

# A nonreciprocal optical device using ferromagnet-semiconductor hybrid structures

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Optical isolators are indispensable for stable operation of telecommunication semiconductor lasers. Commercially available optical isolators are composed of Faraday rotators (garnets) and linear polarizers, and are not compatible with semiconductor lasers. Compact semiconductor-waveguide-type optical isolators with more than 30dB isolation, which can be monolithically integrated with edge-emitting semiconductor lasers and other III-V optoelectronic devices are awaited for reducing overall system sizes. We have proposed and designed a TE mode semiconductor-waveguide-type optical isolator based on the nonreciprocal loss shift. This device is composed of a semiconductor optical amplifier (SOA) waveguide and a ferromagnetic metal. The ferromagnetic metal provides the nonreciprocal loss and the SOA compensates the forward propagation loss from the ferromagnetic metal. We demonstrated, for the first time, 9.3dB/mm TE mode nonreciprocal propagation in an InGaAsP/InP active waveguide having an Fe layer on one of the sidewalls (see Fig. 1) at the wavelength of 1560nm [1]. In this paper, we report improved nonreciprocal loss shift of 14.7dB/mm with reduced insertion loss for monolithically integratable optical isolator applications, as shown in Fig. 2. Detail device characteristics will be presented in the conference.

1. H. Shimizu and Y. Nakano, *Jpn. J. Appl. Phys.* **43**, L1561 (2004).

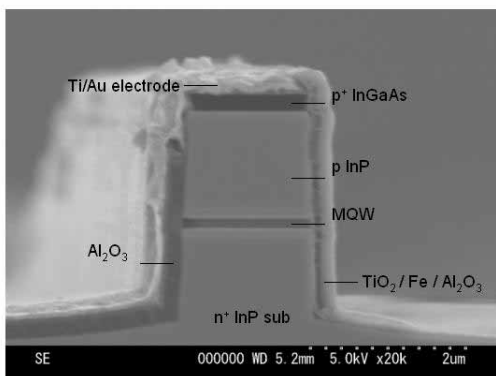


Fig.1 A cross-sectional scanning electron microscope image of the fabricated InGaAsP/InP active waveguide isolator having an Fe layer on one of the sidewalls.

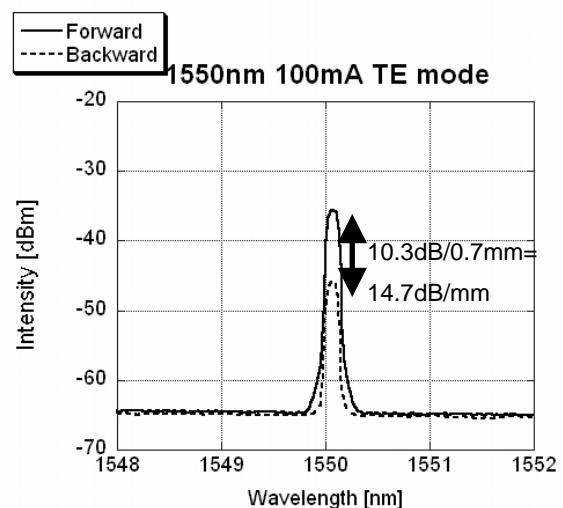


Fig. 2. TE mode nonreciprocal loss shift of the fabricated device (0.7mm) at the wavelength of 1550nm.

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