MEMS tunable integrated polarization rotator using Silicon photonics for optical communications

Communication is the key to the development of human civilization. This development is driven by data - “The new oil of this digital era”. With the advent of Internet of Things (IoT), there has been a huge surge in data traffic all over the world. It has been estimated that by 2020 there will be 26 billion connected devices, and all devices that can be connected will be connected. Eventually, as more and more people use these different ICT services on different devices, this data growth will be higher than ever. Currently, optical communication is used for transmitting the network traffic. Apart from optical communication very fast processors with billions of transistors are used for signal processing. However, we have come to limiting point of adding more transistors in the current processor chips to increase its speed. So a new solution combining photonics and silicon is envisaged to deal with the huge data transmission and signal processing growth. To start with the copper interconnects in between the ICs can be replaced with silicon photonic based waveguides to reduce the latency at the interconnection. Not only that existing optical fiber network capacity can be increased by using spatial multiplexing in existing deployed multi-mode fiber network. However, to develop integrated photonics based solution other circuit components like electrically tunable on-chip modulators, multiplexers, switches, filters, LASER etc. are also necessary.

Microelectromechanical Systems (MEMS) are micrometer-sized sensors and actuators that are used in many devices in our everyday life (For example accelerometers and gyroscopes in mobile phones). Using the same fabrication technology, one can fabricate on-chip optical circuits, which drastically improve the performance of telecommunication systems. However, both MEMS and silicon photonics have been independently developed. The objective of the Master’s Thesis is to do a feasibility analysis of bringing together both the fields and design and develop a MEMS tunable photonic polarization rotator for dispersion compensation in fiber optic communications.

The project starts by gathering information about the state-of-the-art passive polarization rotators. Then mode solver software is being used to optimize the design for waveguide transmission. Next, MEMS tunable device is designed by the checking the port modes in the waveguide cross-sections. The device is fabricated in cleanroom with a standard two-step CMOS fabrication procedure. Finally, the design is being characterized by fabricating other auxiliary components like grating couplers, waveguide tapers and polarization beam splitters along using an optical test bench with LASER and photodetectors.

The possibility of electrically controllable optical polarization rotation utilizing MEMS in silicon photonics establishes new horizons for on-chip integrated photonics. Additionally, advanced optical sensors can be designed since more spectrometric analysis can be done using tunable modes. Furthermore, if necessary, a cascade of MEMS tunable polarization rotator can be designed to yield broadband polarization rotation without the bandwidth constraints.