

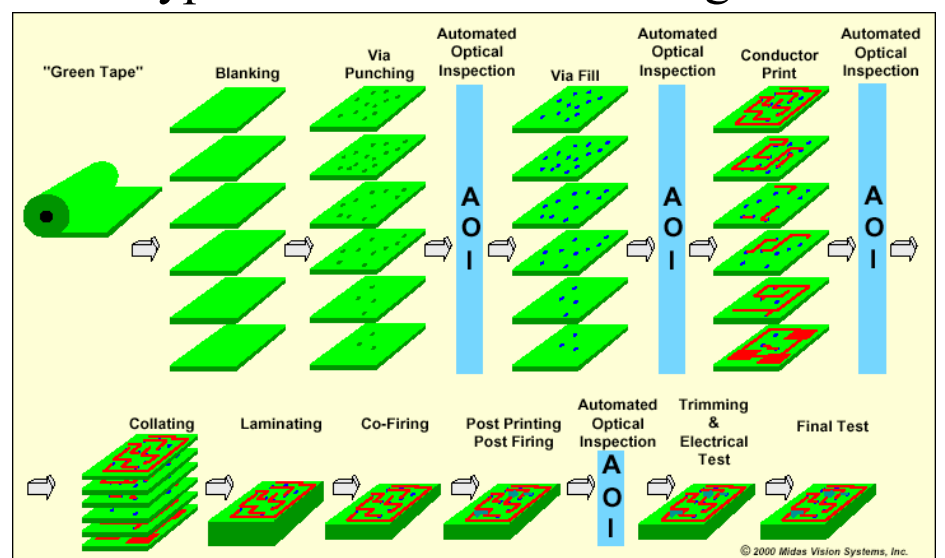
# Integrated LTCC-Piezoelectric Fiber Alignment Structures for Optoelectronics

Richard Eitel, Amanda Baker, Jose Agraz, Kenji Uchino, and Clive Randall  
Materials Research Institute, Penn State, University Park, PA

## Background and Approach:

Fiber to source/receiver alignment is currently a major issue for the optoelectronics industry. Alignment tolerances for high speed optical networking require sub-micrometer precision. Currently, the alignment process, rework and low yields due to misalignment add nearly an order of magnitude to the cost of optoelectronics modules. New methods are clearly needed to address this growing problem. Previous efforts at Penn State had focused on the application of Low Temperature Co-fire Ceramic (LTCC) materials for the construction of optoelectronic modules. This work evaluated the current and next generation LTCC technologies in terms of process control and material performance. While it was determined that these technologies promise dimensional controls approaching  $10\mu\text{m}$  this alone is not sufficient to meet requirements for optoelectronic modules. Recently, our approach has focused on the integration of low cost piezoelectric actuators in on-board LTCC alignment structures for either active or passive optical fiber alignment.

## Typical LTCC Process Diagram



## LTCC Packaging/ Integration

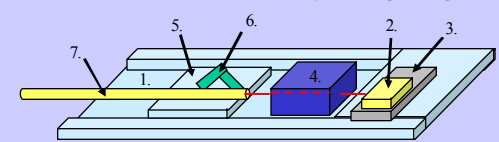
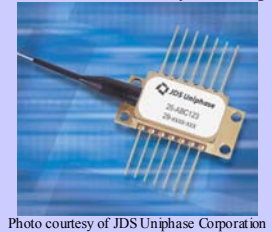
LTCC Capabilities/Advantages:

- Low Sintering Temperature ( $850-875^\circ\text{C}$ )
- Compatible with High Conductivity Metallization
- Good Thermal Conductivity
- Three Dimensional Structures Possible
- Integration of Both Active and Passive Elements

Proposed LTCC Optical Sub Assembly:

1. LTCC Substrate
2. Laser Diode
3. Thermoelectric Cooler
4. Optical Modulator Crystal
5. LTCC MEMS Stage
6. Piezoelectric Motor
7. Optical Fiber

Commercial "Butterfly" Package



## Bending Piezoelectric Elements

LTCC-Piezo Structures

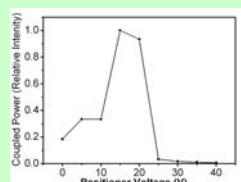
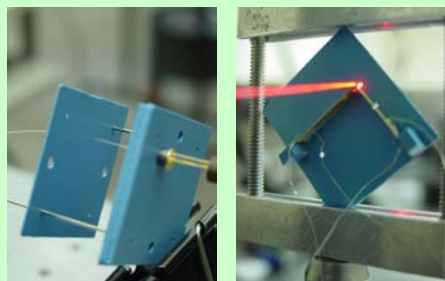
- LTCC Tolerances
  - $\pm 10\mu\text{m}$
- Piezo-unimorph Alignment
  - Goal:  $<1\mu\text{m}$

FEM Model PZT/Brass Unimorph



Coupled Power Experiment:

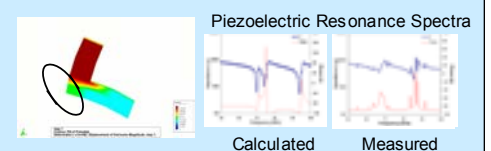
- Manually Coupled VCSEL Laser Output to Bare Fiber
- Varied Unimorph Drive Voltage
- Recorded Coupled Power



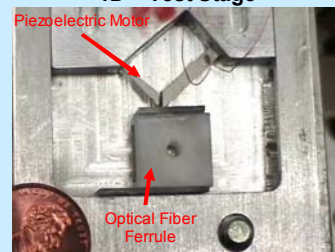
## Piezoelectric Ultrasonic Motors

Operational Principle

- Excitation of an Ultrasonic Wave
- Creates Elliptical Motion of Surface Particles on Driver Surface
- Frictional Coupling to Rotor or Slider Mechanism by Grip and Slip Cycle



1D - Test Stage



Prototype LTCC MEMS Module

