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Characterizations of the Hybrid Si/GaN Microring Resonator with Asymmetric Vertical Coupling

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1. Introduction

Hybrid nanophotonic platforms are thought to be an essential technology for on-chip ultrahigh-bandwidth optical interconnects in futuristic computers. Although various hybrid nanophotonic platforms have been demonstrated, e.g., Si/InP [1], Si/$LiNbO_3$ [2], Si/Si_3N_4 [3], an all-round hybrid Si/GaN platform that utilizes both the materials to form functional structures has been investigated only by our group recently [4]. Such hybrid nanophotonic platform is expected to be useful not only for nanophotonics but also for microelectromechanical systems (MEMS). In this work, we present a hybrid Si/GaN microring resonator which consists of a flowable oxide-clad GaN ring on top of Si waveguide circuit. The microring structure could potentially be used for high-speed electro-optic modulations.

2. Fabrication and Experimental Results

The hybrid Si/GaN microring resonator structure consists of a straight 260-nm-thick and 300-nm-wide Si strip waveguide (SW) and a 500-nm-thick GaN microring (MR) of a trapezoidal cross-section of an average width of 1105 nm. The fabricated device is shown in Fig. 1. The fabrication processes of the devices are summarized in Fig. 2.

We studied the spectral characteristics of the fabricated MR by wavelength scanning technique (1520 nm to 1630 nm). Two GaN MR designs of radius of 20 µm and 40 µm were studied. Excitations of the GaN MR occurred when lightwave coming from SW circuit vertically coupled to the GaN MR as shown in Fig. 3. We observed the MR characteristic, i.e., unity transmission at all source wavelengths except no transmission at the resonant wavelengths which periodically occurred along the source wavelength axis, as shown in Fig. 4. At the resonant wavelengths, lightwave is trapped inside the GaN MR, causing high optical power buildup in the structure as shown in Fig. 3b. Using the transmission spectrum, we estimate the maximum intrinsic quality factor of the GaN MR to be about 70,000. The minimum full-width half-maximum at resonance of 40 pm was found. The maximum extinction ratio of up to 17 dB was measured. The scattering loss at the GaN microring surface was estimated to be around 5 to 6 dB/cm.

3. Conclusions

We presented a working hybrid Si/GaN microring resonator which showed promising microring characteristic that may be suitable for further studies of optical modulations or non-linear optical processes in the GaN MR resonator.

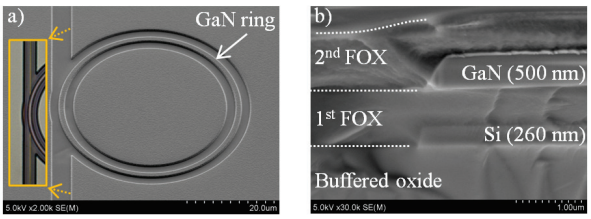

Fig. 1. The hybrid Si/GaN MR resonator. a) Electron micrograph of the GaN ring without top flowable oxide. The inset shows the underlying Si SW. b) A dummy structure representing the cross-section of the device and the thickness of each layer.

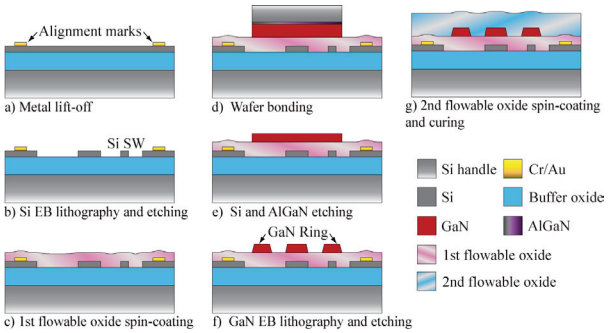

Fig. 2. Fabrication processes of the hybrid Si/GaN device.

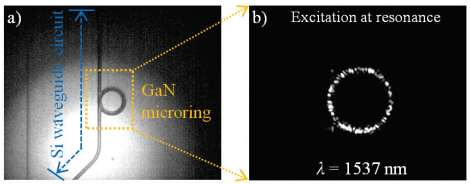

Fig. 3. Excitation of the GaN ring at a resonant wavelength

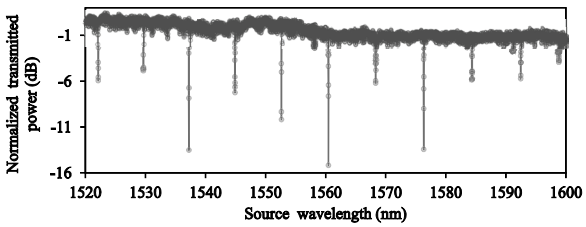

Fig. 4. Transmission spectrum for GaN MR of 20 µm radius.

Acknowledgements

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