Magneto-optical waveguide isolator with 104 dB/cm non-reciprocal propagation

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Optical isolators protect active devices (i.e. lasers) from optical feedback. All research in the past focused on transmission of the light through ferromagnetic garnets [1] with low optical loss at telecom wavelengths and strong magneto-optical (MO) Faraday effects. The monolithic integration with III-V host materials would greatly reduce the cost of a laser diode package by avoiding the accurate alignment needed with an external isolator. The best reported result based on bonding of garnets on III-V materials shows an isolation ratio of only 5dB [2]. A novel concept for a – transversal magnetic mode (TM) - isolator based on a semiconductor optical amplifier (SOA) with a ferromagnetic contact was proposed [3] and demonstrated by us [4]. Lateral magnetization of the contact induces a non-reciprocal shift of the refractive index of TM guided modes, due to the MO Kerr effect. The propagation losses can be compensated by electrical pumping of the SOA through the ferromagnetic contact. Fig. 1a illustrates the device structure and Fig. 1b the operation principle.

A novel AlGaInAs-based multi-quantum well (MQW) active layer structure with built-in tensile strain has been developed [5] for TM-selective gain at 1.3μm wavelength. The sputter-deposited 50 nm thick $Co_{50}Fe_{50}$ film was patterned into 3.5 μm wide stripes through lift-off and serves as an etch mask to define the ridge waveguides. Fig. 1c shows a hysteresis measured by looping an external field to change the magnetization of the FM contact while measuring the amplified spontaneous emission of the SOA. The isolation strength of the device extracted from the transmitted optical power for both lateral magnetization directions is 104dB/cm.

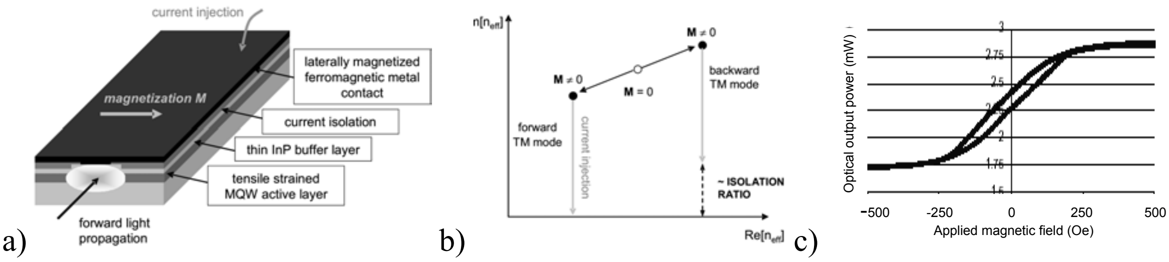

Fig. 1. Schematic presentation, operating principle and hysteresis of the optical isolator.

References

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