Silicon Nanowires for All-Optical Signal Processing in Optical Communication

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Abstract

Silicon (Si), the second most abundant element on earth, has dominated in microelectronics for many decades. It can also be used for photonic devices due to its transparency in the range of optical telecom wavelengths which will enable a platform for a monolithic integration of optics and microelectronics. Silicon photonic nanowire waveguides fabricated on silicon-on-insulator (SOI) substrates are crucial elements in nano-photonic integrated circuits. The strong light confinement in nanowires induced by high index contrast SOI material enhances the nonlinear effects in the silicon nanowire core such as four-wave mixing (FWM) which is an imperative process for optical signal processing. Since the current mature silicon fabrication technology enables a precise dimension control on nanowires, dispersion engineering can be performed by tailoring nanowire dimensions to realize an efficient nonlinear process. In the last four years, we investigated and demonstrated different ultra-fast all-optical nonlinear signal processing applications in silicon nanowires for optical time domain multiplexing (OTDM) systems, including wavelength conversion, signal regeneration, ultra-fast waveform sampling, demultiplexing, and multicasting, which shows great potentials in the future optical communication systems. Although the strong light confinement in nanowires allows efficient nonlinear optical signal processing, it also leads to coupling difficulty between on-chip sub-micron nanowires and micro-size fibers due to the large mode mismatch and index mismatch. Both end-coupling and grating-coupling solution utilizing nano-structures were demonstrated with optimized coupling efficiencies, which make the silicon on-chip nanowire devices more practical for real optical communication systems.

Biography

Dr. Pu received the B.Eng degree from Tianjin University, China, in 2005, the M.Sc degree in from the Royal Institute of Technology (KTH), Sweden, in 2007, and the Ph.D degree in photonics from the Technical University of Denmark (DTU) in 2010. He is currently working as a Postdoctoral researcher in the Nanophotonic Devices group at DTU Fotonik, Department of Photonics Engineering. Dr. Pu has a solid background in silicon integrated nanophotonic devices with research experience in simulation, fabrication and characterization, especially for nonlinear nanowires, microring resonators and photonic crystal waveguide and cavities. During his stay at DTU Fotonik, he has successfully demonstrated silicon microring resonator-based devices for communication and microwave applications and dispersion engineered silicon nanowires for ultra-fast signal processing applications. He has authored or co-authored 55 peer-reviewed publications. Dr. Pu is the recipient of a Danish Research Council project (SiMOF) aiming at developing ultra-compact, monolithic frequency comb generators based on silicon micro-ring resonators, a project that started in 2012. He is also involved in several other national and international projects.