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Editorial: Recent developments in Si-based materials and devices

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Editorial on the Research Topic
Recent developments in Si-based materials and devices

Due to its compatibility with existing CMOS processes, Silicon photonics is promising technologies for optoelectronic integrated chip with the high degree of integration and low power consumption. Silicon photonics has emerged as a leading platform for data communications, quantum technologies, on-chip sensors, etc [1–3]. By integrating large number of diverse photonic components in single chip enables silicon photonics as a scalable and reliable platform for advanced optical communication system [4]. Recently, another milestone of research is being under progress in silicon photonic neural network accelerators. In particular, the waveguides and modulators based on silicon materials have been attracted a lot of attention along with the development of nano-micro fabrication techniques. However, the higher than desirable propagation loss plays significant bottle-neck problem in on-chip communication applications.

Under the Research Topic “*Recent Developments in Silicon-Based Materials and Devices*” we have compiled a total of seven articles covering the recent advances in the design of Si-based modulators, resonators and edge couplers. We have given brief highlights of these articles. Pavesi gave a brief overview of silicon photonics, in particular the development of porous silicon for quantum devices and neural networks. Liu et al. has demonstrated the low cross talk arrayed waveguide grating (AWG) by integrating with micro ring resonator (MRR). The structure is designed so that the heater-tunable MRR acts as a filter to significantly reduce the noise of the AWG. The side lobe crosstalk level can be reduced from −16.3 to −26.8 dB, and the integrated AWG crosstalk has improved over the entire 3 dB bandwidth. Feng et al. have presented the numerical simulation study of the electro-optical SiGe/Si heterojunction modulator. A reduction in the modulation voltage of about 50% is observed for the SiGe/Si heterojunction compared to the silicon modulator with a similar modulation effect. Liang et al. has developed the adiabatic operation slope-loss algorithm (AO-SLA) for designing adiabatic waveguide tapers. The waveguide taper efficiency is improved with AO-SLA design compared with parabolic design and SLA design with broad operating bandwidth. Hu et al. has proposed a large wavelength bandwidth Mach-Zehnder modulator. The symmetrical structure of the designed modulator allows to increase the optical operating bandwidth by 56.1 nm compared to conventional Mach-Zehnder modulator. Similarly, Ma et al. has demonstrated the ultra-low coupling loss edge coupler on SOI platform. The edge coupler features a cantilevered SiO_2 waveguide with amorphous silicon nano taper and crystalline silicon nano taper. The coupling losses are according to the simulation 0.97 dB for TE modes, the measured coupling losses are only −1.7 dB per facet for the TE mode at 1,550 nm without index matching liquid. The designed tapers have a coupling loss of less than 1 dB in a wide bandwidth of 1,550 nm. The high density integration of semiconductor materials such as oxides, nitrides are an active research field to increase the performance of devices and manipulate the properties of both counterparts. Chang et al. has demonstrated the Ge PIN photodetector on Si and configured the design based on the carrier mobility of the active region. Considering the mobility of electrons and holes, the device was designed asymmetrical configuration and achieved better performance both in vertical and lateral device.

We hope that this Research Topic can serve as a guide for the development of advanced silicon-based electronic and optoelectronic devices. We thank all the authors, reviewers, and editors for their valuable contribution to this Research Topic.

Author contributions

CP: Writing–original draft. CL: Writing–review and editing. JZ: Writing–review and editing.

Conflict of interest

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