

Optoelectronics (광전자공학)

Lecture 1. Introduction

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<http://www.gist-foel.net>

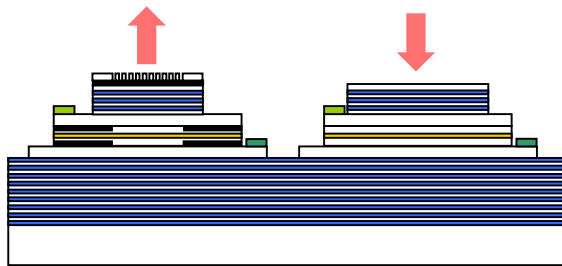
ymsong@gist.ac.kr, ymsong81@gmail.com

A207, ☎2655

Overview – Optoelectronic Devices

Optical interconnection

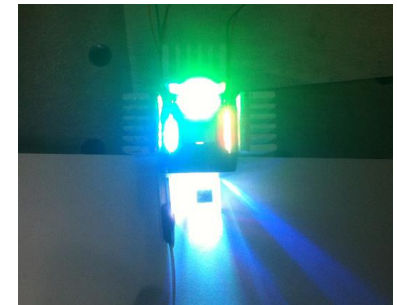
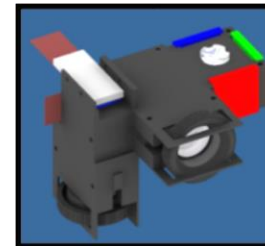
Laser Diodes, Photodetectors



Lightings, Projection displays

RGB Light Emitting Diodes

LEDs
+
LCoS



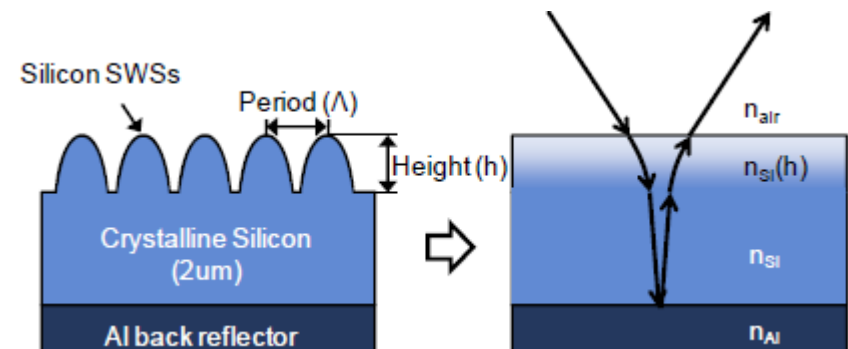
Modulators and others

Electro-absorption modulators,
RC-LEDs



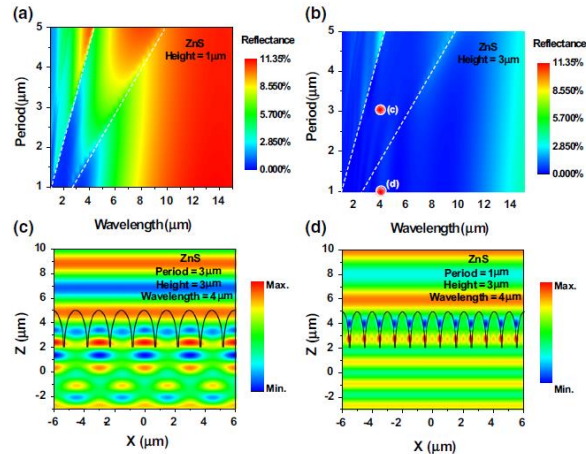
Photovoltaics

III-V solar cells, c-Si, a-Si, etc.

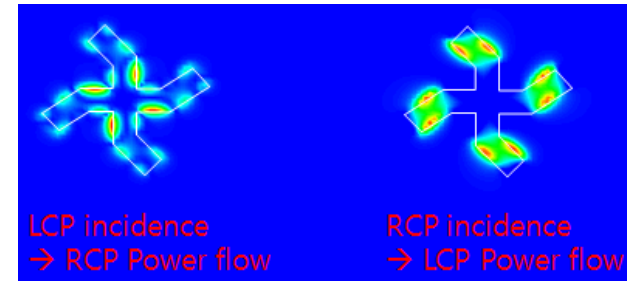


Overview - Optical simulations

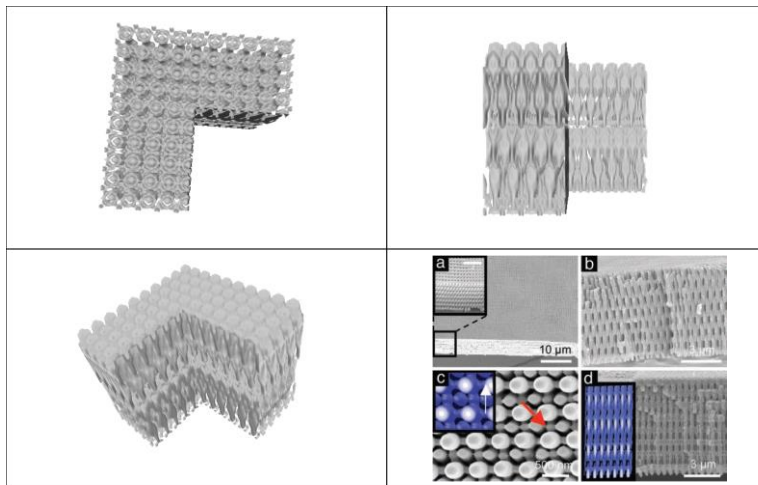
RCWA, periodic patterns, multi-layers



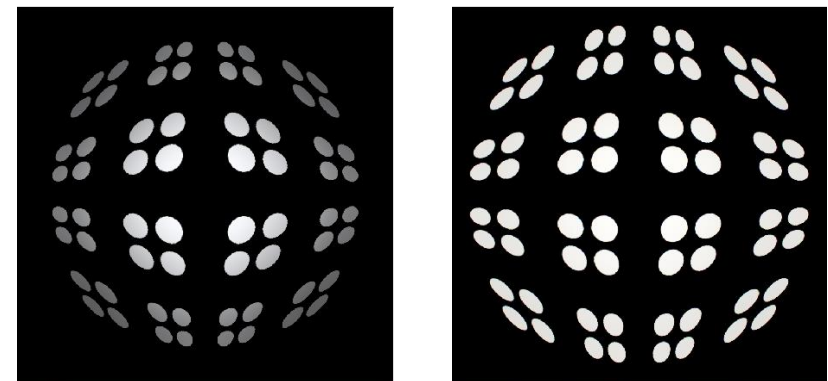
FDTD, plasmonics, metamaterials



3D e-field profile, Phase mask, 3D pattern construction



Ray optics, biomimetic designs



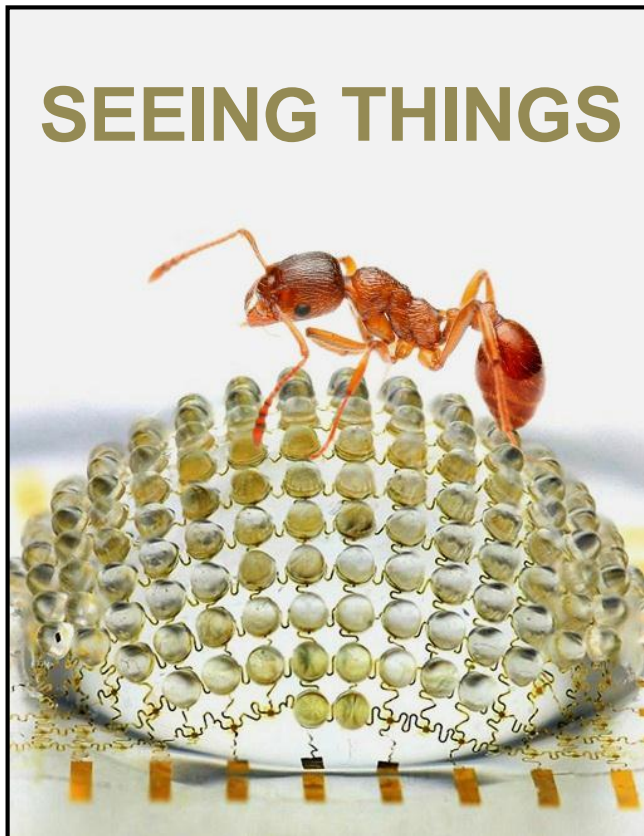
Spherical

Our design
(Three)

Overview – Flexible Devices

Insect's Eye Cameras

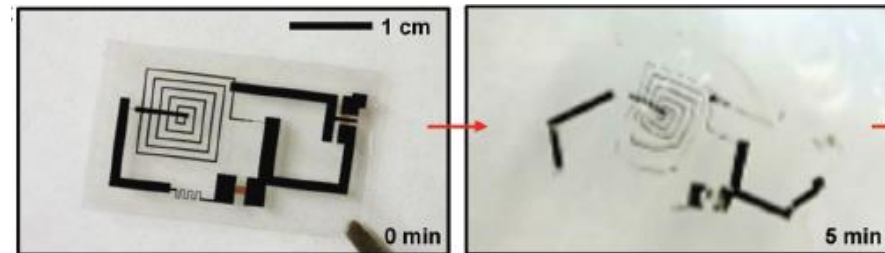
Stretchable optoelectronics



Nature **497**, 211 (2013)

Transient Electronics

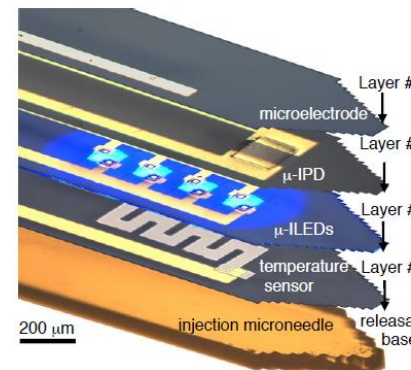
Bio-degradable optoelectronics



Science **337**, 1640 (2012)

Optogenetics

Injectable optoelectronics



Science **340**, 211 (2013)

Optoelectronics

Wikipedia

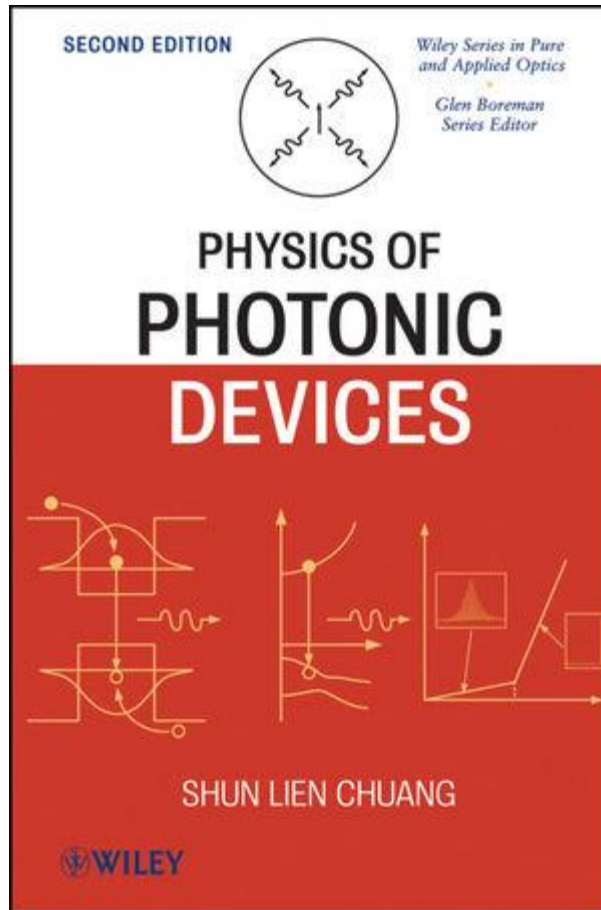
Optoelectronics is the study and application of [electronic](#) devices that source, detect and control [light](#), usually considered a sub-field of [photonics](#). In this context, *light* often includes invisible forms of radiation such as [gamma rays](#), [X-rays](#), [ultraviolet](#) and [infrared](#), in addition to visible light. Optoelectronic devices are electrical-to-optical or optical-to-electrical [transducers](#), or instruments that use such devices in their operation.

Examples – Semiconductor lasers, Light emitting diodes, Photodetectors, Solar Cells, Electro-Absorption modulators, Electro-Optic modulators, (Image sensors)

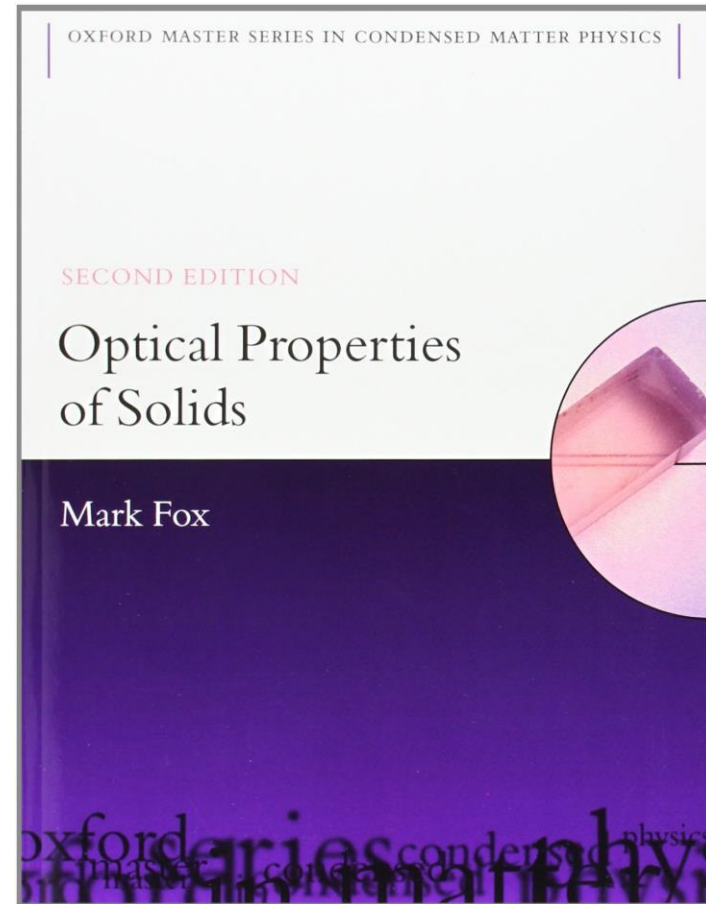
Optoelectronics is based on the [quantum mechanical](#) effects of [light](#) on electronic materials, especially [semiconductors](#), sometimes in the presence of [electric fields](#).

Prerequisites – Semiconductor Physics and Devices, Electromagnetics, Optics

Textbook and References



**Physics of Photonic Devices, Chuang,
Wiley, 2nd edition**



**Optical Properties of Solids, M. Fox,
Oxford, 2nd edition**

Additional reading

Solid State Electronic Devices, B. G. Streetman

Optoelectronics and Photonics, S. O. Kasap

Fundamentals of Photonics, B. A. E. Saleh

Selected research articles

Course Schedule

Weekly Course Schedule		
Calendar	Description	*Remarks
1st week	Overview	
2nd week	Fundamentals of EM waves, Optics	
3rd week	Fundamentals of EM waves, Optics	
4th week	Optical properties of solids	
5th week	Heterostructures	
6th week	Optical process in semiconductors	
7th week	Optical process in semiconductors	
8th week	Mid-term Exam	
9th week	Laser diodes	
10th week	Light emitting diodes	
11th week	Photodiodes, Solar Cells	
12th week	Optical modulators	
13th week	Flexible Optoelectronics Technology	
14th week	Student presentation	Term Project
15th week	Student presentation	Term Project
16th week	Final Exam	

Assessment and grading

Home work (10%)

Midterm (30%)

Student presentation/report (30%)

Final Exam (30%)

Assessment and grading

Student presentations/reports (30%)

One literature presentation and report will be required. For this, you will read and article (not a review article) on optoelectronics/nanophotonics published recently in one of leading scientific journals, such as Science or Nature family journals, and make a presentation and report with a critical review of the paper. In your presentation/report you should describe major observations of the article and provide its summary and critique.

Your presentation/report is important; it will show how you can apply your new knowledge and work with the current scientific literature in the optoelectronics/nanophotonics areas.

Assessment and grading

Tentative list of topics for possible presentations

- Control of heat radiation with photonic structures
- Micro-LED displays
- Random lasers
- Coherent Perfect Absorber or 'Anti-Laser'
- Optical switch for silicon photonics
- Electro-absorption modulators
- All-dielectric metasurfaces
- Photonics/Optoelectronics with artificial intelligence
- Optical Imaging with artificial intelligence
- Bioinspired Photonics

Lecture Notes

Http://www.gist-foel.net

Flexible OptoElectronics Lab
Gwangju Institute of Science and Technology

People Research Publications Media News Photos Contact

광주과학기술원 Gwangju Institute of Science and Technology
한국연구재단 NRF
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미래창조과학부 Ministry of Science, ICT and Future Planning
CISS Center for Integrated Smart Systems
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Open position
There are multiple open positions for undergraduate, graduate, and post-doctoral researchers.
Post-doctoral researcher
To apply, please send a cover letter, CV, summary of research, and publications (journal or conference; published or in preparation; preferred electronic format: pdf) in one pdf file.
Graduate researcher
I am looking for students seeking M.S. or Ph.D. degrees. Applicants with top credentials and/or research experience in electronics, photonics, materials, nanotechnology, and/or medicine are encouraged to apply.
Undergraduate researcher
I always welcome undergraduate students who wish to learn about optoelectronics and its application for future electronics. It would help if you state in your email the scope of research experiences are looking for and why you would like to work in this lab.

Name
Email
Title
Message

Visitors
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FLAG counter

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Lecture

Question or Comment?

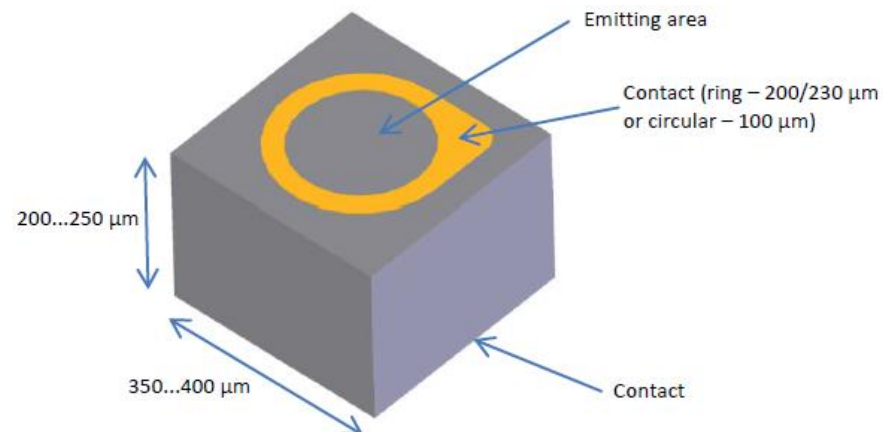
Example : Cutting Edge Technology on LED research

Conventional LEDs

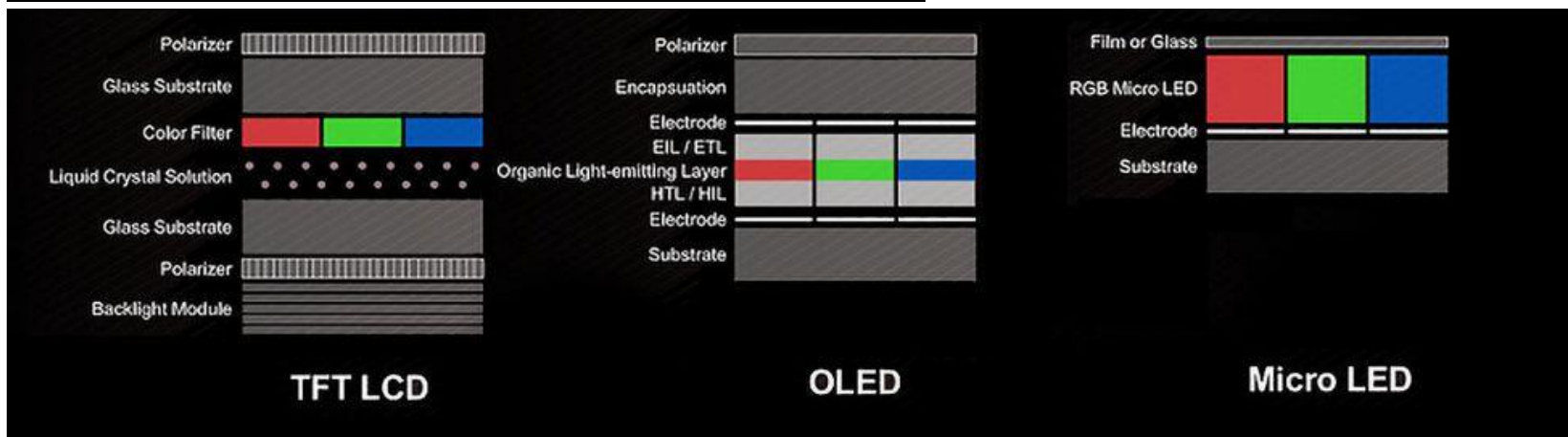
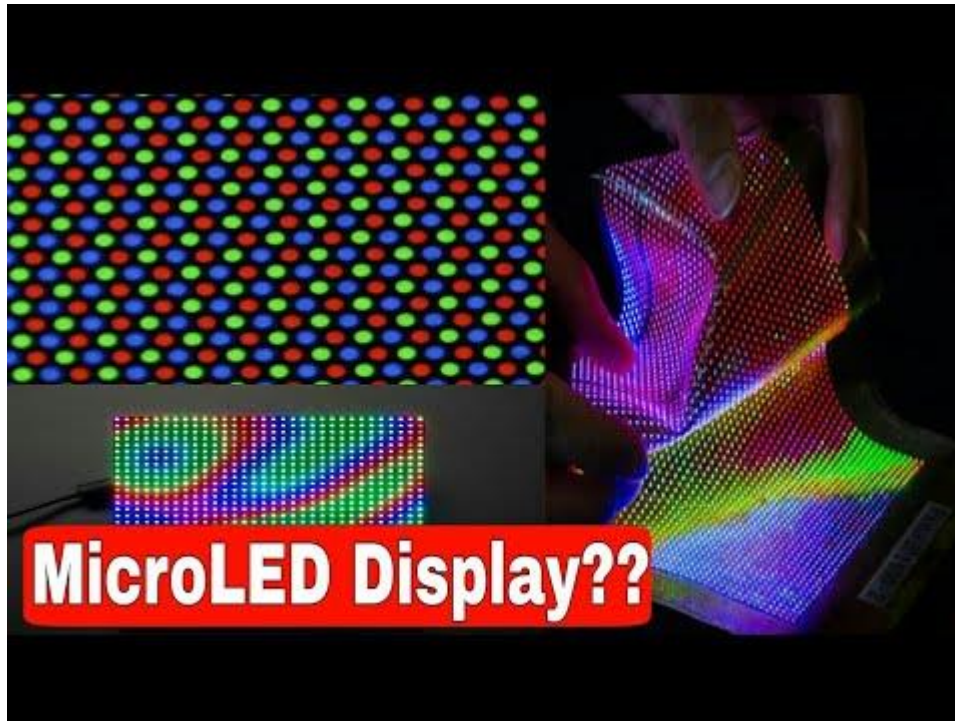
Conventional LED modules



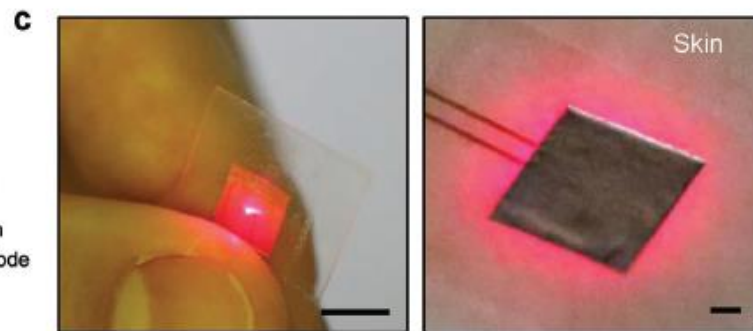
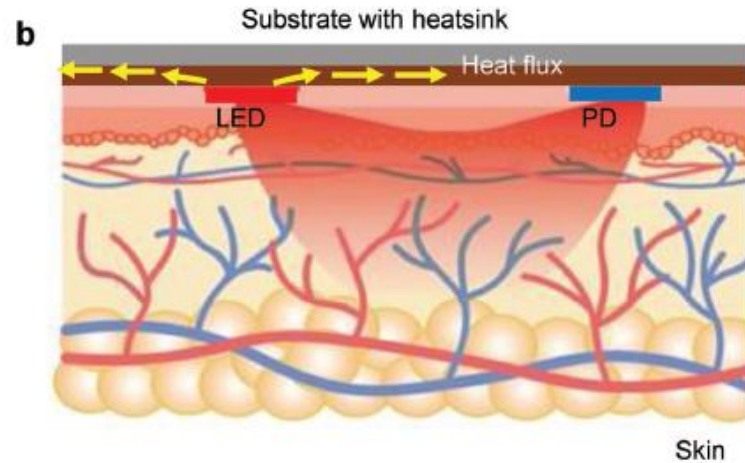
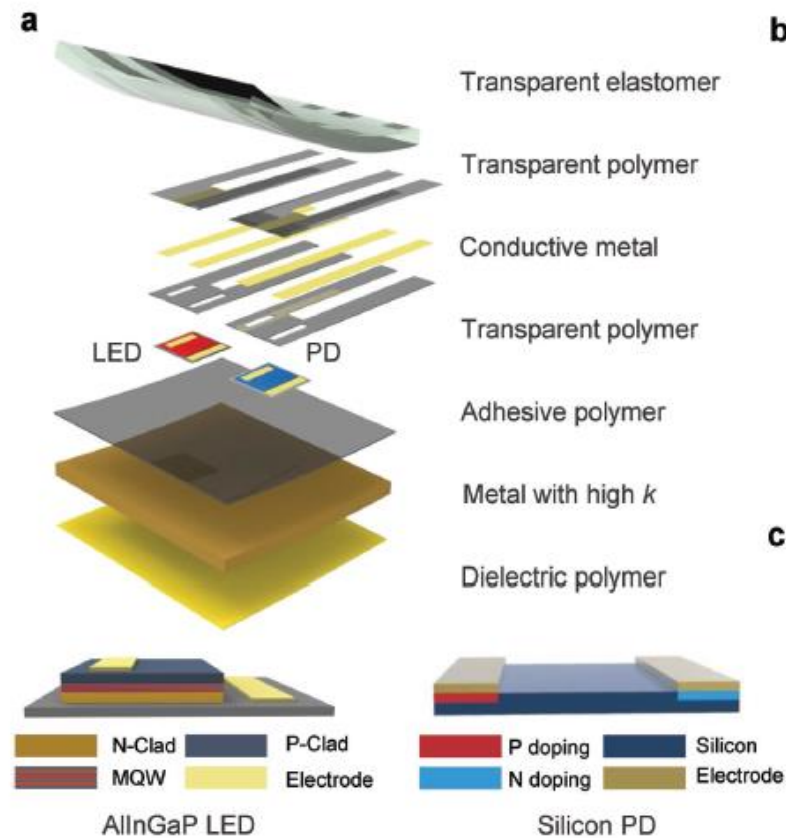
Single LED chip



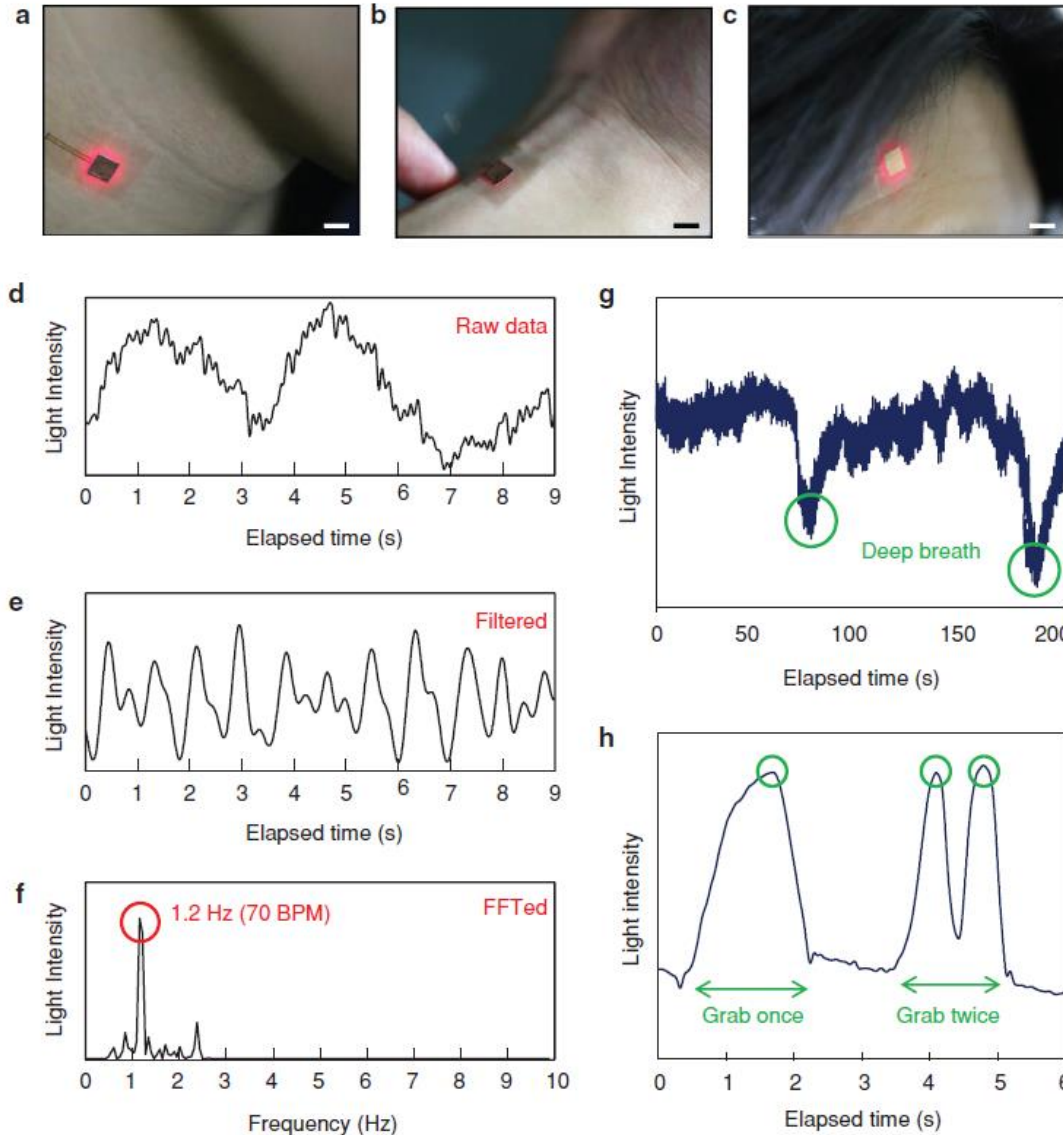
Unconventional LEDs



Unconventional LEDs



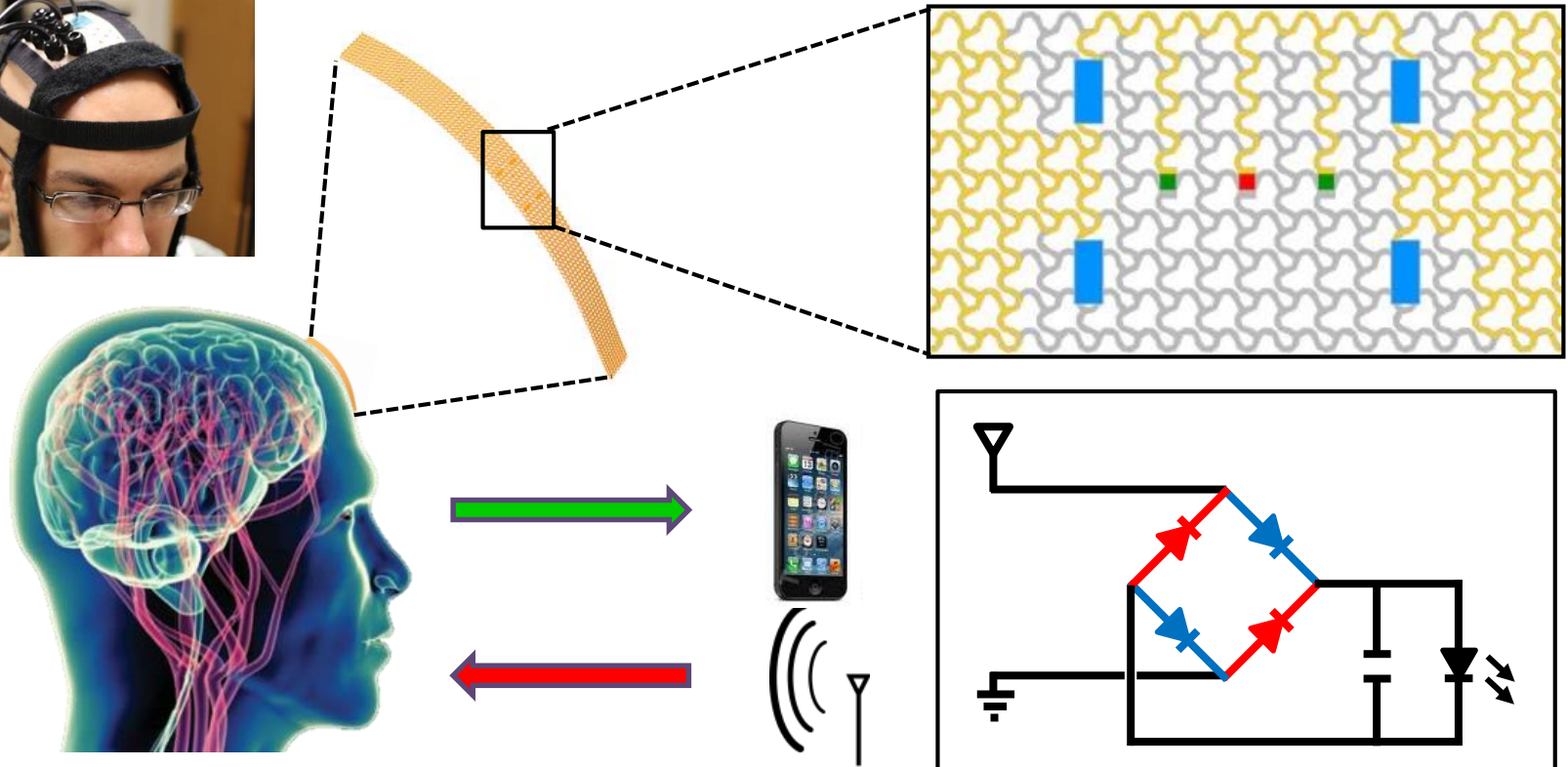
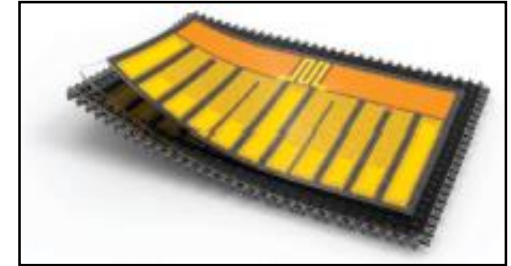
Unconventional LEDs



Patch-type LEDs for Cerebral Oximetry

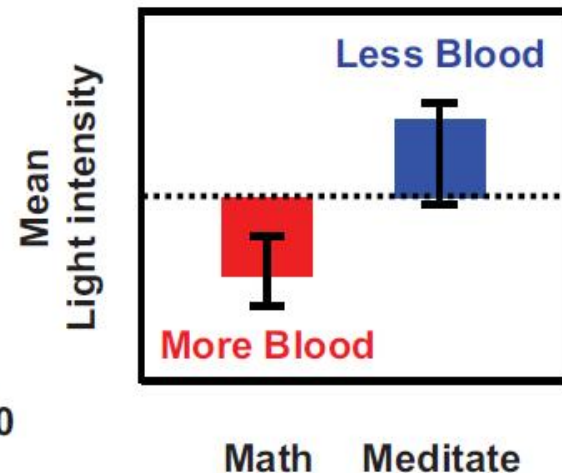
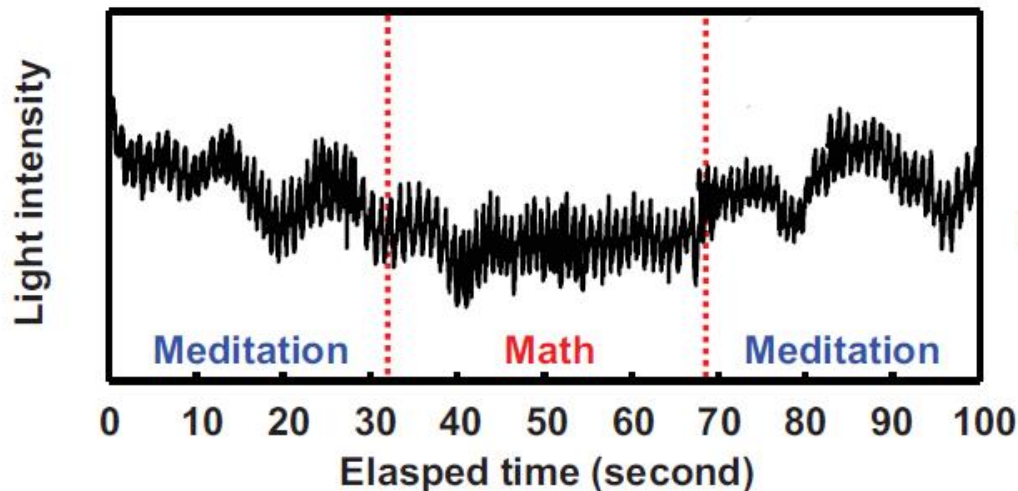
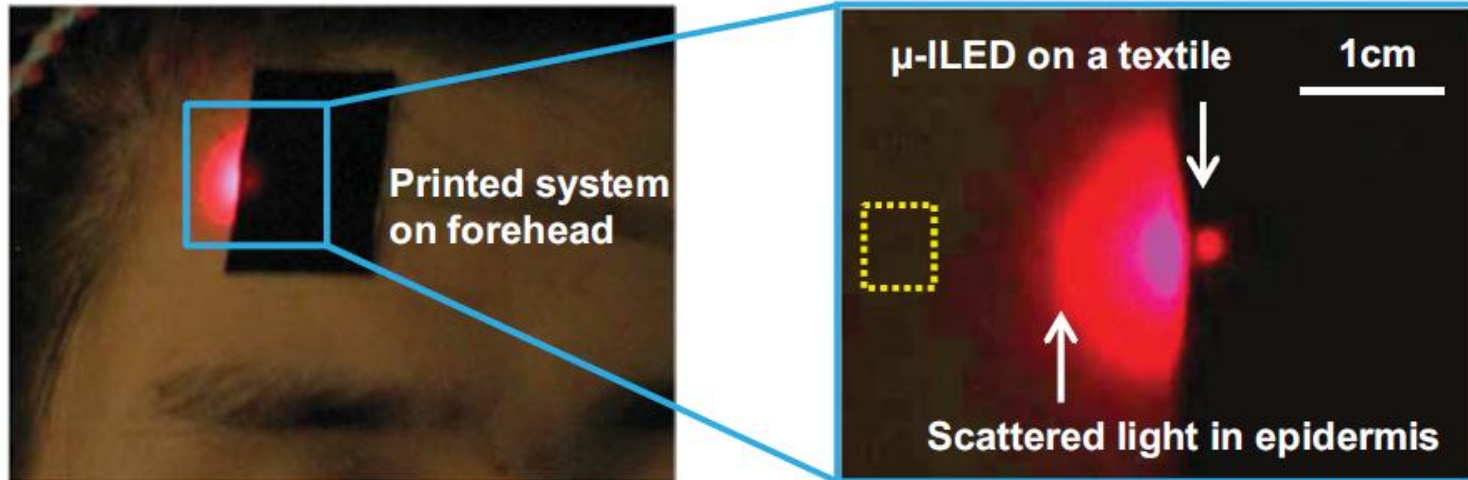
Epidermal optic diagnosis

Conventional Cerebral oximetry



Nat. Comm. (2014)

Patch-type LEDs for Cerebral Oximetry



Nat. Comm. (2014)

- Research Motivation, Scientific Impact
- Operating principles
 - LEDs, PDs
 - Device structures and fabrication details
 - Materials issues, optical behaviors
 - Semiconductor fundamentals, EM waves (Prerequisites)

