Optical CrossLinks Waveguide Grating Technology and Applications

Diffraction gratings in combination with guided light inside glass fibers are being used to create novel wavelength division multiplexing functions typically referred to as WDM devices. For telecom the wavelengths are becoming increasingly closely spaced down to nanometer spacing. At these levels it is referred to as dense WDM or DWDM. This technology is becoming increasingly important for combining, separating, and/or monitoring different closely spaced communication wavelengths, performing functions where selected wavelengths are added or removed from the light guided data stream or add drop multiplexers. Increasingly there is a growing need to combine wavelengths for datacom applications in building infrastructure systems, which will require wider spaced wavelengths ≥10nm. It is expected that these coarse WDM's or CWDM or even more confusingly metro DWDMs will require the grating technology to be compatible with large multimode high NA guides with larger acceptance angle capability required. Unique gratings with versatile configuration manufacturable at low costs will be required to meet these needs.

Optical CrossLink's (OXL) unique proprietary waveguide forming technology, which depends on monomer diffusion into exposed regions, can also be used to form volume phase Bragg diffraction gratings using the same process. This capability to combine Bragg gratings and waveguides in the same structure through and around the guides in diverse sizes and configurations is a truly unique and demonstrated core competency of OXL's GuideLink™ polymer waveguide technology. High resolution diffraction gratings have been holographically constructed using interfering laser light with spacing of the grating fringes to at least 0.2 microns or better, which is adequate to handle both DWDM and CWDM applications. Alternatively a master grating can be use to generate two interfering beams for manufacturing purposes.

The technology's feasibility was initially demonstrated in 1989 and presented at a at an OSA conference[1], following which DuPont reassigned the key personnel in a restructuring. The results are demonstrated in the attached figures. In Figure 1 a nominal 9 micron square waveguide is shown with gratings embedded in the guide only at nearly 45 degrees to the guide when viewed from the top. A roughly 6 micron slice cut perpendicular to the gratings was cut from the guide and when viewed similarly as shown demonstrates that the grating fringes are only in the guide. Alternatively, in Figure 2 gratings where embedded in both the guide and the surrounding layers but perpendicular to the guide axis. In addition, the guide region was a 1 to 2 splitter that contained the gratings. The splitter with the gratings shown at two magnifications is depicted. This splitter was able to selectively reflect 1550nm light coming in on one of the two splitter arms back into the other arm while passing the 1300nm light straight through. Although only about 20% of the light was reflected back with a 15nm full width half maximum peak with a nearly gaussian profile, the results were sufficiently encouraging to demonstrate the potential and promise for creating highly functional grating waveguide devices. Unfortunately due to DuPont's restructuring the work was not able to proceed further to optimize the design, process parameters, or materials. It is OXL's intent to develop and optimize the technology with practical CWDM's as part of our advanced product portfolio.

The ability to configure by light exposure only, both grating and waveguide structures, offers, we believe for the first time, an incredibly powerful tool for WDM designs and manufacturing. For example, gratings can be created:

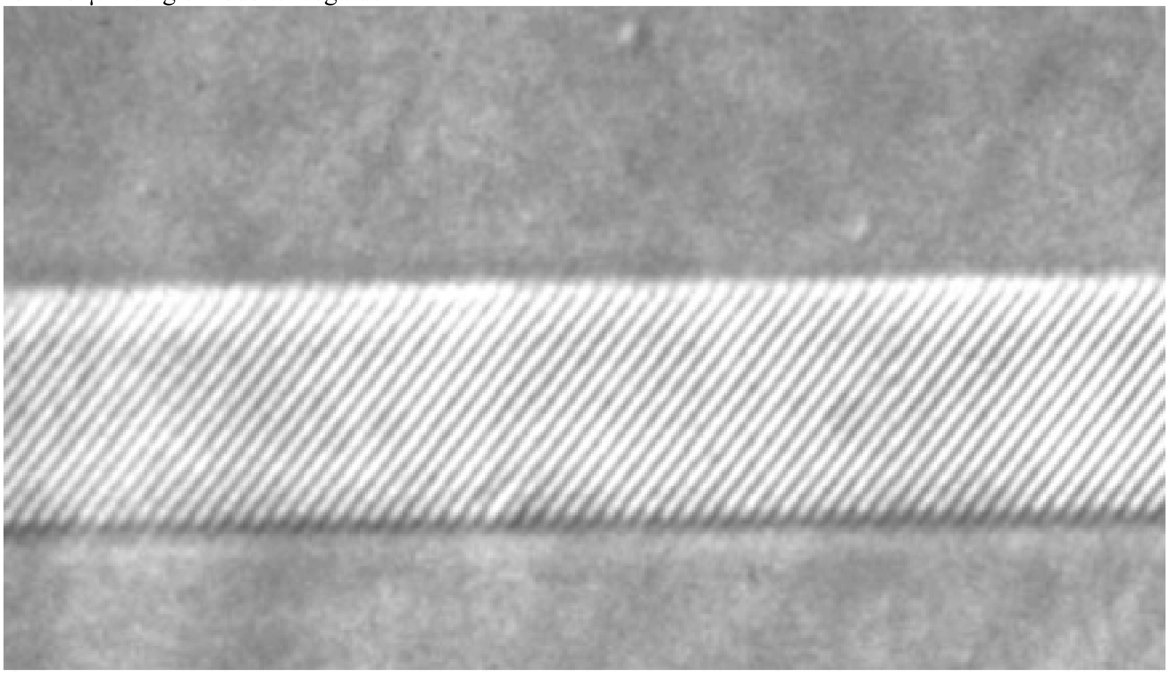
1) in the waveguide only or in the waveguide and the surrounding cladding to optimize the impact on the guided light,
2) with any angle to the guide to diffract in a transmission mode the light out of the guide either vertically out of the film or within the film layer into another waveguide, or in a refection mode as is done with optical fibers for current DWDMs,
3) with varying grating strength (index modulation) and grating dimensions to enable the acceptance angle for diffraction to be altered for large NA multimode guides or for narrow angle single mode guides
4) with index modulation profiles along the guide and through the grating to optimize the signal performance (referred to a apodizing)
5) periodically along the guides in dense arrays of individual gratings to select different wavelengths and couple to another guide for handling multi wavelength systems or to create novel pass band filters.

The potential for a diverse range of configurations is significant and the above is only suggestive and an indication of the diversity available. We recognize that considerable effort will be needed to develop practical WDM systems including modeling, process development, fixturing, and probably some polymer material manipulations and/or alterations to completely optimize performance and enable practical manufacturing approaches to be developed. Focusing on metro multimode CWDM applications in the near term seems to offer the best near term business opportunity as opposed to competing with embedded DWDM fiber based systems at this time. Our focus however remains to work closely with key customers and strategic partners to meet their product needs and drive for new applications.

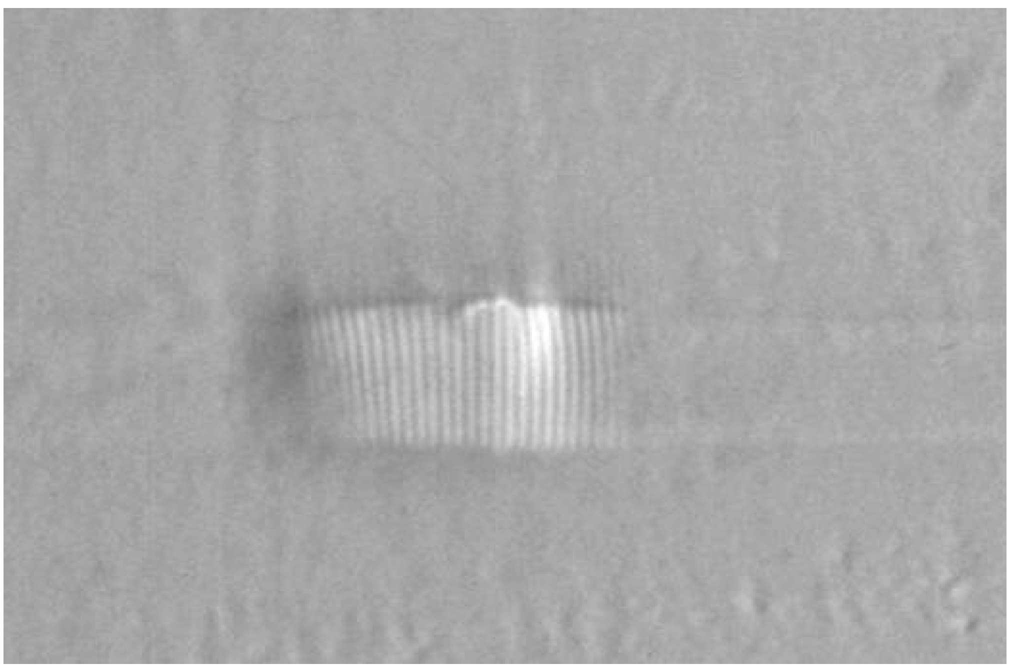
BLBooth 5/7/01

[1] K.W.Steijn, B.L.Booth, J.E.Marchegiano, "Bragg Gratings in Photopolymer Buried-Channel Waveguides", Optical Society of America Conference, Conference Proceedings, Optics '89, Orlando, FL, October 15-20, 1989.

(Fig 1) Unique capability demonstrated for creating waveguide embedded volume Bragg diffraction gratings shown for in 9 µm single mode waveguide

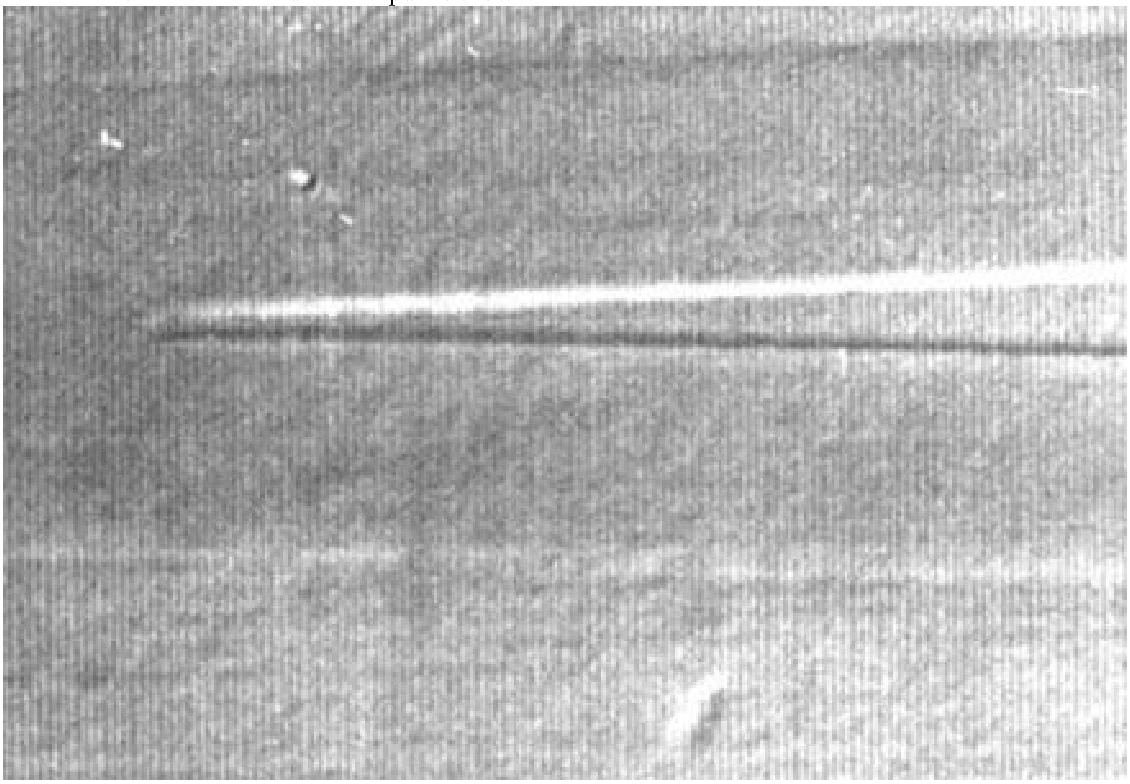


Grating in 9 µm waveguide, top view



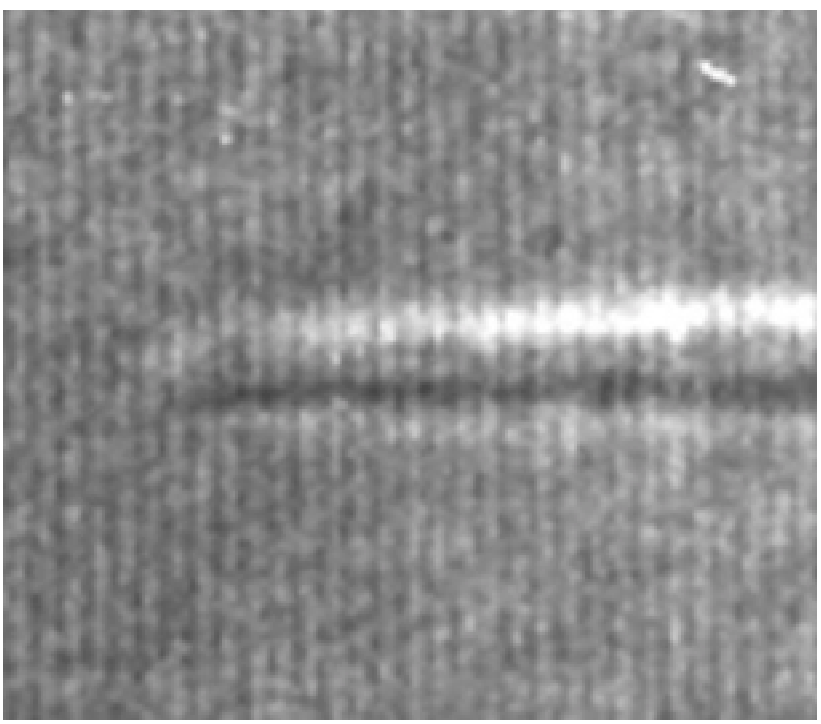
Grating cross sections cut perpendicular to fringes in top view above

(Fig. 2) Reflective volume Bragg gratings in both single mode guide and clad regions of a 1x2 splitter for separating 1550 nm from 1300 nm and 1350 input as shown.



1300 nm and
1550 nm

1550 μm



Magnification of
splitter region above