propagation constant of $m$ th mode in SPTMI coupler when no optical pulse is applied
$\beta_m^{im}$	Imaginary part of propagation constant of $m$ th mode propagating in SPTMI coupler

$\beta_m^{im}(n_1, n_2(E), n_m)$	Imaginary part of propagation constant of $m$ th mode in SPTMI coupler as a function of refractive indices $n_1$ , $n_2(E)$ and $n_m$
$\beta_m^{im}(n_2(E))$	Imaginary part of propagation constant of $m$ th mode in SPTMI coupler when optical pulse of energy $E$ is applied
$\beta_m^{im}(n_2(0))$	Imaginary part of propagation constant of $m$ th mode in SPTMI coupler when no optical pulse is applied
$\beta_e$	Propagation constant of even mode in a directional coupler
$\beta_o$	Propagation constant of odd mode in a directional coupler
$\delta w$	Deviation of width in SPTMI coupler
$\Delta\beta_{m,r}^{eff}(n_2(E))$	Change in real part of propagation constant of $m$ th order mode ( $m = 0, 1$ ) due to application of optical pulse energy
$\Delta n_{m,r}^{eff}(E)$	Effective real refractive index change of $m$ th order mode ( $m = 0, 1$ ) due to application of optical pulse energy
$\Delta n_2(E)$	Change in refractive index of GaAsInP cladding due to application of optical pulse
$\Delta n$	Index contrast between core and cladding in a waveguide
$\Delta\Phi_T(E)$	Phase difference between the fundamental and first order modes at the end of coupling region after application of optical pulse of energy $E$
$\Delta\Phi(E)$	Additional phase shift induced between the excited SPP modes due to application of optical pulse of energy $E$
$\epsilon$	Dielectric constant of any medium
$\epsilon_0$	Dielectric constant of free space
$\epsilon_d$	Dielectric constant of pure dielectric medium
$\epsilon_m$	Dielectric constant of metal
$\epsilon_i(i=1,2,3)$	Dielectric constant of $i$ th medium
$\epsilon_{eff}'$	Effective dielectric constant of dielectric medium with refractive index $n_1$ and width $W_T$ sandwiched between layers of dielectric medium with refractive index $n_2(E)$

$\eta_{core}$	Optical power launching efficiency to silicon core of SPTMI waveguide coupler
$\eta_{clad}$	Optical power launching efficiency to the nonlinear GaAsInP cladding of SPTMI waveguide coupler
$\kappa$	Coupling coefficient in directional coupler
$\lambda$	Wavelength of incident light
$\lambda_{spp}$	Wavelength of surface plasmon polariton wave
$\omega$	Angular velocity of incident light
$\phi$	Bending angle
$A_{clad}$	Effective cross sectional area of GaAsInP cladding
$A_{core}$	Cross sectional area of access waveguide core
$a(z)$	Amplitude of mode in waveguide-1 in directional coupler
$a_e$	Amplitude of even mode
$a_o$	Amplitude of odd mode
$b(z)$	Amplitude of mode in waveguide-2 in directional coupler
$b_I$	Normalized guide index
$b_i$	Mode field excitation coefficient of the $i$ th mode in MMI coupler
$b_m^T$	Field excitation coefficient for the $m$ th order mode in the SPTMI coupler
$c$	Velocity of light
$c_{M,i}$	Contribution of $i$ th mode to $M$ th output access waveguide
$c_{3,m}^T$	Coefficient of field contribution of $m$ th mode for third output access waveguide
$c_{4,m}^T$	Coefficient of field contribution of $m$ th mode for fourth output access waveguide
$C$	Coupling coefficient estimated from coupled mode theory
$d$	Half of separation between waveguides in directional coupler
$E$	Energy of optical pulse applied to obtain index modulation in SPTMI coupler
$E_x(z)$	Electric field component in the $x$ -direction
$E_y(z)$	Electric field component in the $y$ -direction
$E_z(z)$	Electric field component in the $z$ -direction

$h$	Coupling gap in DC and MMI coupler
$H(y, 0)$	Input field incident on access waveguide in MMI coupler
$H(y, L)$	Output field at $Z = L$ in MMI coupler
$H_M(y, L)$	Output field at $Z = L$ at $M$ th output access waveguide in MMI coupler
$H_{M,i}(y, L)$	Field contribution of $i$ th mode to $M$ th output access waveguide
$H_i(y)$	Mode field distribution of the $i$ th mode in MMI coupler
$H_1(x, 0)$	Input field launched through input access waveguide-1 at $z = 0$
$H_3(x, L, E)$	Output fields at output access waveguide-3 at $z = L$
$H_4(x + w, L, E)$	Output fields at output access waveguide-4 at $z = L$
$H_5(L_1, E)$	Field at access waveguide-5
$H_6(L_2, E)$	Field at access waveguide-6
$H_7(L_3, E)$	Output field at access waveguide-7
$H_8(L_3, E)$	Output field at access waveguide-8
$H_m(x)$	Mode field of the $m$ th excited mode in TMI region at $z = 0$ ( $m = 0, 1$ )
$H_x(z)$	Magnetic field component in the $x$ -direction
$H_y(z)$	Magnetic field component in the $y$ -direction
$H_z(z)$	Magnetic field component in the $z$ -direction
$H_S$	Separation of bent access waveguides in SPTMI coupler
$H_T$	Bending height of bent access waveguides
$k_0$	Wave vector in free space
$k_1$	Wave vector in medium 1
$k_2$	Wave vector in medium 2
$k_3$	Wave vector in medium 3
$k_d$	Wave vector in dielectric medium
$k_m$	Wave vector in metallic medium
$k_i (i = 1, 2, 3)$	Wave vector in $i$ th medium
$L$	Length of coupling region in SPTMI waveguide coupler
$L_\pi$	Beat length
$L_A$	Width of PbS doped Silica absorber in cascaded structure

$L_C$	Coupling length
$L_D$	Device length of basic SPTMI waveguide coupler
$L_M$	Distance of separation between the two mirrors in mode locked laser
$L_T$	Transition length of access waveguides in SPTMI waveguide coupler
$L_{P,m}$	Propagation length of $m$ th mode in SPTMI coupler
$L_{cascaded}$	Device length of cascaded structure for implementation of NOR, NAND and XOR logic gates
$L_1$	Length of coupling region of first SPTMI waveguide coupler in cascaded structure
$L_2$	Length of coupling region of second SPTMI waveguide coupler in cascaded structure
$L_3$	Length of coupling region of third SPTMI waveguide coupler in cascaded structure
$m$	Mode number
$n_1$	Refractive index of silicon core in SPTMI waveguide coupler
$n_2(0)$	Refractive index of GaAsInP cladding in SPTMI waveguide coupler before application of optical pulse
$n_2(E)$	Refractive index of GaAsInP cladding in SPTMI waveguide coupler after application of optical pulse
$n_m$	Refractive index of silver cladding in SPTMI waveguide coupler
$n_{m,real}$	Real part of refractive index of silver
$n_{m,im}$	Imaginary part of refractive index of silver
$n_{nl}$	Nonlinear coefficient of GaAsInP
$n_{1,eff}$	Effective refractive index of medium with refractive index $n_1$ and thickness $t$ sandwiched between medium with refractive index $n_m$
$n_{2,eff}$	Effective refractive index of medium with refractive index $n_2(E)$ and thickness $t$ sandwiched between medium with refractive index $n_m$
$n_{eff}^l$	Effective refractive index of medium with refractive index $n_1$ and width $W_T$ sandwiched between medium with refractive index $n_2(E)$
$n_{m,r}^{eff}$	Effective refractive index for $m$ th mode propagation in SPTMI coupler

$n_{m,r}^{eff}(0)$	Effective refractive index for $m$ th mode propagation in SPTMI coupler before application of optical pulse
$n_{m,r}^{eff}(E)$	Effective refractive index for $m$ th mode propagation in SPTMI coupler after application of optical pulse
$n_i (i = 1, 2, 3, 4)$	Refractive index of dielectric media
$N$	Number of oscillating modes in mode locked laser
$NA_{core}$	Numerical aperture of silicon core in SPTMI coupler
$NA_{clad}$	Numerical aperture of GaAsInP cladding in SPTMI coupler
$P_1$	Power at access waveguide-1
$P_2$	Power at access waveguide-2
$P_3$	Power at access waveguide-3
$P_4$	Power at access waveguide-4
$P_5$	Power at access waveguide-5
$P_6$	Power at access waveguide-6
$P_7$	Power at access waveguide-7
$P_8$	Power at access waveguide-8
$P_M$	Power at $M$ th output access waveguide in MMI coupler
$P_C$	Power of optical pulse at cladding of SPTMI waveguide coupler
$P_{C1}$	Power of optical pulse at cladding of first SPTMI waveguide coupler in cascaded structure
$P_{C2}$	Power of optical pulse at cladding of second SPTMI waveguide coupler in cascaded structure
$P_{in}$	Power incident on a bent waveguide
$P_{out}$	Power at output end of a bent waveguide
$R$	Bending radius of access waveguides in SPTMI coupler
$r$	Radius of optical fiber used to launch optical power in SPTMI coupler
$S$	Arc length of S-bent waveguide
$t$	Core thickness in SPTMI coupler
$t_1$	Core thickness of first waveguide in directional coupler
$t_2$	Core thickness of second waveguide in directional coupler

$T_P$	Full width at half maximum of optical pulse applied at GaAsInP cladding
$T_B$	Bending loss in a waveguide with single bend
$T_S$	S-bending loss
$T_R$	Cavity round trip time in mode locked laser
$V_I$	Normalized frequency
$w$	Core width of access waveguides in SPTMI coupler
$w_1$	Core width of first waveguide in directional coupler
$w_2$	Core width of second waveguide in directional coupler
$W_A$	Width of PbS doped Silica absorber in cascaded structure
$W_C$	Width of GaAsInP cladding in SPTMI coupler
$W_e$	Effective width of coupling region in MMI waveguide
$w_{MMI}$	Width of core in MMI coupler
$w_P$	Width of optical pulse coupling channels in cascaded structure
$W_T$	Core width of silicon core in SPTMI coupler

