Reference No.:	70
Project Title:	Evaluation of Alignment Tolerant Optoelectronic Structures
NEPP Project:	Electronics Packaging Project
Point of Contact:	Harry Shaw, GSFC, 301-286-6916 Siamak Forouhar, JPL, 818-354-4967
Proposing Center:	GSFC
Participating Center(s):	JPL
Status:	X New: On going:
Performance Periods:	FY 00 – FY02

Benefits:

The increasing functionality and complexity of Optoelectronic (OE) devices is driving the need for large scale and low-low cost assembly of OE components and modules. There has been an increased interest in hybrid and monolithic integration of OE devices to obtain high speed, high functionality and reliable fiber optics modules.

We expect that the development of this innovative generic OE integration technology will be of benefit to all of the NASA strategic enterprises. In particular, it will find applications in the transport of high-speed communication signals via fiber-optics links. This generic technology will benefit both the Goddard Space Flight Center and JPL via their Space Science and Mission to Planet Earth Strategic enterprises (MTPE). This technology will most likely also have appeal to the Langley Space Center via its atmospheric science program in the MTPE enterprise, in the Marshall space Flight Center via its program on space transportation systems and to the Kennedy Space Center via its program in space launch.

Partnerships and Endorsements

JPL

Objectives of Proposal Activity:

The requirement to achieve a high degree of laser-fiber alignment is a driving factor in the efficiency of fiber coupled laser microelectronics. Alignment tolerant structures is an inexpensive method to reduce coupling losses and improve end-to-end efficiency of a fiber optic system. This is very important in space based fiber optic systems which may suffer from alignment induced losses which cannot be subsequently corrected. GSFC and JPL will evaluate a novel approach for alignment tolerant structures for ease of alignment of optoelectronic(OE) devices to a single-mode fiber.

Technical Approach:

This work will leverage off of the funding the University of Maryland has invested in the development of adiabatic vertical mode transformers that do not necessitate regrowth[1,2]. Please note that the University of Maryland is the technology developer using their own funds for development. They have demonstrated a large mode laser at 1550 nm using two vertically placed waveguides where the top waveguide is the highly confined active waveguide and the bottom waveguide is a large loosely confined passive waveguide. The mode is pushed from the top waveguide to the underlying waveguide adiabatically by tapering the top waveguide slowly as shown in Fig. 1. The results have been good butt-coupling efficiencies to single mode fibers with relaxed alignment tolerances making these devices suitable for hybrid integration using passive packaging. Testing must now be done to see if the technology is applicable for additional wavelengths of interest to a variety of NASA programs.

We will also evaluate a new approach (patent pending) that relies on resonant vertical coupling of two supermodes of the waveguide that has already been demonstrated. This will permit the implementation of much more compact mode transformers than what has been demonstrated so far. We have demonstrated a low-loss mode expander with mode transformation region as short as 200 μm as shown in Fig. 2. This is the shortest transformation region reported and is about 3 times shorter than the corresponding adiabatic mode transformers. This not only allows for compact devices but also high-speed operation. In addition, the above transformation scheme allows a new very powerful approach to monolithically integrate different OE devices on the same substrate. The two vertically placed waveguides can be optimized for different optical functions with different bandgaps. By transforming the mode between the waveguides, various OE integrated modules like lasers and modulators, semiconductor amplifiers and splitters, optical switches and passive waveguides, can be built. For example, one of the waveguides can be optimized for gain, and the second waveguide can be optimized for passive devices like splitter. In this way, by pushing the mode into the active waveguide and giving it gain we can make loss-less splitters as shown in Fig. 3. Mach-Zehnder interferometers with integrated amplifiers needed for high speed wavelength conversion, can also be built.

- Identify suitable packaging platforms for the monolithic integration of different active and passive components on the same substrate in single epitaxial growth and using conventional fabrication schemes.
- Integrate high-speed (2.5 and 10 Gb/s) electronic drivers and transimpedance amplifiers within monolithic OE modules.
- Characterize the performance of the module
- Evaluate the reliability of the packaging and integration

Note that this is not a “packaging development activity. This is a packaging assessment activity where we will evaluate the integrated package (module) which includes the input fiber, waveguide, splitter and output fibers. Also characterization of the entire module includes packaging assessment.

Deliverable and Milestones:

- Identify and procure packaging	3QTR00
- Establish test plan	3QTR00
- Build parts	4QTR00
- Test Report	3QTR01

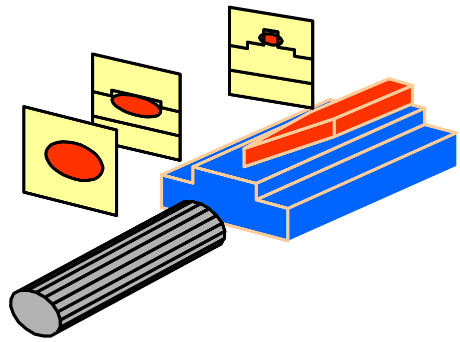

Fig. 1. Schematic of the
adiabatic mode expander

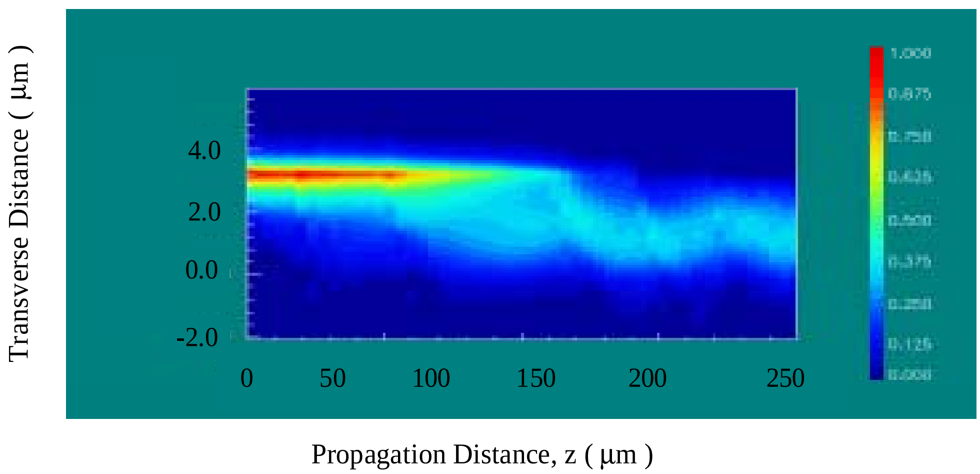

Fig. 2. Simulation showing the compact resonant coupling

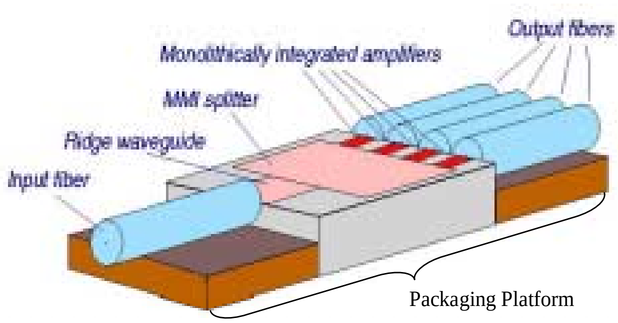

Fig. 3. Schematic of a packaged lossless