WB1 **WDM DETECTION USING INTEGRATED GRATING DEMULTIPLEXER AND HIGH DENSITY p-i-n ARRAY**

J.B.D.Soole, A.Scherer, Y.Silberberg, H.P.LeBlanc,
N.C.Andreadakis, and C.Caneau.

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

Summary

Multi-wavelength systems are being advocated for use in future telecommunication networks and for computer processor links. In research systems the multiplexing and demultiplexing of the different wavelength signals is currently achieved through the use of bulk optical components. When channel separation are on the order of a nm or so - which is typical of 'high density' direct detection systems - the MUX/DMUX function is generally done with a diffraction grating. WDM detection at the receiver end is then btained by assembling a detector array, placed in the focal plane of the optical grating system.

There is apparant advantage to be gained if the hybrid bulk-optic demultiplexer and array detector system can be replaced by a single monolithic component. Multiple component assembly would be eliminated and the internal alignment would be automatic; reliability would be increased, with the potential for significant cost reduction. In this paper, we report our recent realisation of such a monolithic component. The InP-based device presented integrates a grating-based wavelength demultiplexer with a dense p-i-n array on a single planar waveguide structure, measuring about 12mm x 4mm.

The 'optical cavity' of the device is a double heterostructure waveguide, InP/InGaAsP/InP. Through this structure, a vertical-walled focusing diffraction grating is etched [1]. The multi-wavelength input signal is fed into the cavity via a single moded etched ridge waveguide and the demultiplexed, 1-nm spaced, outputs are taken away by similarly etched guides which feed them into monolithically integrated p-i-n detectors. The geometry of the device is shown schematically in Figure 1. A device operating on similar principles operating with a channel separation of 4nm was also recently reported [2].

The grating disperses light signals at 1nm wavelength separation into the output waveguides [1]. The WDM performance is shown in figure 2. This plots the detection wavelength across a span of 75 channels. (Only the position of every second channel is shown in the figure.) The FWHM for channel detection was typically 6Å-8Å. Channels far from each other are well isolated (<-30dB cross-talk), though inter-guide coupling reduced next-neighbor cross-talk to ~-15dB and nearest neighbor cross-talk was - 7-8dB. This could presumably be improved by etching isolation trenches between the guides.

The waveguide detectors integrated with the output waveguides employed a novel waveguide / detector coupling geometry [3]. Ths is a 'hybrid' between the conventional butt- and vertical-coupling approaches, obtained by first growing the waveguide core and detector structure; then, after mesa-etching the detector, the upper waveguide cladding layer is regrown. The resulting structure allows strong coupling between the guide and the InGaAs detector absorption layer, giving near-complete absorption in a short length of detector. The 25μm long detectors employed in the WDM array reported here, absorbed ~90% of the incident waveguide light. The small capacitance of the short detector yielded a detector bandwidth of ~15GHz. See Figure 3.

---

[1] J.B.D. Soole et al., *Appl. Phys. Lett.*, 58, 1949, 1991.

[2] C.Cremer et. al., *I.E.E.E. Phot. Tech Lett.*, 4, 108, 1992.

[4] J.B.D.Soole et. al., *O.S.A. Topical Meeting on Optoelectronics*, Monterey, July 1990.

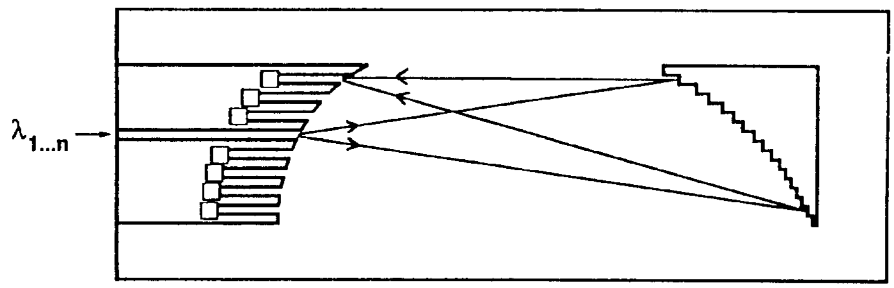

Figure 1. Schematic of the monolithic WDM detector chip.

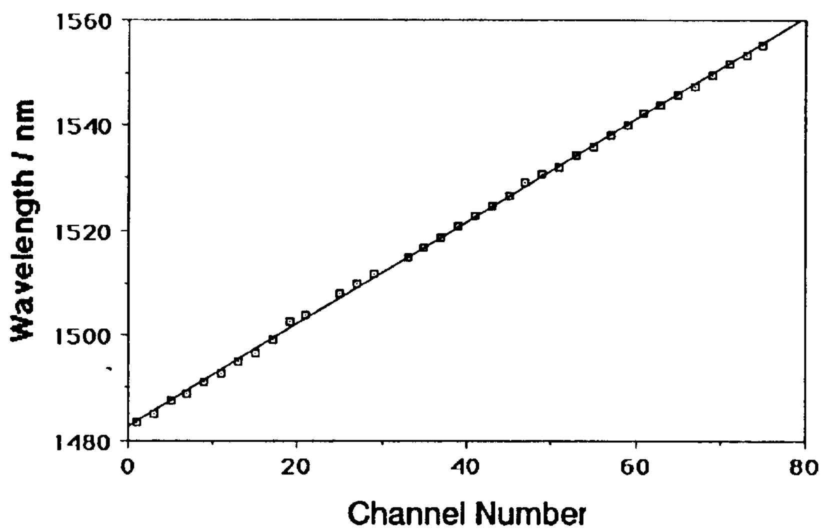

Figure 2. Wavelength demultiplexing performance; position of every second detector shown.

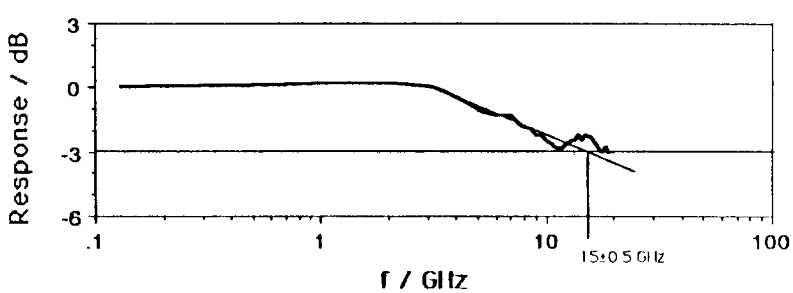

Figure 3. Frequency performance of the 'hybrid' waveguide detector used in the WDM array.