

High-Density Integration of Photonic Devices on InP Chip

Phosistor Technologies Inc.

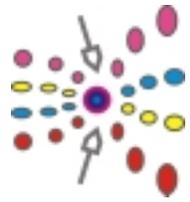
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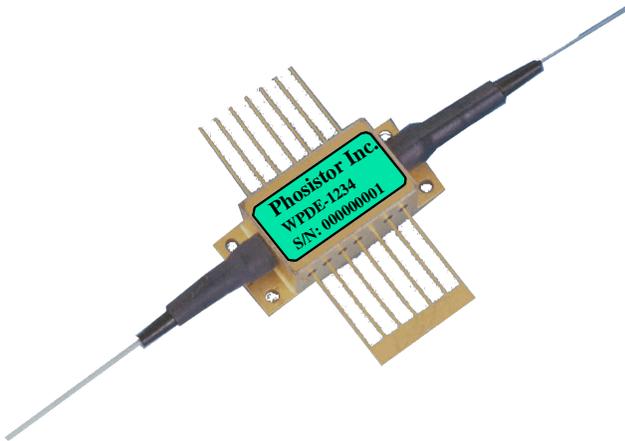
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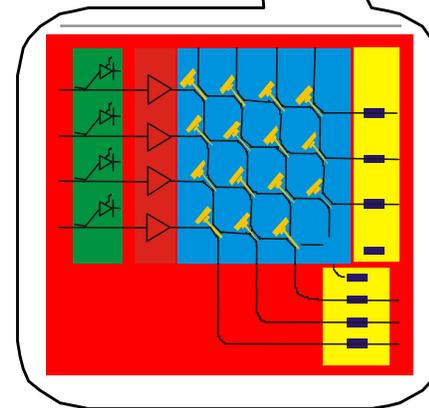
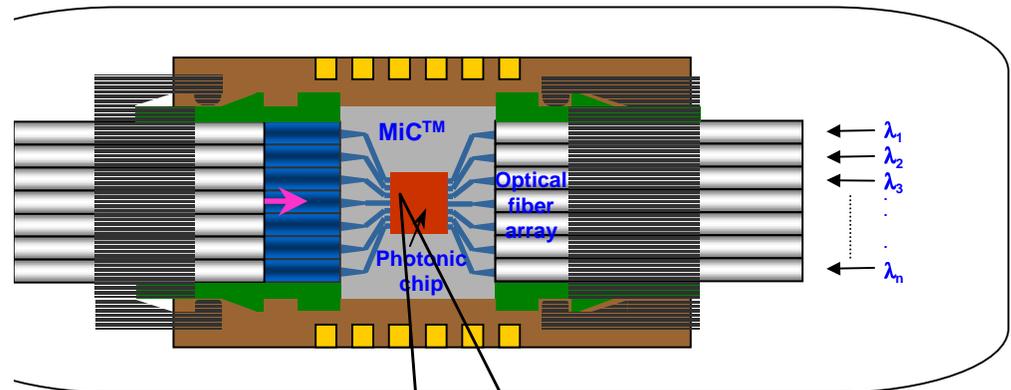


Phosistor's Subsystem on a Chip

Solutions for photonic subsystems on a chip Integrated Module

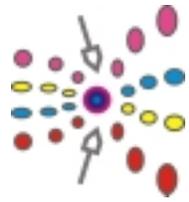


Full integration from
Chip to Module



Integrated
Chip

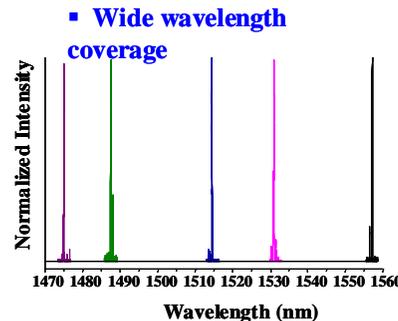
Phosistor's Integrated Chip & Module Platform



- **Phosistor InP Integrated Chip Technology involves Proprietary Advanced Bandgap Engineering Integration Process without Regrowth**

Phosistor's: Fewer Process Steps,
High Manufacturability, Higher Density

Current Photonic Chips: Complex Process, Low Yields,
Low Component Density

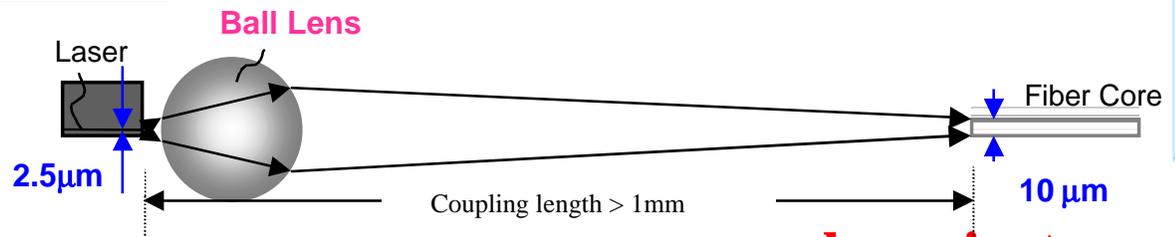
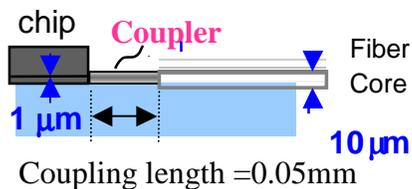


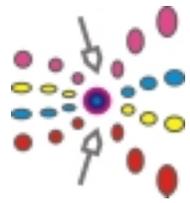
Laser Waveguide

- **Phosistor's Integrated Packaging Technology involves Proprietary Superlens that is 1/20 the Size & Capable of Complete Automation**

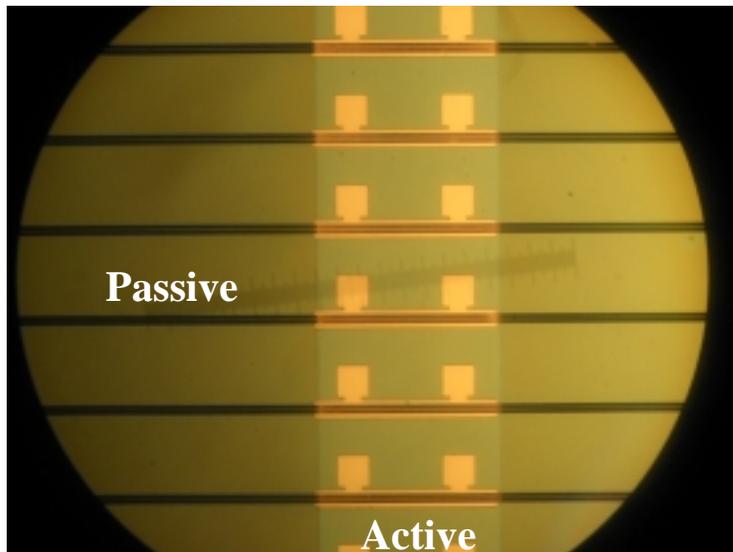
Phosistor's: Small, Automation,
Multiports, High Coupling, Low Costs

Current Photonics Packaging: Large, Manual, Inefficient, Costly

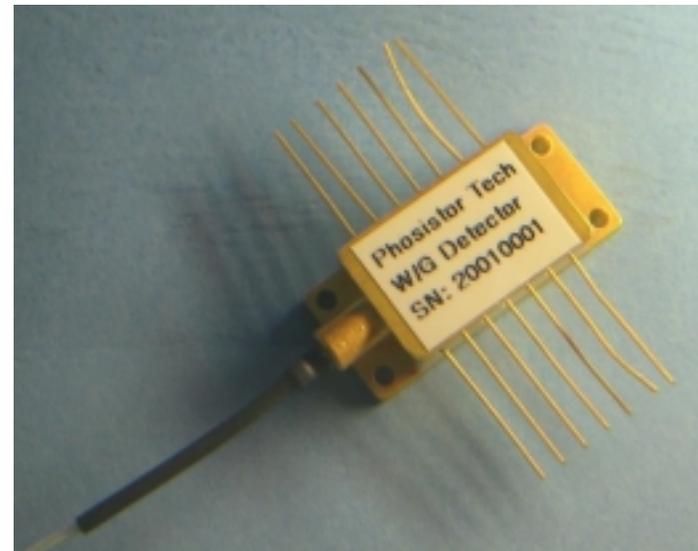




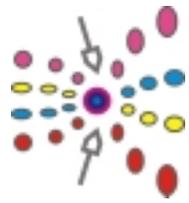
Passive Active Device Integration



2-Section Device Chip



Packaged Device

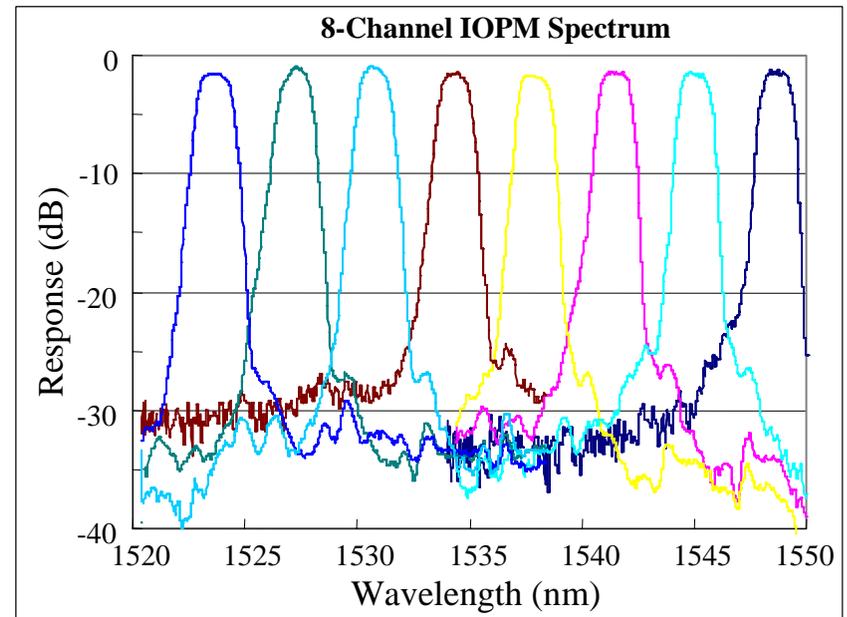


Phosistor's High Density WDM Chip: Smallest Mux/Demux & Optical Spectrometer

Integrated Optical Detectors
+ Wavelength Demux

- This is currently the smallest “Optical Spectrometer” densely integrated with 40 Photodetectors on single InP chip
- Phosistor has developed the smallest Mux/Demux enabling 10X size reduction

Smallest Optical Spectrometer



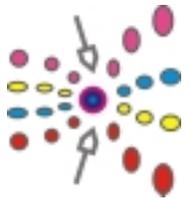
Size of Ours



Size of AWG



phosistor



Optical Devices on a Chip

■ Power Requirement

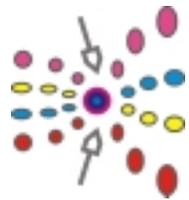
- Practical nonlinear devices must operate with low power
- The use of nanoscale-waveguide will drastically reduce power (for the same intensity)

■ Speed Requirement

- The device must operate at 100psec or faster, Can be achieved with semiconductor nonlinearities

■ Size Requirement

- The use of nanophotonic device concept will reduce the device size

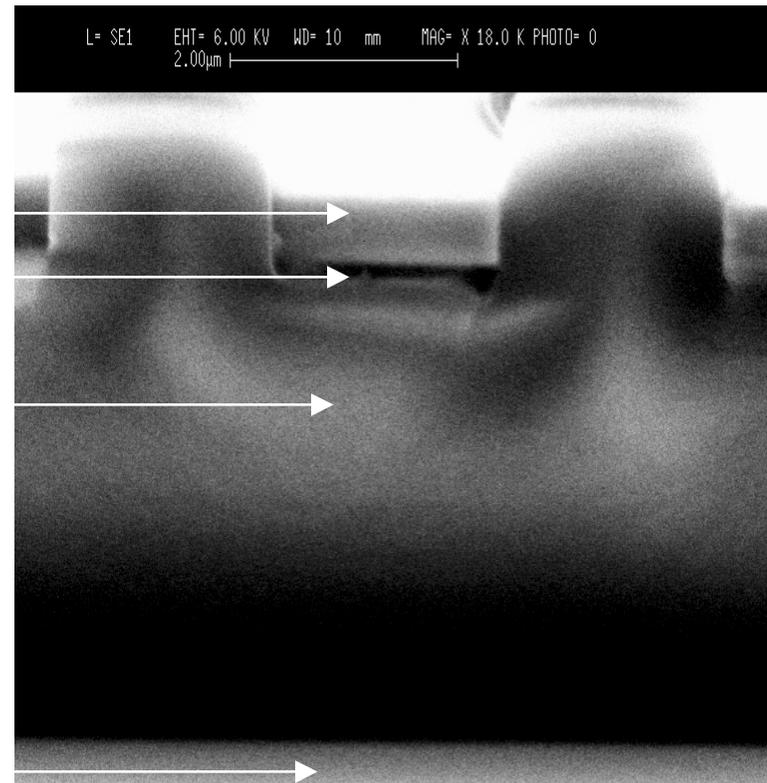


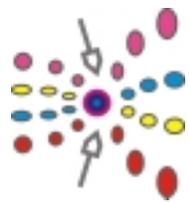
SEM Micrograph of Cross Section

**0.4 μm InGaAsP
SiO₂**

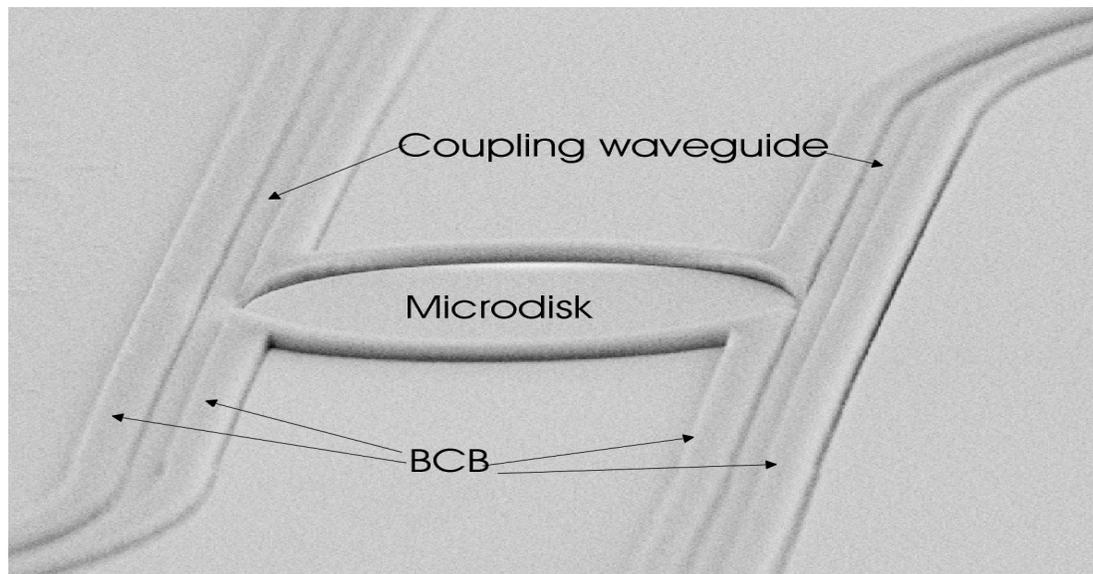
4.0 μm BCB

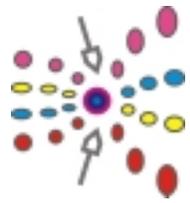
GaAs Substrate





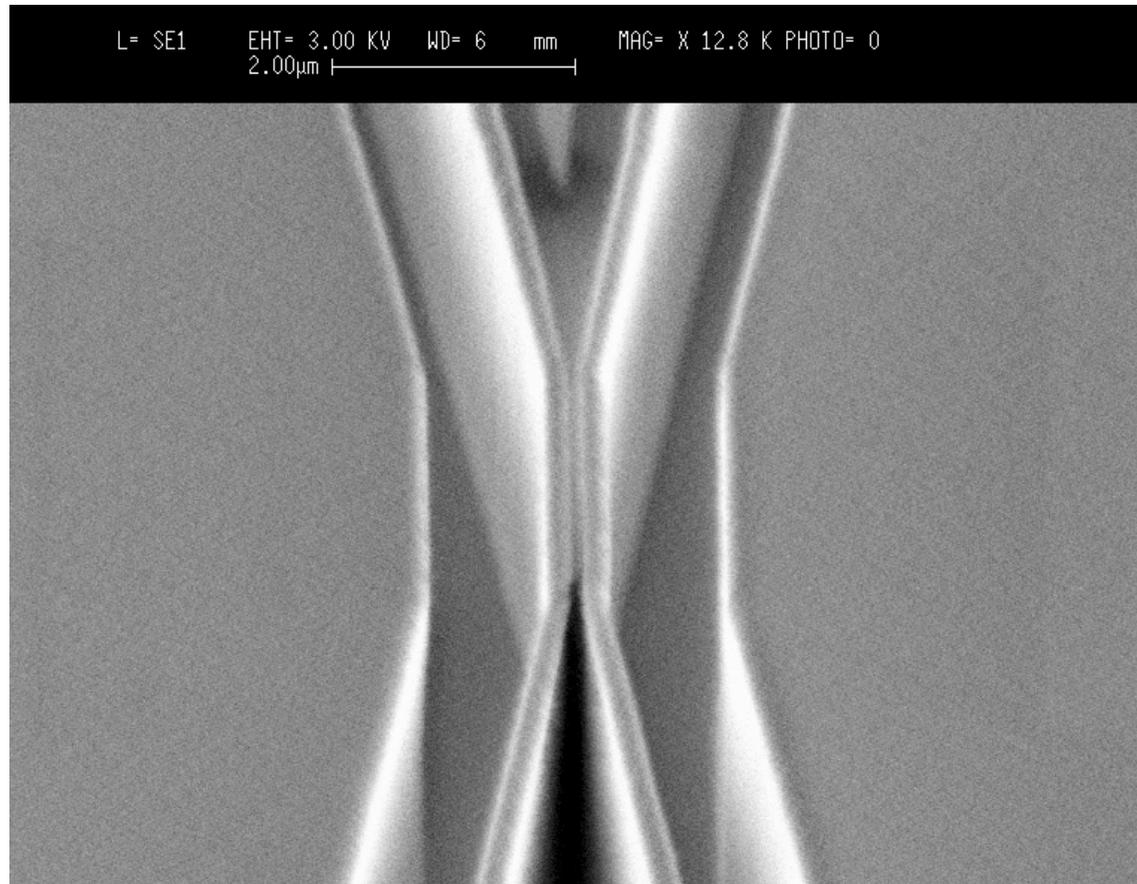
A BCB bonded InGaAsP/InP microdisk



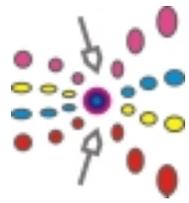


Smallest Coupler—Only 2 Microns

Ultra-compact Directional Couplers



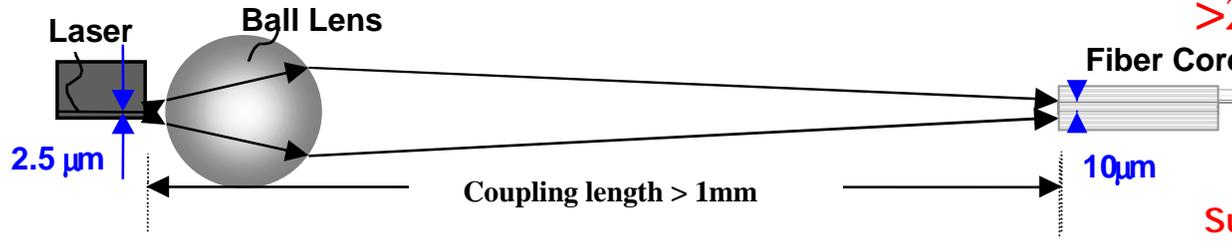
$w = 0.2 \mu\text{m}$, $g = 0.1 \mu\text{m}$, $L = 2 \mu\text{m}$.



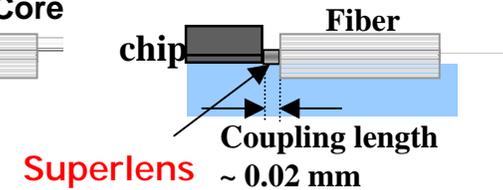
Phosistor's Superlens

Enabling Coupling to Submicron Waveguide

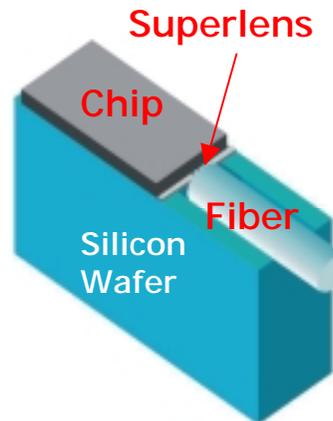
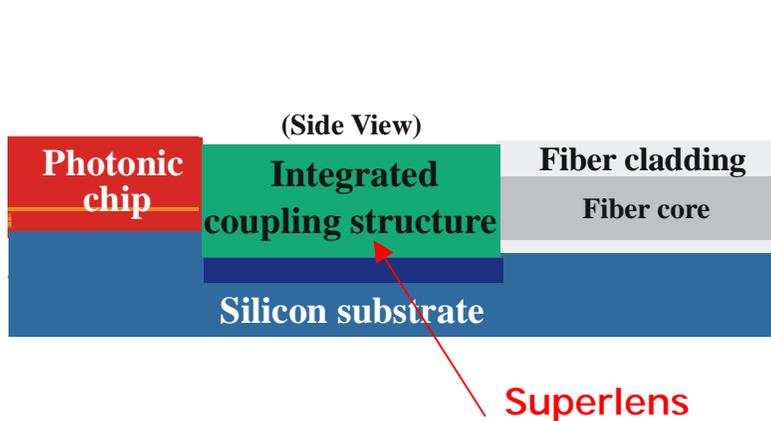
Current Ball Lens Approach



Phosistor's superlens
>20X smaller



Phosistor Integrated Coupling Optics Approach



3D View

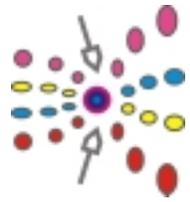
The Smallest and Most Powerful Precision Lens

3X more focusing to Submicron, >20X smaller

Planar silicon surface reference--passive align

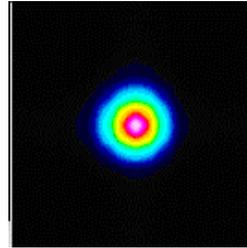
Amenable to complete automation

Matched Spot Size, High Coupling & Low-Cost Wafer-Level Fabrication



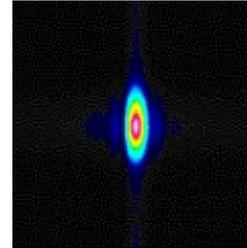
Single Mode Fiber

(spot size: $\sim 10 \mu\text{m}$ by $10 \mu\text{m}$)



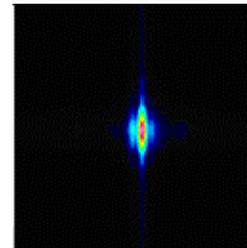
Wedged Fiber

(spot size: $\sim 4 \mu\text{m}$ by $10 \mu\text{m}$)



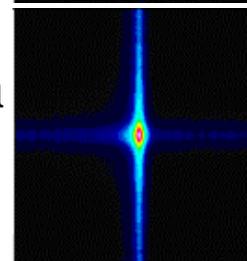
Phosistor's Superlens

(spot size: $\sim 0.9 \mu\text{m}$ by $4 \mu\text{m}$)

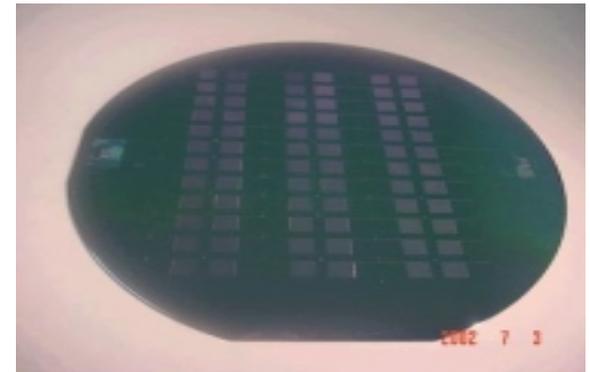


Laser Diode Mode to Match

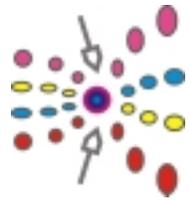
(mode size: $\sim 1 \mu\text{m}$ by $3.5 \mu\text{m}$)



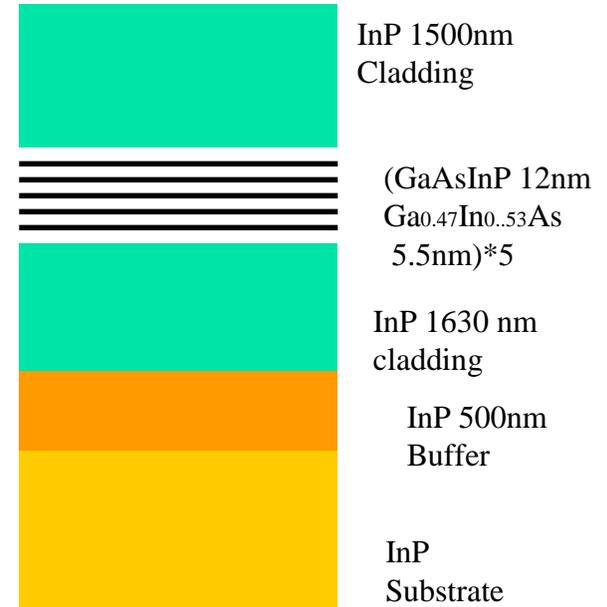
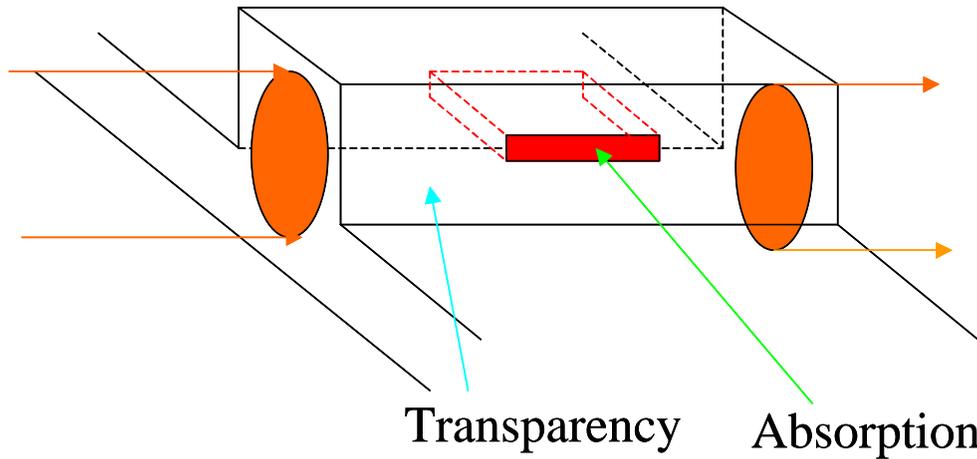
- Significantly higher power into fiber (10%-20% more)
- Better beam matching and manufacturing consistency



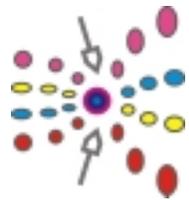
Nonlinear Waveguide



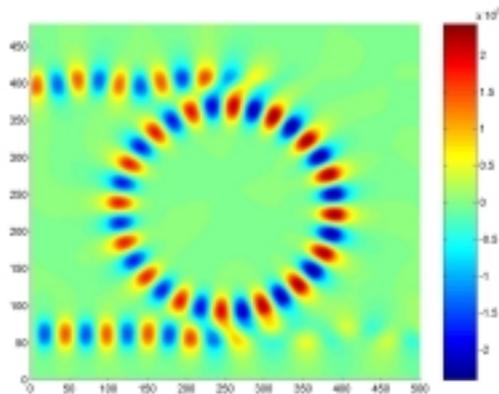
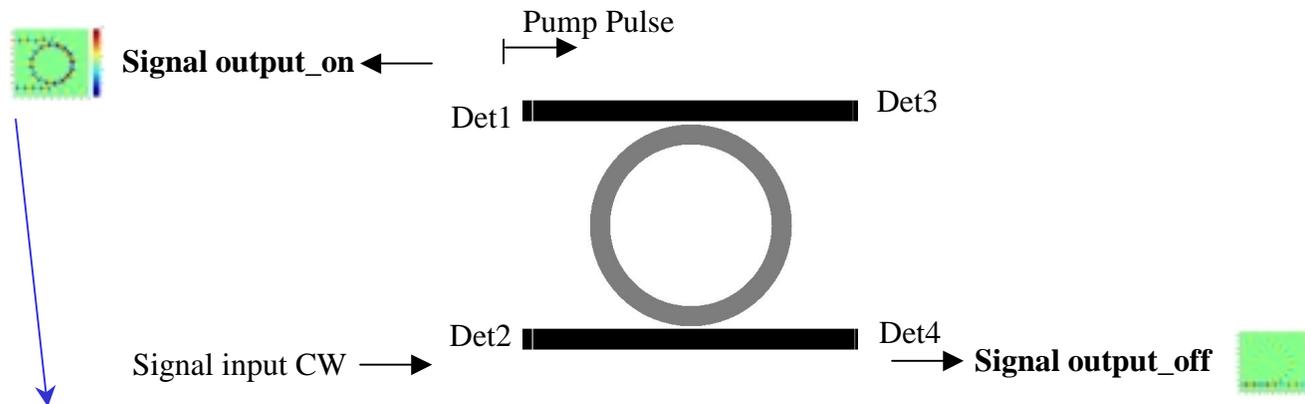
Nonlinear Semiconductor Waveguide



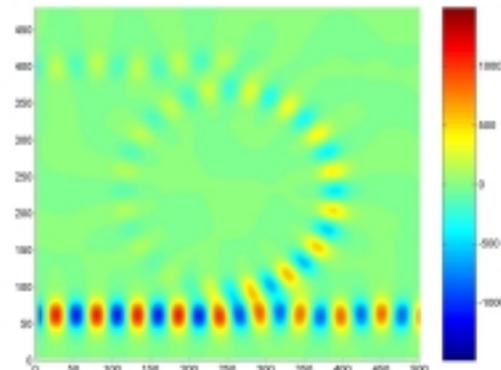
Transparency wave-guide contains the absorption quantum well



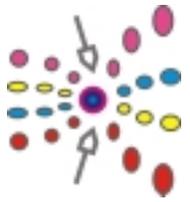
Modeling of Nonlinear Phenomena



**Absorptive ring with $a=0.13/\mu\text{m}$
Pump off**



**Transparent ring
Pump on**



Summary

- **Phosistor has developed high-density integrated InP photonic chips with currently the smallest on-chip WDM Mux/Demux**
- **Phosistor has developed the smallest precision coupling lens enabling efficient chip-to-fiber coupling and submicron focused spot size.**
- **Practical nonlinear devices and photonic circuits with high integration density are within reach of current technologies**