The MAGIC Laser:
a MonolithicWDM Source

K.R.Poguntke *, J.B.D.Soole, A.Scherer, H.P.LeBlanc,
C.Caneau, R.Bhat, and M.A.Koza

Bellcore, 331 Newman Springs Road, Red Bank, NJ 07701.

* Dept. of Physics, University of Surrey, Guildford, U.K.

Abstract

We discuss the Multi-stripe Array Grating Integrated Cavity (MAGIC) Laser: a multi-wavelength laser formed by monolithically integrating a diffraction grating and an array of active stripes in a planar semiconductor waveguide cavity. Recent results will be presented.

Introduction

There is currently considerable interest in the telecommunications and computing industries at developing networks that use many different wavelengths. Not only for increasing the capacity of point-to-point links, but also for broadcast systems and, most interestingly, in multi-wavelength optical networks where wavelength is effectively used as an effective extra "dimension".

Whatever the ultimate network envisaged, multi-wavelength systems will only become widely deployed if sources and wavelength-demultiplexing detectors can be developed that have precise factory-defined wavelengths and high field-reliability, and can also be manufactured at low cost. This talk discusses a new type of multi-wavelength source — the MAGIC, or Multi-stripe Array Grating Integrated Cavity Laser — that we believe has the potential to fulfill these criteria.

The MAGIC Laser

The device structure is illustrated schematically in Figure 1. It is based on a planar InP/InGaAsP/InP waveguide. At one end a number of active laser stripes have been integrated, and at the other a focussing vertical-walled diffraction grating has been etched through the guide layers [1].

If one stripe is injection pumped, the spontaneous radiation emitted into the planar waveguide at one end is reflected at one wavelength by the grating and lasing occurs at the wavelength. different stripes cause lasing at different wavelengths. The integrated laser is acting in a similar fashion to a conventional external cavity laser, with the bulk optic lens and grating of the latter replaced by the etched grating.

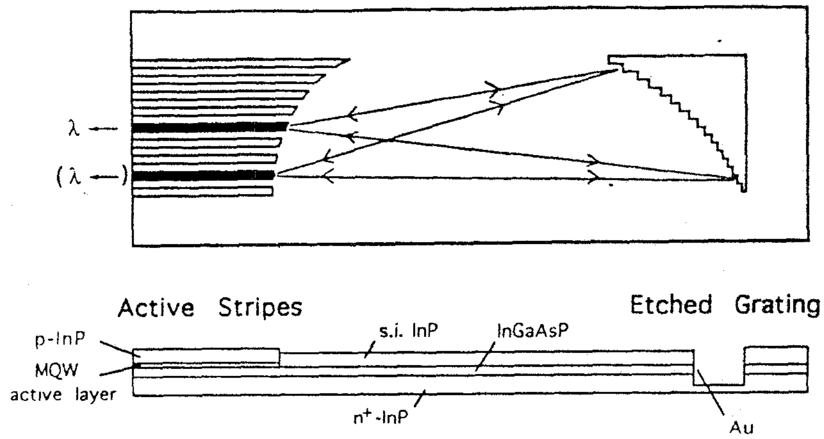

Figure 1. Schematic of the MAGIC laser.

The interesting mode of operation of the MAGIC laser comes, however, when two stripes are pumped simultaneously. This is illustrated schematically in Figure 1. If these stripes are each selected so that, individually, they receive feedback from the grating towards (or beyond) at wavelengths at the opposite extreme ends of the gain curve of the active material, neither stripe is inclined to lase on its own. However, when both are pumped simultaneously a cavity is formed between them - via the grating - at a wavelength midway between, i.e. towards the peak of the gain curve, and consequently lasing occurs at this wavelength. If one denotes one stripe the "output" and takes the radiation from its external facet, by then simply selecting different stripes for the "second" pumped element allows us to select different laser wavelengths without realigning the pick-up fiber. We now have a single-port wavelength-switchable laser.

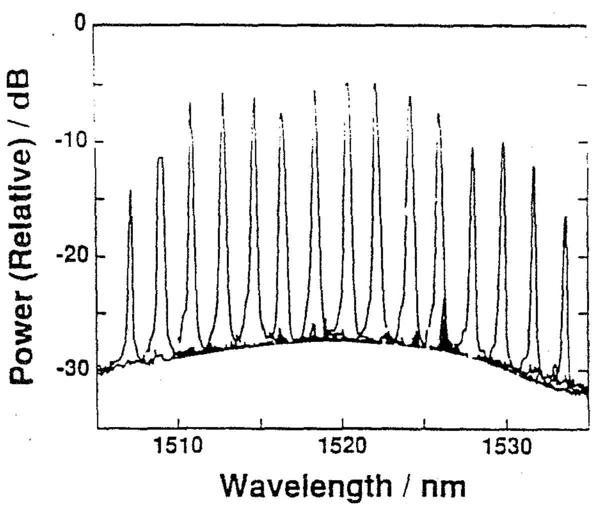

Figure 2. Laser emission at different wavelengths.

Figure 2 gives a compilation of emissions from a MAGIC laser obtained from a single "output stripe" on selecting different "second stripes" to pump.

One of the attractive features of the MAGIC laser is its wavelength accuracy. The emission wavelengths are determined only by the device geometery and the composition and thicknesses of the planar waveguide layers. These can all be held to fairly precise tolerances, which leads to precise wavelength control.

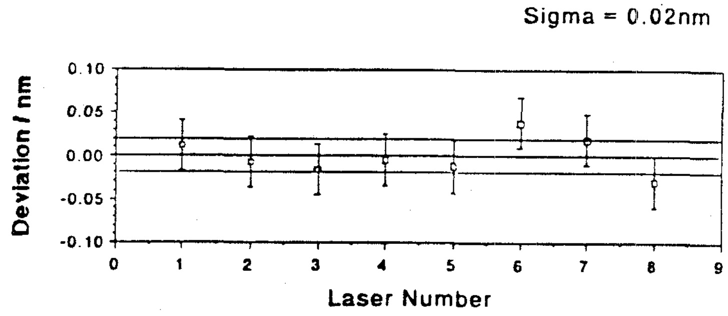

Figure 3. Linearity of the wavelength spacing.

We have demonstrated wavelength spacing accuracies of ±0.02nm; values on the order of ±0.01 should be attainable. This is more than an order of magnitude greater precision than is currently attainable with DFB arrays. The comb of laser wavelengths can be raised or lowered by adjusting the device temperature. An absolute pre-determined accuracy of <±1nm is possible with well-controlled wafer growth. This then requires <10°C temperature tuning for complete alignment of the lasing wavelengths to required network values. Figure 3 shows the linearity obtained from one MAGIC laser.

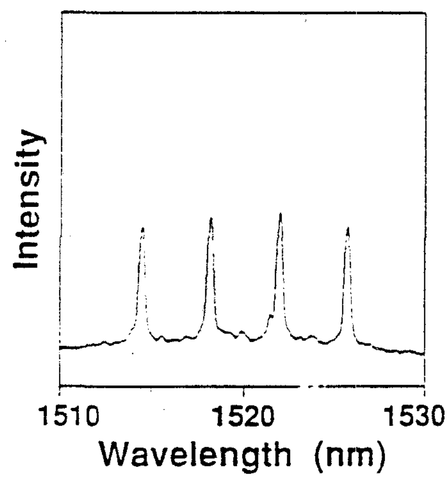

Figure 4. Simultaneous lasing at four wavelengths.

Several wavelength may be emitted simultaneously by pumping different "second stripes" at the same time. Each stripe sets up its own lasing resonance with the output stripe and lasing occurs at each wavelength. Figure 4 shows the simultaneous emission of the MAGIC laser at four wavelengths.

[1] J.B.D.Soole, K.Poguntke, A.Scherer, H.P.LeBlanc, C.Chang-Hasnain, J.R.Hayes, R.Bhat, C.Caneau, and M.A.Koza, *Appl. Phys. Lett.*, **61**, 2750, 1992.