

Scientific presentation topics/dates:

14/03 Zemmy	28/03 Adir	4/04 Pavel	11/04 Yakov	2/05 Daler	16/05 Aviad	23/05 Ted/Adir	30/05 Pavel	6/06 Yakov
13/06 Daler	20/06 Zemmy	27/6 Ted						

## 1. Modelling and design approaches- **Adir/Zemmy**

1.1 Optical waveguide mode solver

1.2 Wave propagation

1.2.1 FDTD

1.2.2 Beam Propagation Method (BPM)

1.2.3 Eigenmode Expansion Method (EME)

1.2.4 Coupled Mode Theory (CMT)

1.2.4.1 Expansion in Terms of Ideal Modes

1.2.4.2 Expansion in Terms of Local Normal Modes

1.2.4.3 Perturbation Solution of the Coupled Amplitude Equations

1.2.4.4 Coupling Coefficients for the Asymmetric Slab Waveguide

1.2.4.5 Coupling Coefficients for the Optical Fiber

1.2.4.6 Applications of the Coupled Mode Theory

1.2.5 Transfer Matrix Method (TMM)

1.2.6 The effective Index Method

## 2. Optical coupling to Silicon Photonic chips - **Daler**

2.1 The challenge

2.2 Directional couplers theory

2.3 Theory of Grating coupler and grating assisted directional couplers

2.4 Forward Grating Coupler

2.5 Grating-Assisted Backward Couplers

2.6 Mode overlap calculations

2.7 Coupled power theory

2.7.1 Derivation of Coupled Power Equations

2.7.2 Power Fluctuations

2.7.3 Pulse Propagation in Multimode Waveguides

2.7.4 Diffusion Theory of Coupled Modes

2.7.5 Power Coupling between Waves Traveling in Opposite Directions

2.8 Phase dependence

2.9 End-firing

## 3. Lasers - **Daler**

3.1 Fundamentals of lasing on a chip - Theory

3.2 Fabrication of on-chip lasers

3.3 Hybrid silicon waveguides base lasers

3.4 Monolithic lasers 1) III-V epitaxial growth; and 2) Germanium lasers

3.5 Alternative light sources: principle of operation

- 3.6 Laser modeling
- 3.7 Supercontinuum generation
- 3.8 Solitons

#### **4. Modulators – Aviad**

- 4.1 Theory of Silicon Photonics modulators
- 4.2 Electro-absorption
- 4.3 Electro-refraction
- 4.4 Modulator speed limitations
- 4.5 Energy/Power consumption
- 4.6 Modulation efficiency
- 4.7 Insertion loss
- 4.8 Phase modulation
- 4.9 Applications: Interferometers, ring resonators, MZI
- 4.10 Modulation based on carrier depletion, carrier injection

#### **5. Nonlinear effects in silicon- Adir**

- 5.1 Non-linear Schrödinger equation
- 5.2 Linear and Nonlinear polarization
- 5.3 Second Harmonic Generation in silicon
- 5.4 Electrooptic effect in silicon
- 5.5 Origin of Nonlinear effects in silicon
  - 5.5.1 Third-order nonlinear susceptibility  $\chi^{(3)}$
  - 5.5.2 Two-photon absorption
- 5.6 Major nonlinear effects
  - 5.6.1 Self-phase modulation
  - 5.6.2 Cross-phase modulation
  - 5.6.3 Four-Wave mixing
  - 5.6.4 Stimulated Brillouin Scattering
  - 5.6.5 Stimulated Raman Scattering

#### **6. Silicon Photonics Detectors - Pavel**

- 6.1 Theory and principle of operation
- 6.2 Responsivity
- 6.3 Bandwidth
- 6.4 Fabrication
- 6.5 Types of detectors
- 6.6 Photoconductive detector
- 6.7 PIN detector
- 6.8 Avalanche detector
- 6.9 Design considerations
  - 6.9.1 PIN junction orientation
  - 6.9.2 Detector geometry
  - 6.9.3 Detector length
  - 6.9.4 Detector width
  - 6.9.5 Detector height

## **7. Testing and packaging- Pavel**

7.1 Electrical and optical interfacing

7.2 Optical interfaces

7.2.1 Grating couplers

7.2.2 Edge couplers

7.2.3 Individual fibres

7.2.4 Spot-size converter

7.2.5 Fibre array

7.2.6 Free-space coupling

7.2.7 Fibre taper coupling

7.3 Electrical interfaces

7.3.1 Bond pads

7.3.2 Probing

7.3.3 Flip-chip bonding

## **8. Silicon photonic transmitter – Angeelene Ang**

8.1 Transmitter – theory and principle of operation

8.2 Wavelength division multiplexed transmitter

8.3 Ring-based WDM transmitter architectures

8.4 Common-bus WDM transmitter

8.5 Mod-Mux WDM transmitter

8.6 Electronic-Photonic designs

## **9. Silicon Photonic Amplifier Ted**

9.1 Theory of Raman Amplifiers

9.2 CW Raman Amplifiers

9.3 Pulsed Raman Amplifiers

9.4 Power combining

9.5 Amplifier Biasing

## **10. Silicon Photonic Switches - Angeelene Ang**

10.1 Theory and principle of operation

10.2 Switching elements

10.3 Phase tuning schemes

10.4 Broadband switching

10.5 Thermo-Optic switches

10.6 Crosstalk

10.7 Wafer-scale manufacturing

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