Bragg Grating Coupled High Q-Factor Ring Resonator using Liquid Source CVD Deposited Si_3N_4 Film at 150°C

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The micro-ring resonator is the promising optical device for a variety of applications due to its compact size design, wavelength selectivity, and flexible structure. Based on the intra-cavity effective refractive index change or resonance shift, the micro-ring resonators work as a crucial component in optical sensors, de-multiplex system, optical modulator and so on. In this work, authors report for the first time on CMOS-compatible integrated micro-ring resonators with Bragg gratings coupled at both bus ends using a high quality Si_3N_4 film deposited by the liquid source CVD method at ultra-low temperature of 150 ºC.

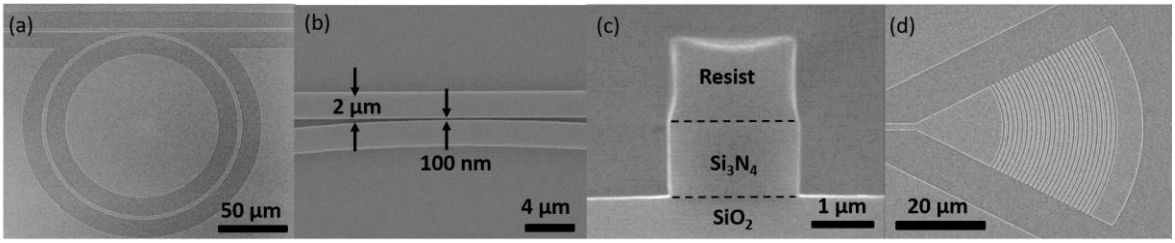

Fig. 1. SEM micrograph of (a) top view of ring resonator; (b) Enlarged view of the coupling region between bus and ring waveguide; (c) Cross section view of waveguide; (d) Fabricated grating coupler waveguide region.

Generally, the Si_3N_4 films deposited by either LPCVD or PECVD have demonstrated high tensile stress which prevents a thicker film deposition greater than 250 nm-thick with low loss state. Considering above, LSCVD is developed to fabricate the high quality Si_3N_4 films of several micrometers thickness without the limitation of cracking using the liquid SiN-X source at only 150 ºC, which guaranteed Kerr-based nonlinearity while featured high thermal compatibility with existing silicon photonics and front-end electronic devices especially those involving flexible/organic substrate. Furthermore, LSCVD deposition without needing SiH_4 and NH_3 chemistry also avoided the dangling Si-H and N-H bonds, which usually occur to PECVD and LPCVD and required extra 1200 ºC post-annealing to deal with such intrinsic absorption loss in C-band. We demonstrated high Q-factor ring resonators in this Si_3N_4 films, showing Q-value of over 1.5×10^5 with 100-µm radius. A 3-dB bandwidth of around 70 nm for grating coupler was also achieved with 1550 nm central wavelength, while the coupling efficiency from fiber to grating is around 3 dB. In this case, the measured spectral bandwidth can cover most of operating frequency of C-band and L-band. The LSCVD deposited Si_3N_4 is therefore a promising CMOS-compatible integration platform for nonlinear functional devices and circuits at telecommunication wavelengths.