Project No:	10.3.1		
Supervisor:	Sun Xiaowei (Asst Prof)	**E-mail address:**	exwsun@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials and Devices		
Research Area:	Display Materials and Devices		
Project Title:	High Performance Organic Light-Emitting Devices		
Summary:	Organic light-emitting diodes (OLEDs) have been developed as a new technology for next generation flat panel displays. High brightness and efficiency red, green and blue OLEDs were achieved using discrete emitting layer or by doping fluorescent dyes into a host layer. Besides display, another even more large market for OLEDs is the lighting industry. OLED technology has the potential to impact general lighting applications. In particular, a large-area white-light-emitting OLED could potentially provide a solid state diffusing light source that could compete with conventional lighting technologies in performance and cost. In this project, the student will fabricate OLED devices and a low resolution display panel. Various substrates including ITO and ZnO coated glass with various treatments will be used. Device performance will be characterized. Doping will be studied to tune the emitting wavelength.		

Project No:	10.3.2		
Supervisor:	Sun Xiaowei (Asst Prof)	**E-mail address:**	exwsun@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials and Devices		
Research Area:	Display Materials and Devices		
Project Title:	Liquid Crystal Applications in Photonic Crystals		
Summary:	Photonic-band-gap (PBG) materials, or photonic crystals (PC), are a distinct class of dielectrics that facilitate two fundamentally new optical principles, namely the localization of light and the controllable inhibition of spontaneous emission of light from atoms and molecules. With intensive research, synthesizing PBG materials with submicron lattice constants using self-assembly method has been realized. However, for many applications, it is advantageous to obtain some degree of tunability of the photonic band structure. The tunability can be obtained by electro-optic effect, i.e., controlling optical anisotropy of the constituent materials. Liquid crystal (LC) has the largest birefringence known for all materials (as large as 0.2). This property makes LC an ideal infiltration material into PCs to create a controllable device. In the project, the student will study LC based PCs.		

Project No:	10.3.3		
Supervisor:	Sun Xiaowei (Asst Prof)	**E-mail address:**	exwsun@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials and Devices		
Research Area:	Optoelectronic Materials		
Project Title:	P-type Zinc Oxide		
Summary:	Zinc oxide has Zinc oxide (ZnO) is a II-VI compound semiconductor with a wide direct energy bandgap of 3.37eV, and a large excitonic binding energy of about 60 meV at room temperature. ZnO is promising for applications in blue light-emitting diodes (LEDs), ultraviolet laser diodes (LD), field-effect –transistors (FET), sensors, acousto-electrical devices, and detectors. However, ZnO compounds occur naturally as low resistive n-type semiconductor. It is similar to GaN and a lot other large bandgap materials, is unipolar in doping. The p-type ZnO is of crucial importance for electrically injected LED and LD devices based on ZnO can be realized. It is recently, a theoretical prediction of co-doping to realize p-type ZnO by Yamamoto has really stirred the interest of p-type doping of ZnO. Inspired by the theoretical prediction, we would like to carry out this project to for realizing real p-type ZnO by filtered cathodic vacuum arc (FCVA) and metal-organic chemical vapor deposition (MOCVD). If the result is proved to be successful, it will be groundbreaking. A new industry would be generated.		

Project No:	10.3.4		
Supervisor:	Ng Beng Koon (Asst Prof)	**E-mail address:**	ebkng@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	GaInNAs/$Al_xGa_{1-x}As$ Avalanche Photodiodes for Long Wavelength Detection		
Summary:	Avalanche photodiodes (APDs) are used in many diverse applications such as optical communications and quantum cryptography. GaAs-based APDs operating in the telecommunication wavelength range of 1.3−1.55 μm are not available, in spite of its mature technology and lower cost, due to the lack of an absorbing, lattice-matched material. The recent demonstration of GaInNAs, a suitable absorbing material that is lattice-matched to GaAs, brings the realisation of GaAs-based telecommunication APDs closer to reality. Recent studies on the avalanche characteristics of high aluminium $Al_xGa_{1-x}As$ indicate that very low excess avalanche noise can be achieved using this material. In this project, these recent results will be extended and exploited to develop GaAs-based APDs using GaInNAs as the absorbing medium and high aluminium $Al_xGa_{1-x}As$ as the avalanching medium.		

Project No:	10.3.5		
Supervisor:	Ng Beng Koon (Asst Prof)	**E-mail address:**	ebkng@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Impact Ionization in Wide band Gap Semiconductors		
Summary:	The impact ionization process in wide band gap semiconductors is an important parameter that determines the eventual breakdown of high performance semiconductor devices. Low excess avalanche noise is achieved when the ionization coefficients are widely differing or in the presence of strong dead space effects. The physics behind widely differing ionization coefficients and how the ionization threshold energies scale with the band gap of semiconductor are not well understood and have baffled physicists and engineers for a long time. This project involves a theoretical investigation of the dependence of the ionization coefficients and ionization threshold energies on the semiconductor band structures. Experimental measurements of $Al_xGa_{1-x}As$ diodes, which exhibit disparate ionization coefficients and low excess avalanche noise for $x > 0.6$, will also be carried out to complement the theoretical study. .		

Project No:	10.3.6		
Supervisor:	Ng Beng Koon (Asst Prof)	**E-mail address:**	ebkng@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	ZnO UV Photodetectors		
Summary:	There is a wide range of applications for photodetectors in the UV regime, including UV astronomy, combustion engineering, flame sensing, secure space-to-space communications and rocket plume detection. Although Si-based photodetectors and photomultipliers are widely available for such applications, they degrade after prolong UV exposure, have poor efficiency or require high operating voltages. Zinc oxide is a wide bandgap II-VI material with many favourable optoelectronic properties, making it an attractive candidate for application in the short wavelength range. This project involves the study of UV MSM, PIN and avalanche photodetectors based on ZnO films. Student will be involved with the fabrication, characterisation and modeling of these photodetectors.		

Project No:	10.3.7		
Supervisor:	Wong Kin Shun, Terence (Assoc Prof)	**E-mail address:**	ekswong@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Silicon Germanium Microphotonic Devices		
Summary:	This project is concerned with the design and fabrication of silicon germanium (SiGe) heterostructure devices for microphotonic applications. SiGe optoelectronic devices can be readily integrated with silicon microelectronics and thus can significantly decrease their unit cost and provide additional functionality to Si ICs. Currently, there is a need to develop coherent light sources based on Si. Device structures based on the SiGe quantum dot and thin multilayers will be investigated both theoretically and experimentally. Material growth will be by chemical vapor deposition and involve collaboration with a research institute. Some multilayer samples have already been grown. Optical and electrical characterization of the SiGe heterostructure emitters for possible coherent applications will be carried out.		

Project No:	10.3.8		
Supervisor:	Wong Kin Shun, Terence (Assoc Prof)	**E-mail address:**	ekswong@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Optical Interconnects and Photonic Device Integration		
Summary:	Due to continued miniaturization of semiconductor devices, the bandwidth of semiconductor integrated circuits will soon exceed the fundamental capability of electrical interconnects based on metals. A solution to overcome this impending bottleneck is to introduce optical interconnects for some of the input output signals. The main goal of this project is to design and develop optical waveguides using dielectric materials that can be integrated with silicon integrated circuits. Material characterization and electro-optical measurements of waveguide structures will be carried out. In addition, schemes for integrating the waveguides with photodetectors and light sources on chip will be investigated. This project will involve collaboration with research institute.		

Project No:	10.3.9		
Supervisor:	Yoon Soon Fatt (Prof)	**E-mail address:**	esfyoon@ntu.edu.sg
Candidature:	MEng / PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Development of VLSI-Photonics Integration Optical Interconnect Technologies		
Summary:	Silicon-based VLSI electronics are the foundation of modern Microsystems technology. Rapidly increasing processing speeds and systems complexity need to be accompanied by increase in data transmission rates between chips and systems. This project sought to develop the optical interconnect technologies based on the integration of optical functionality on a silicon circuit platform. Various technology options will be investigated; including selective area pillar bonding, epitaxial regrowth, and monolithic metallization systems on a silicon CMOS platform. The goal is to develop enabling technologies and processes needed for full-scale implementation of an optoelectronic IC (OEIC). This project is carried out in collaboration with the Institute of Microelectronics and the Massachusetts Institute of Technology.		

Project No:	10.3.10		
Supervisor:	Yoon Soon Fatt (Prof)	**E-mail address:**	esfyoon@ntu.edu.sg
Candidature:	MEng / PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Development of Nitride-based Semiconductor Materials and Devices for Photonic Device Applications		
Summary:	Nitride-based semiconductor materials are attracting a good deal of research attention due to their bandgap tunability by controlling its nitrogen content. This project sought to develop the materials growth processes needed for the development of quarternary nitride systems such as InGaAsN using molecular beam epitaxy in conjunction with a radio frequency nitrogen source. Device structures based on quantum wells and quantum dots will be fabricated and tested for their luminescence property. This behavior is correlated against changes to the growth parameters and external thermal annealing conditions which induces diffusion in the device structures. Quantum well lasers will be fabricated and tested for its CW and pulsed characteristics. The process will be extended to quantum dot lasers, which the group is actively involved in.		

Project No:	10.3.11		
Supervisor:	Yoon Soon Fatt (Prof)	**E-mail address:**	esfyoon@ntu.edu.sg
Candidature:	MEng / PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Integration of Optical Functionality on a Silicon Platform Through Silicon-Germanium Buffer Layers		
Summary:	The integration of optical functionality based on III-V compound semiconductors on a silicon substrate is a much sought after technological innovation. The driving force behind this is the capability of fabricating high efficiency photonic devices based on compound semiconductors onto robust and economical silicon substrates. However because III-V compound semiconductors are non-lattice matched to silicon substrates and have different thermal coefficient of expansion, a compliant buffer layer is needed to accommodate the mismatch. This project sought to develop the technology based on SiGe graded buffer layer to accommodate optical functionality based on compound semiconductors on silicon substrates. This project is to be carried out in collaboration with the Institute of Microelectronics and Massachusetts Institute of Technology.		

Project No:	10.3.12		
Supervisor:	Yu Siu Fung (Asst Prof)	**E-mail address:**	esfyu@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Ultra-violet Zinc Oxide Semiconductor Thin-film Lasers		
Summary:	Ultraviolet semiconductor lasers find enormous applications in commercial products (i.e., the ultra-high density storage in CDs and DVDs), scientific research (i.e., low-cost activated biological or chemical sensors) as well as military application (i.e., portable on-site detector for natural or human-caused epidemics). Recently, we have demonstrated that our zinc oxide thin films fabricated by filtered cathodic vacuum arc technique have very bright ultraviolet emission and this indicated that we have a very high chance to realize thin-film lasers using zinc oxide thin films prepared from our laboratory. In this project, the students are required to design and fabricate of zinc oxide thin-film lasers and demonstrated high intensity ultraviolet lasing.		

Project No:	10.3.13		
Supervisor:	Yu Siu Fung (Asst Prof)	**E-mail address:**	esfyu@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Design and Fabrication of Vertical-cavity Surface-emitting Semiconductor Lasers		
Summary:	This project involves the design and fabrication of short wavelength vertical cavity surface emitting lasers (VCSELs) for the applications in biomedical sensing. The semiconductor laser is required to have high output power (>10mW), single mode operation emitting at $0.39\mu m$. This project involves some theoretical studies as well as some fabrication process, which have been already defined in the previous analysis. The successful realization of high power VCSELs will lead to the commercialization of our devices. This project requires students with some computational skill and background in semiconductor physics as well as some practical knowledge in optics and semiconductor fabrication.		

Project No:	10.3.14		
Supervisor:	Yu Siu Fung (Asst Prof)	**E-mail address:**	esfyu@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Study of Random Lasing Mechanism in Silicon Nanocrystals based Lasers		
Summary:	Silicon dioxide (SiO_2) thin films containing silicon (Si) nano-crystals have been received enormous attention because of their light-emitting ability. The prospect of using Si based materials to fabricate optoelectronics devices (i.e., light emitting diodes and lasers) is very attractive because it would be compatible with the existing manufacturing infrastructure for ultra-large-scale-integrated electronic circuits. The successful usage of Si-based materials (i.e., doped Si or SiO_2) to fabricate photonic devices (i.e., photodetectors, phototransistors and optical waveguides) has already been demonstrated and a very challenging future task in this area of investigation will be to realize Si-based light emitting devices and lasers. This project involves the realization of lasing in Si-based lasers using random lasing mechanisms.		

Project No:	10.3.15		
Supervisor:	Yu Siu Fung (Asst Prof)	**E-mail address:**	esfyu@ntu.edu.sg
Candidature:	PhD		
Research Programme:	Photonic Materials & Devices		
Research Area:	Semiconductor Optoelectronic Materials, Devices and Processing		
Project Title:	Influence of Side Modes in Chaotic Communication Optical Fiber Systems for Secure Data Transmission		
Summary:	Chaotic light sources can be used to realize secure optical chaotic communication system provided that the synchronization of transmitting and receiving messages can be achieved in a master-slave configuration. However, the available coding methods only allow the transmission of one-data-channel per fiber, in which the potential usage of wide bandwidth optical fiber has been neglected. Therefore, it is proposed to use multiple-mode chaotic light sources (for frequency division multiplexing) to achieve multiple-data-channel per fiber transmission with maximum security. The main application of this proposal is to maximize the number of channel used in the chaotic communication system such that the transmission of secured data can be at a low cost.		