



High Capacity
Optoelectronic
Interconnects

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Polymer-Based Si CMOS Process-Compatible Guided-wave Optical Interconnects

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The University of Texas at Austin**

11/09/2000

R. Chen



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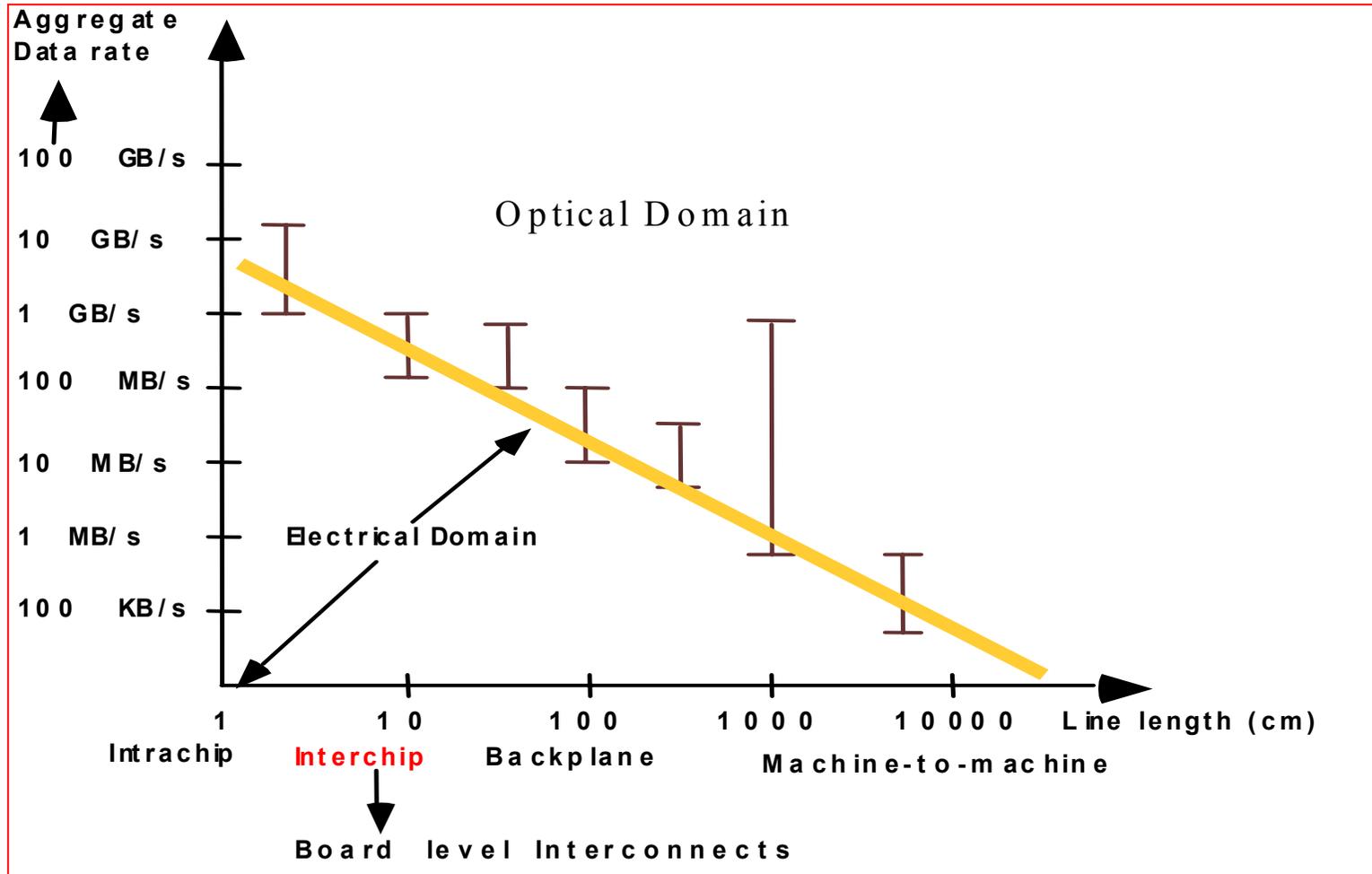


Program Objectives

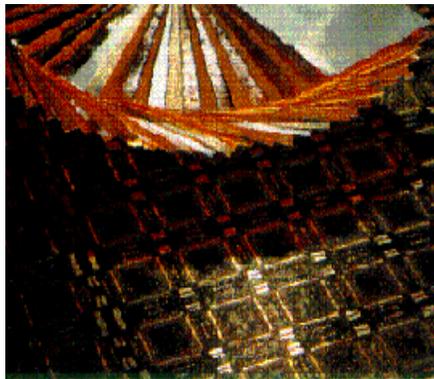
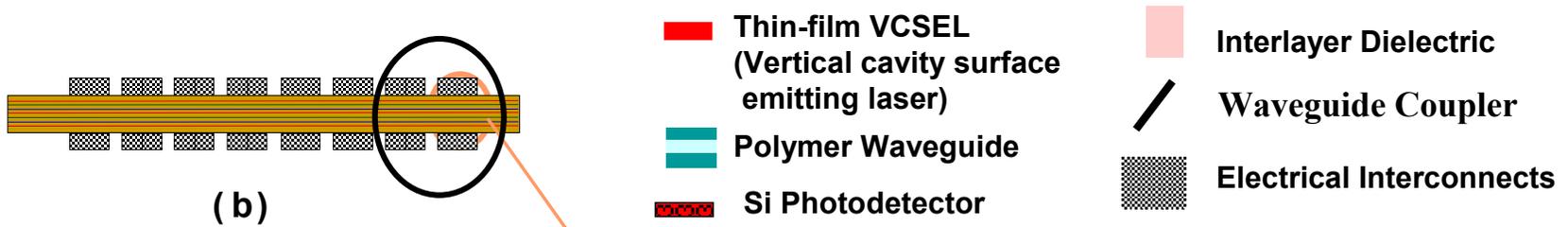
To develop a fully embedded Si-CMOS process-compatible polymeric waveguide based optical interconnects technology where transmitting and receiving functions will be incorporated within the embedded interconnection layers of 3-D integrated multilayer boards and ASICs.

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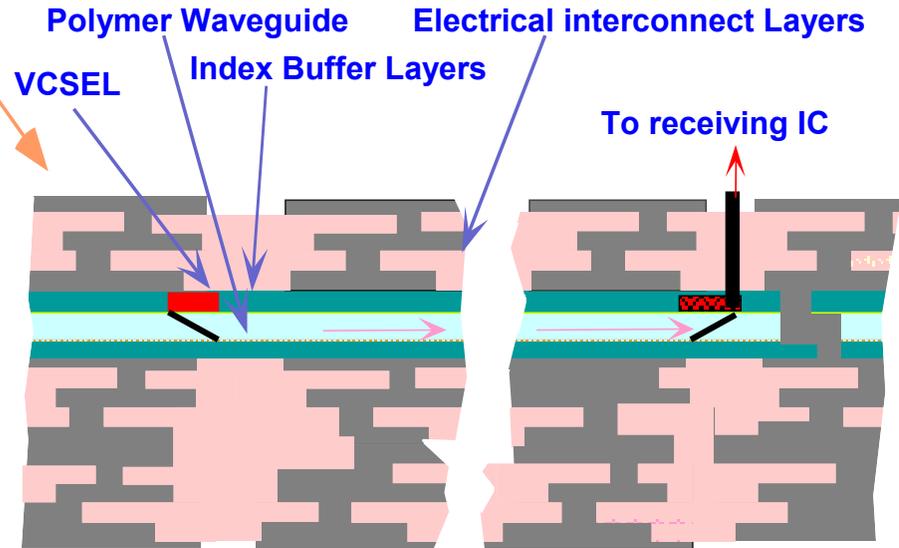
Data rates as a function of interconnection length



Schematic of Imbedded Optoelectronic Interconnects

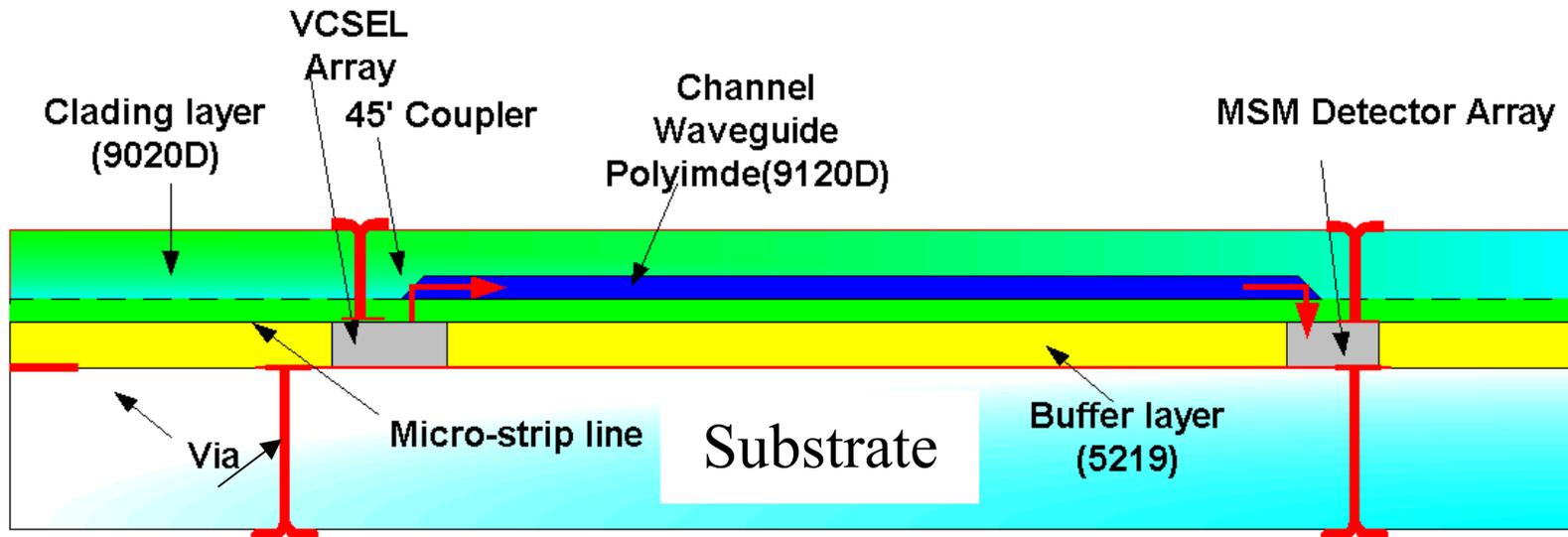


(a)



Section of Electrical/Optical Interconnects on a multilayer Board

Transmitter and Receiver Function in an Embedded Optical Interconnect



Technical Issues:

- Integration of VCSELs and photodetectors
- Planarization while maintaining optical properties
- Packaging

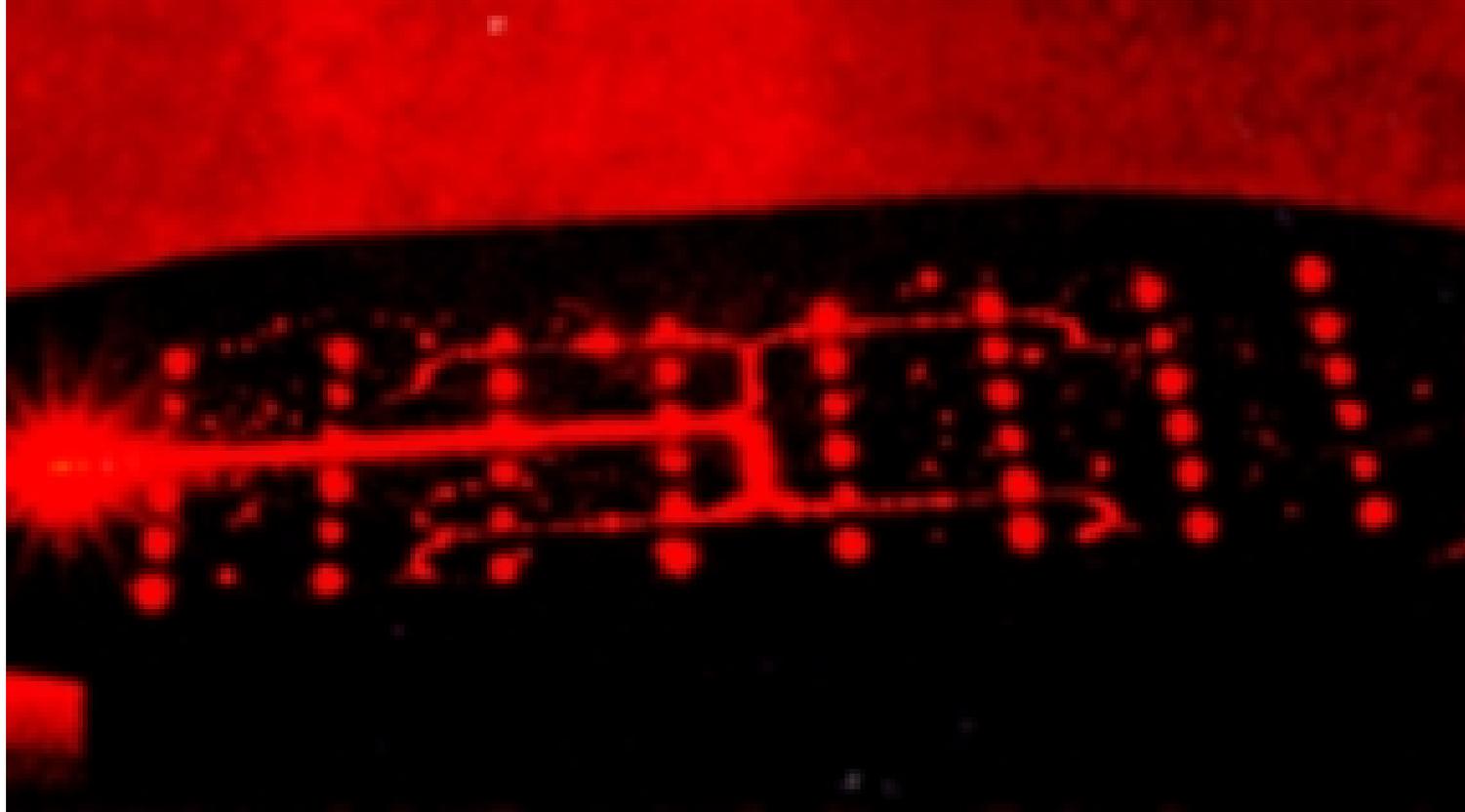


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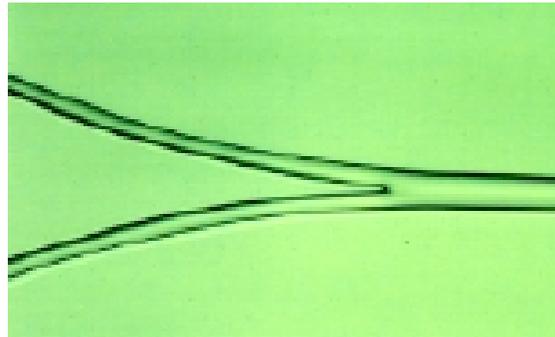
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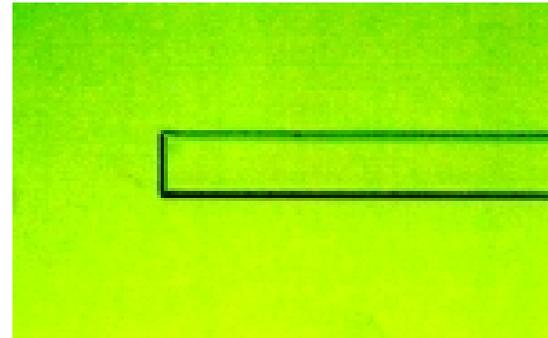
Polyimide Based 1-to-48 Fanout H-tree Optical Waveguide on Si-substrate



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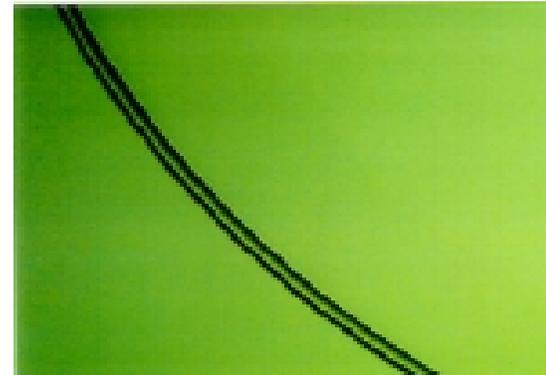
(a)



(b)



(c)



(d)

Components of a polyimide waveguide structure under microscope
(a) splitter, (b) end branch, (c) and (d) show the tapered and curved waveguides.

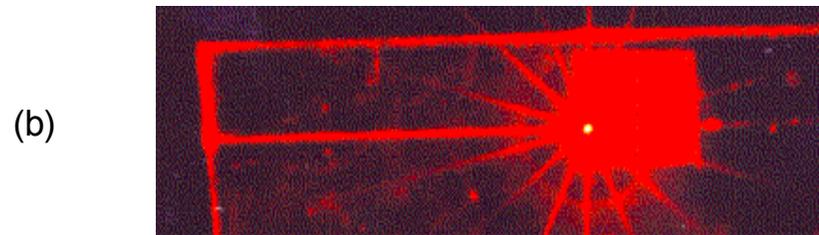
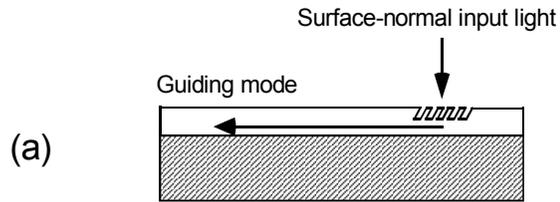


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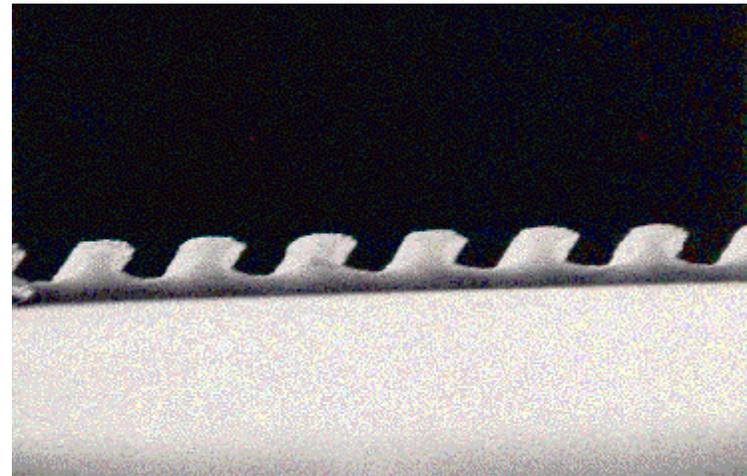
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Polymer Based Tilted-Profile Waveguide Grating Coupler



632.8 nm light coupled into
planer waveguide



SEM micrograph of tilted gratings

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Waveguide Micro-mirror Coupler

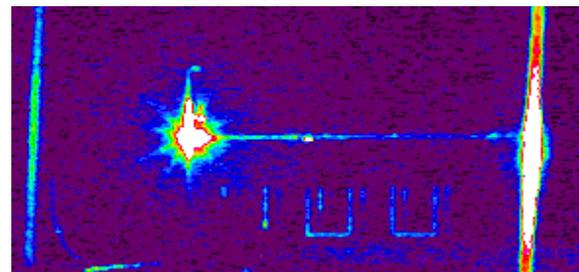
45-degree
micro-coupler



Waveguide

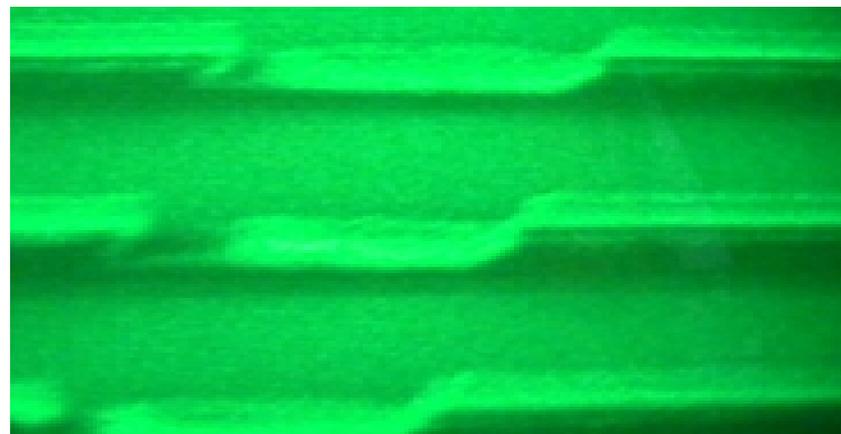
Substrate 10um

SEM micrograph of
mirror-coupler



632.8 nm light coupled into planer
waveguide through micro-coupler

Channel Waveguides with
Micro-mirror couplers



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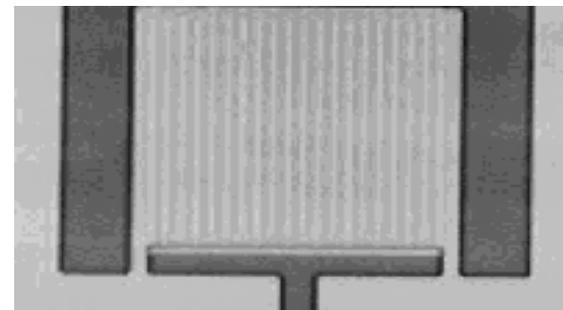
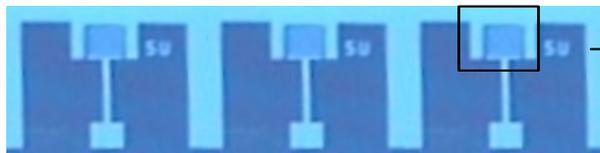
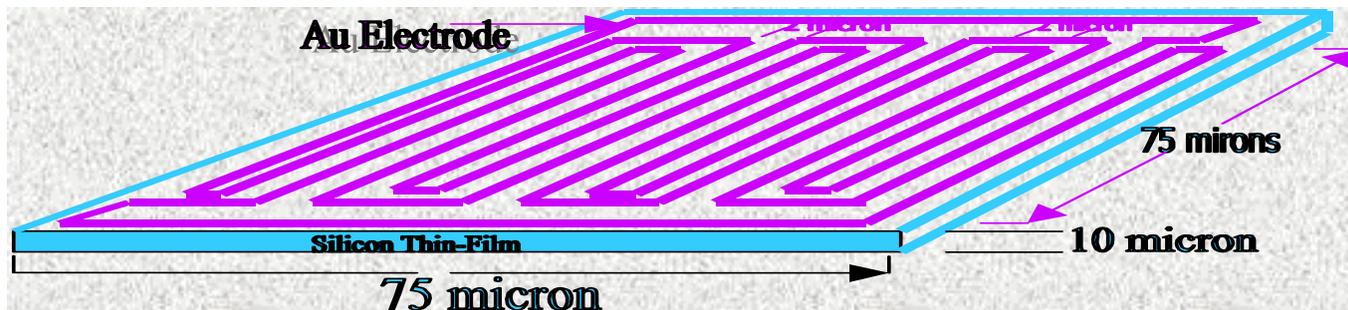


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Si and GaAs MSM Photodetector for thin-film integration



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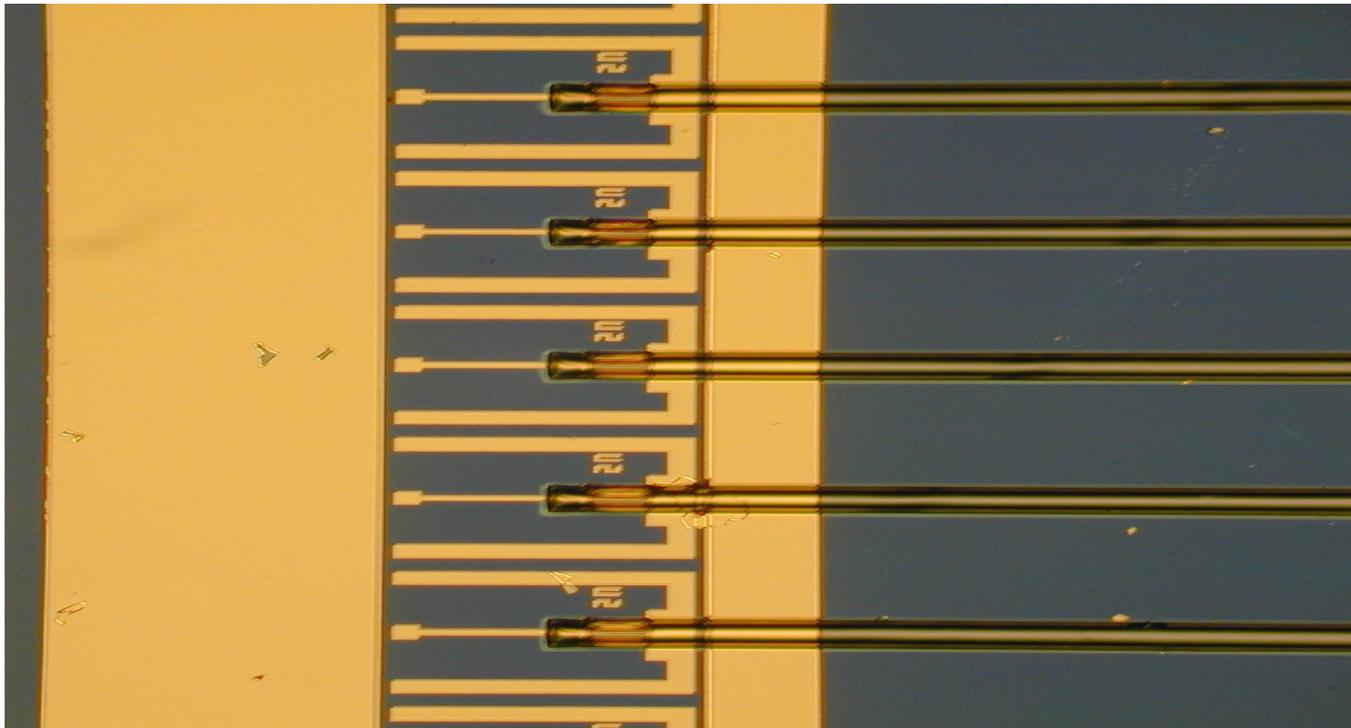


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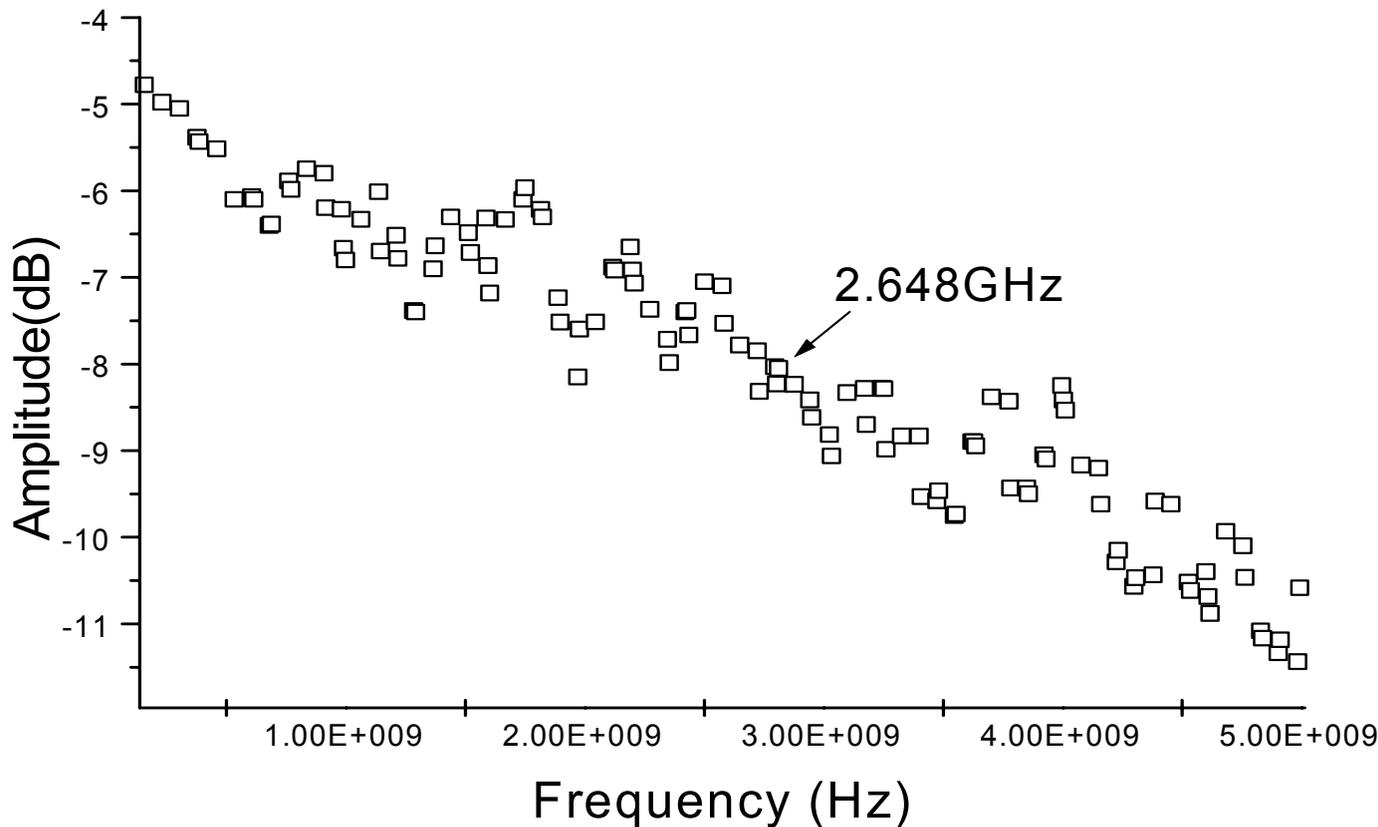
Polymer channel waveguide array aligned with MSM photodetector array



R. Chen



The frequency response of integrated GaAs MSM photo-detector and polyimide waveguide with 45° TIR mirror





VCSEL Epi-Layer Structure

Layer	Al(x)GaAs Fraction [x]	Optical Thickness	Physical Thickness [μm]	Dopant	Doping Level [cm ⁻³]	Type	Comments
GaAs	0.00		625.0000			n+	Substrate
AlGaAs	0.90		0.0400	Si	1-3E18	n	Sacrificial Layer
GaAs	0.00		0.0500	Si	1-3E18	n	Buffer
AlGaAs	grade		0.0100	Si	1-3E18	n	1/2 n-DBR
AlGaAs	0.90	λ/4		Si	1-3E18	n	
AlGaAs	grade		0.0100	Si	1-3E18	n	
AlGaAs	0.15	λ/4		Si	1-3E18	n	n-DBR
AlGaAs	grade		0.0100	Si	1-3E18	n	32x
AlGaAs	0.90	λ/4		Si	1-3E18	n	
AlGaAs	0.60		0.0920	-	-	nid	Spacer
AlGaAs	0.30		0.0100	-	-	nid	Barrier
GaAs	0.00		0.0070	-	-	nid	Quantum well
AlGaAs	0.30		0.0100	-	-	nid	Barrier
GaAs	0.00	4 λ/4	0.0070	-	-	nid	Quantum well
AlGaAs	0.30		0.0100	-	-	nid	Barrier
GaAs	0.00		0.0070	-	-	nid	Quantum well
AlGaAs	0.30		0.0100	-	-	nid	Barrier
AlGaAs	0.60		0.0920	-	-	nid	Spacer
AlGaAs	grade		0.0100	C	3-5E18	p	
AlGaAs	0.90	λ/4		C	3-5E18	p	
AlGaAs	0.98		0.0200	C	3-5E18	p	p-DBR
AlGaAs	0.98		0.0200	C	3-5E18	p	
AlGaAs	grade		0.0180	C	3-5E18	p	
AlGaAs	0.15	λ/4		C	3-5E18	p	
AlGaAs	grade		0.0090	C	3-5E18	p	
AlGaAs	grade		0.0090	C	3-5E18	p	
AlGaAs	0.90	λ/4		C	3-5E18	p	
AlGaAs	grade		0.0090	C	3-5E18	p	p-DBR
AlGaAs	grade		0.0090	C	3-5E18	p	21x
AlGaAs	0.15	λ/4		C	3-5E18	p	
AlGaAs	grade		0.0090	C	3-5E18	p	
AlGaAs	grade		0.0090	C	3-5E18	p	
AlGaAs	0.90	λ/4		C	3-5E18	p	
AlGaAs	grade		0.0090	C	3-5E18	p	p-DBR
AlGaAs	grade		0.0090	C	3-5E18	p	
AlGaAs	0.15	λ/4		C	3-5E18	p	
GaAs	0.00		0.0200	Zn	>5.0E19	p+	Cap Layer

3-QW Structure

Bottom DBR: 32.5 pairs

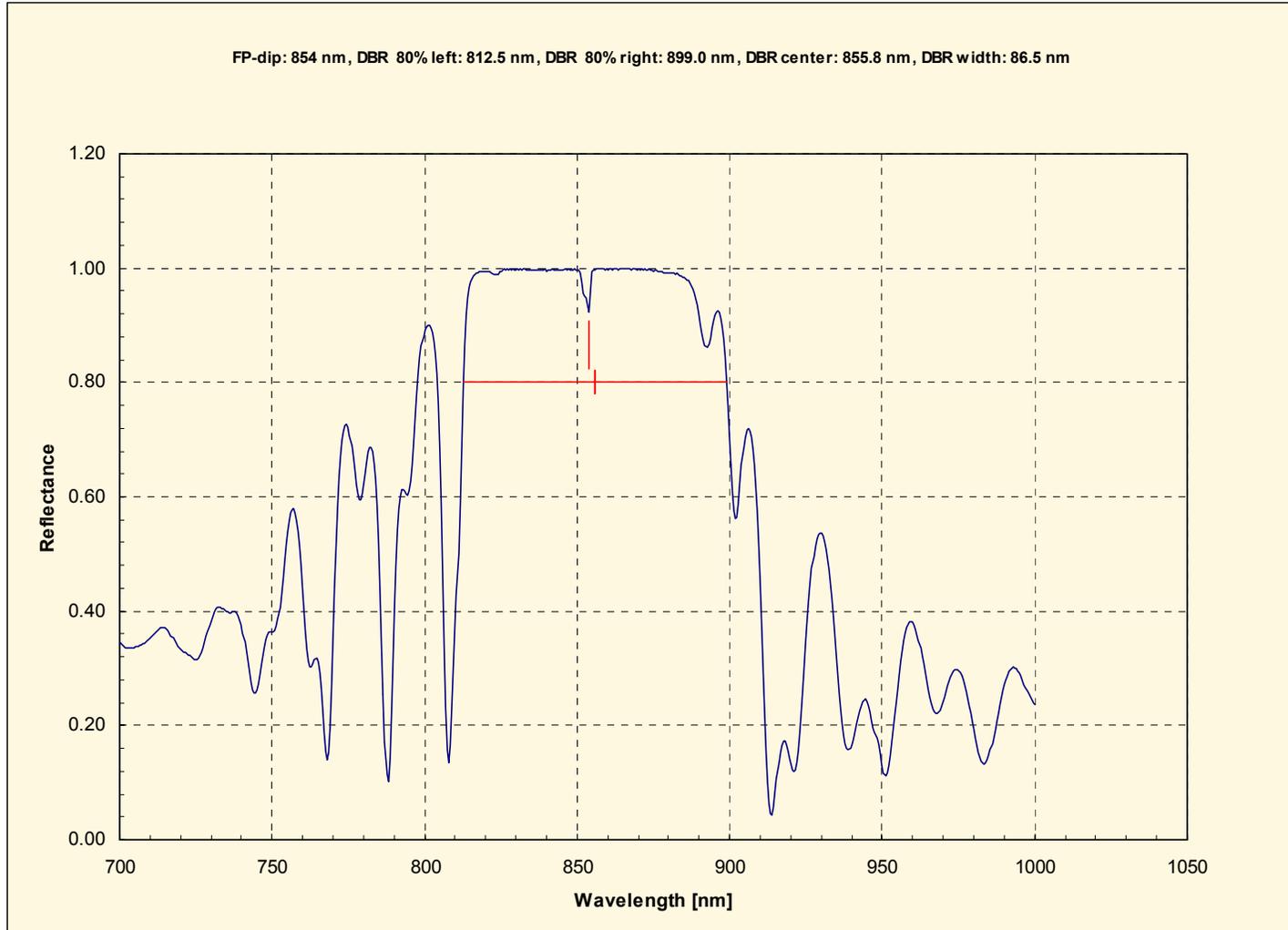
Top DBR: 21 pairs

GaAs(Sub)/Al_{0.9}GaAs(40nm)/GaAs(50nm)/n-DBR/3-QW/p-DBR/Cap

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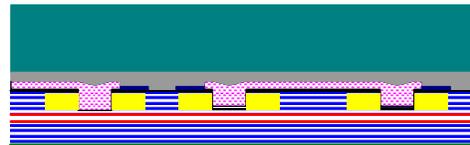
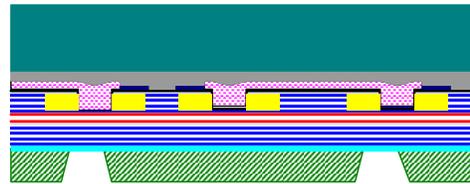
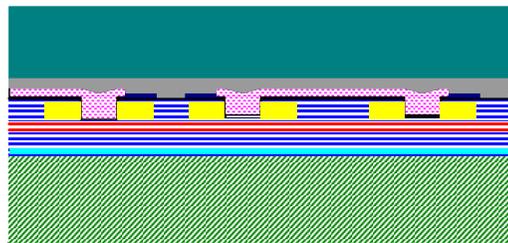
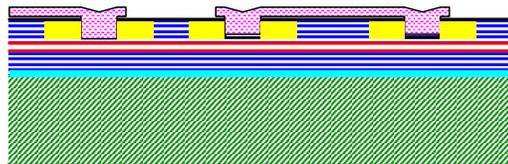
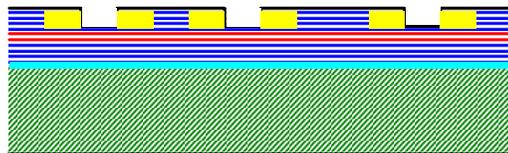


DBR Reflectance



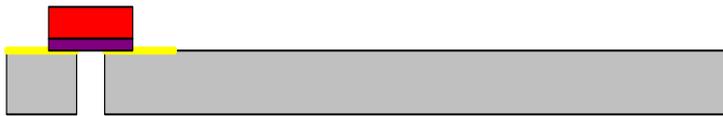
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VCSEL Thin Film Lift-off Process





Integration on PWB



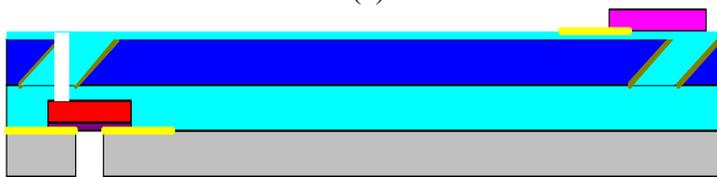
(a)



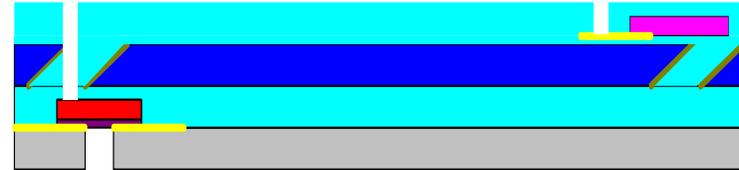
(b)



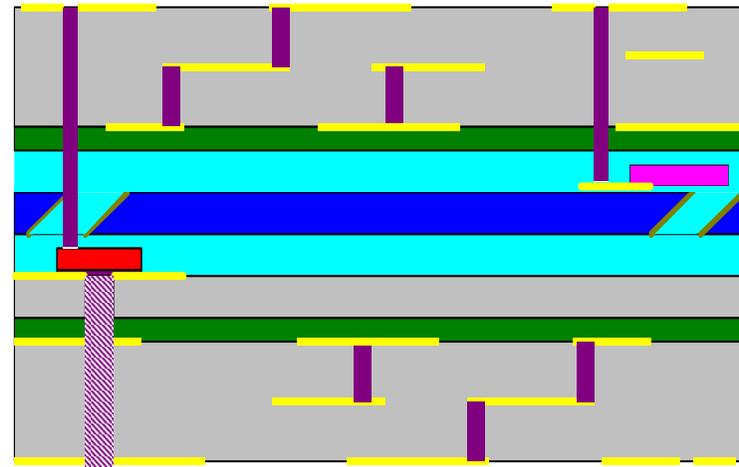
(c)



(d)



(e)



(f)

