

India's Electronics Market

Electronics Industry – projection by segment

(USD billion)	Target	
	2014	2020
Semiconductor design	20.0	58.2
High-tech manufacturing	4.0	22.6
Electronic components	2.6	3.4
Electronic Manufacturing Services	1.4	2.3
Electronic systems		
IT systems and hardware	16.7	54.4
Telecom products and equipments	29.5	153.5
Consumer electronics	8.1	17.8
Others (Industrial, Automotive and others)	2.7	7.8
Exports	15.0	80.0
Total of all segments	100.0	400.0

Source: Industry estimates

Source: ISA, India

- India imports > 90% of its electronics equipment.
- Import is estimated to exceed US \$300B in future

→ **Electronics import may exceed the petroleum import**

!!! Because India missed the semiconductor revolution !!!

Indian Institute of Technology Kanpur



FlexE

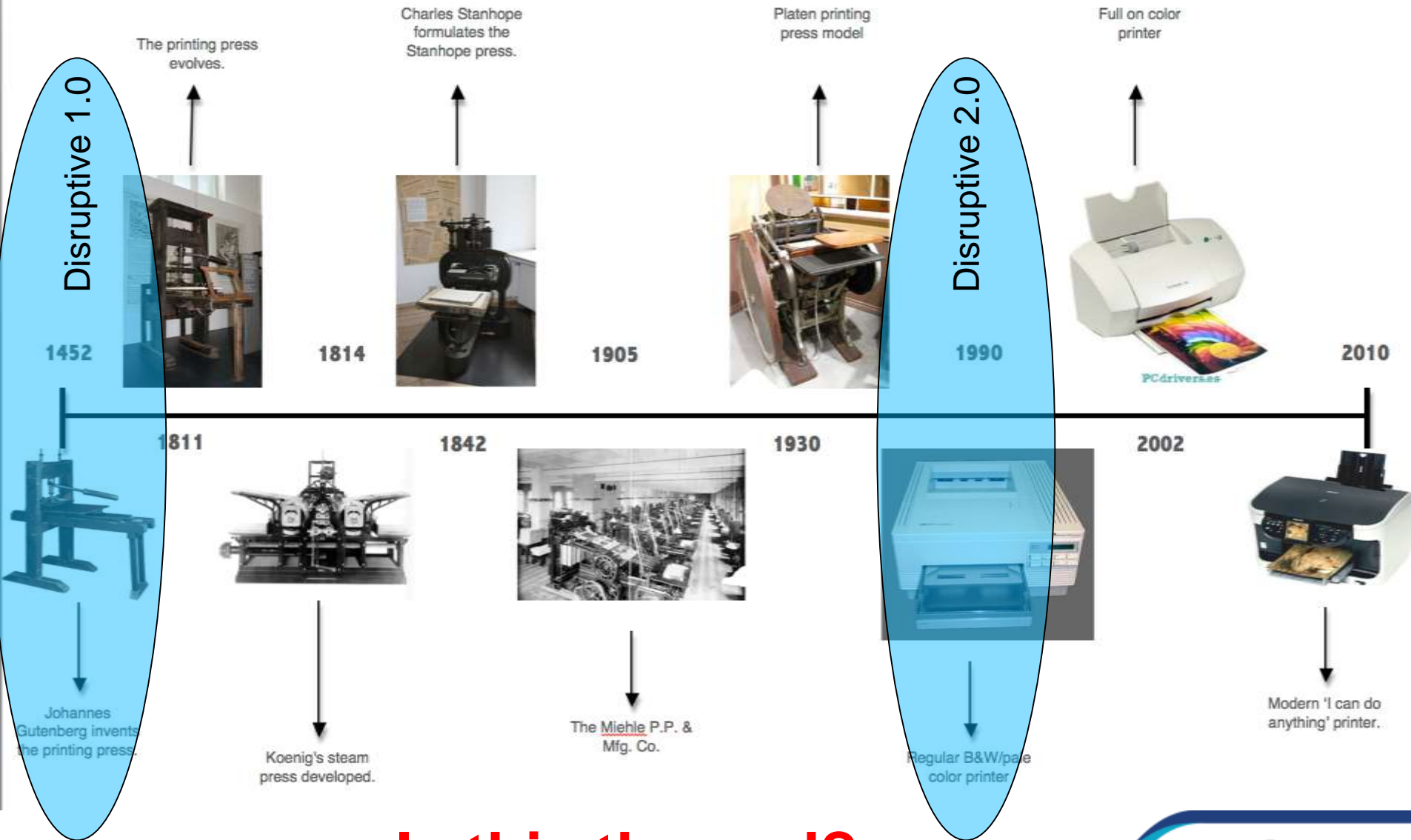
National Centre for Flexible Electronics

“Printed Electronics – Challenges and Opportunities for India”

Ashutosh Tripathi, FlexE Centre, IIT Kanpur

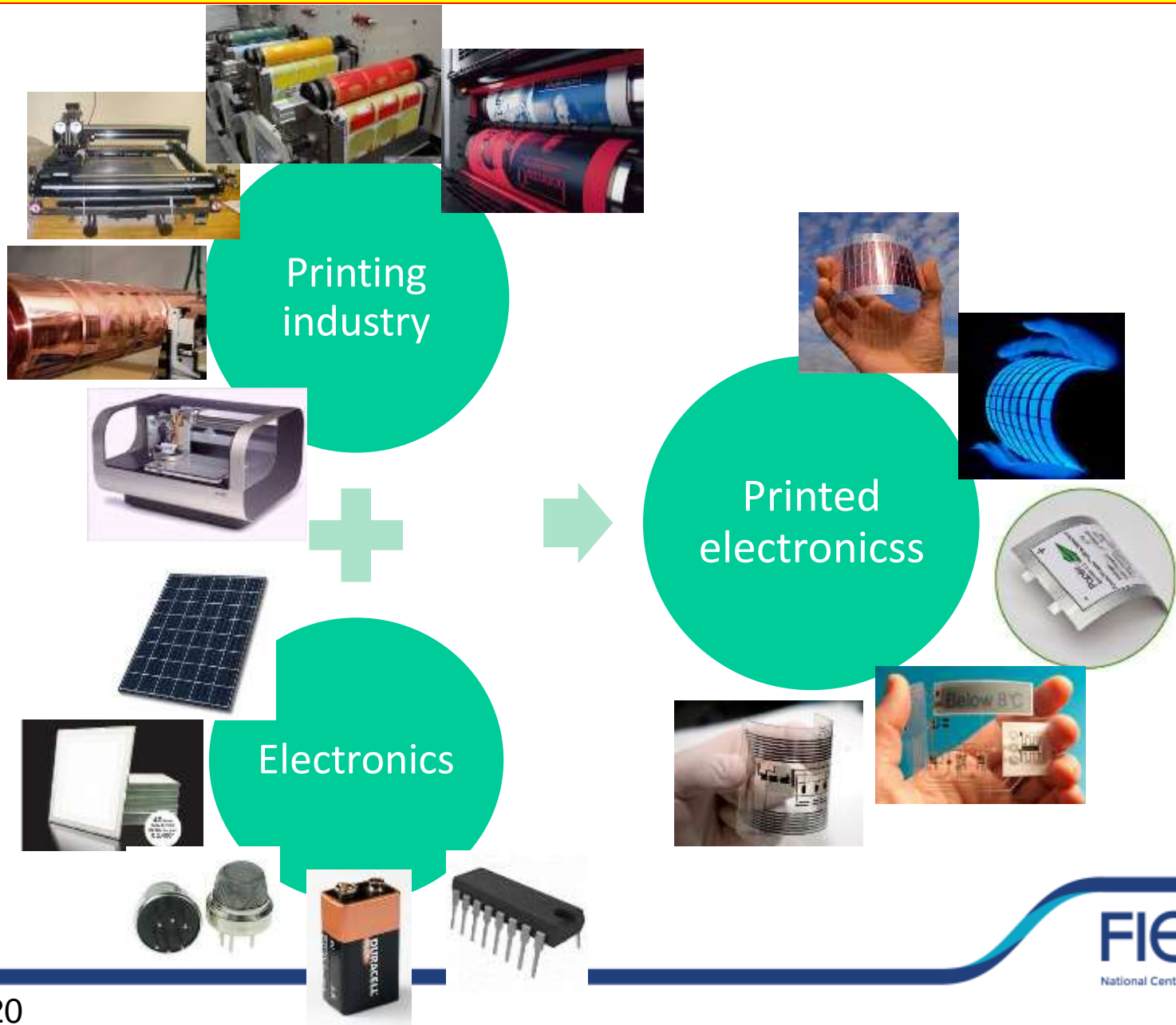
PAMEX 2020, 8th January 2020

Evolution of printing



Is this the end?

Disruptive 3.0 : Printed Electronics



Why printing of electronics?

Low Production Costs!

- Solution processing enables fast printing and coating technologies
- Easy to pattern
- High Speed
- Large area
- No expensive vacuum technology
- No time loss by waiting for vacuum
- Multiple layer deposition

Advantages of flexible substrates

- Flexible
- Any size, any shape
- Non fragile
- From transparent to opaque
- Light weight
- Low cost
- New form factors



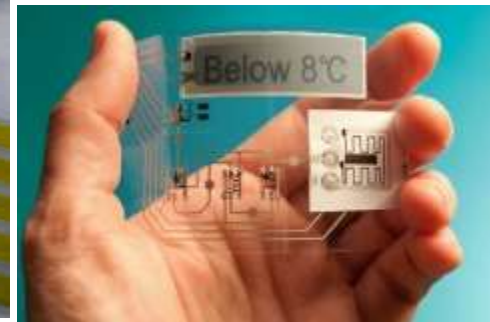
www.Printedelectronicsarena.com



Konarka



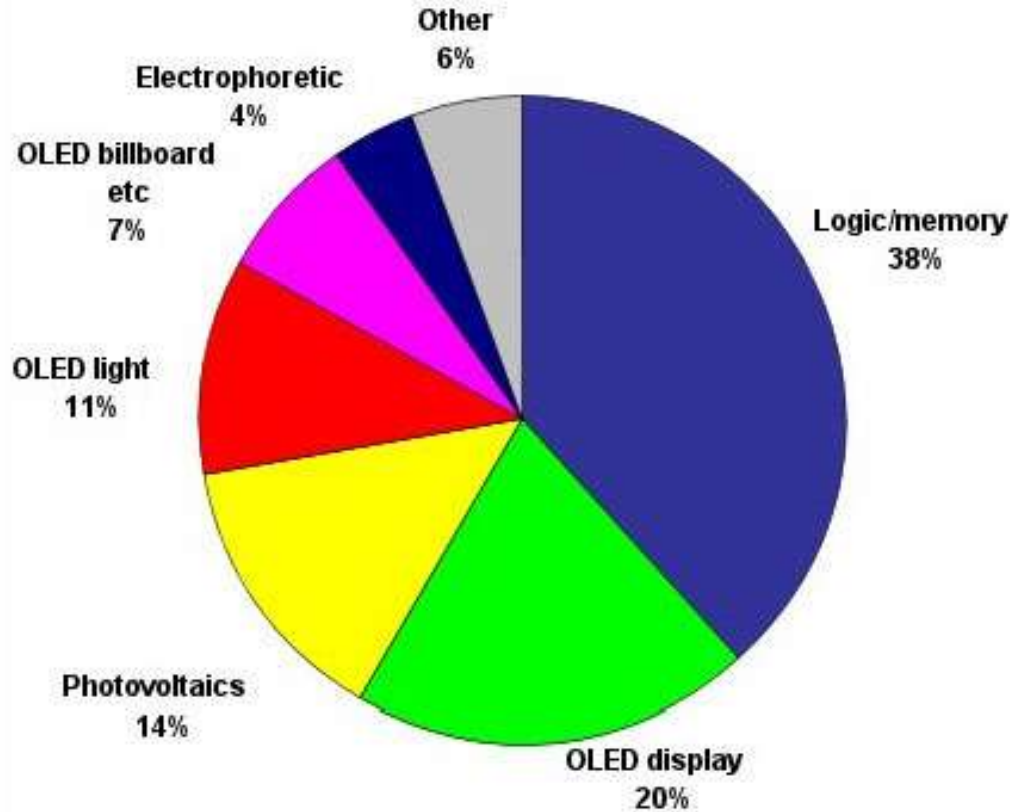
VTT



Thin Film

Printed electronics market?

Market forecasts to 2027 - a \$330 billion market



Idtechex.com

We cannot afford to miss this opportunity

Introduction to FlexE Centre

www.ncflexe.in

ncflexe.in

Follow @flexe_iitk LinkedIn Like

National Centre for Flexible Electronics

Indian Institute of Technology Kanpur

FlexE
National Centre for Flexible Electronics

Leverage on our vast collective experience

Home About FlexE Partnership Technology Domain Career Opportunities

Work In Progress(Click Here)

Architectural Drawing

National centre for Flexible Electronics was established in 2014 through a grant from Department of Electronics and Information Technology (DeitY) under ESDM scheme of Electronics Policy 2012 of Government of India and support from the Institute (IIT Kanpur). This centre will function as a nodal point in India to bring academia, industry and public research organizations under one umbrella for research and development of large area flexible electronics. The centre will simultaneously support research with the academia and develop products with (and also for) the industry.

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www.ncflexe.in

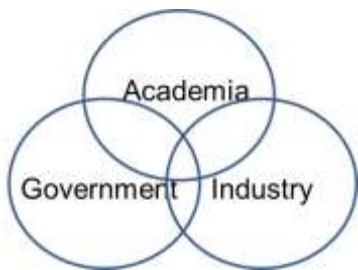
FlexE
National Centre for Flexible Electronics

Timeline

2000



Samtel Centre for
Display Technologies
--- Organic Electronics



Co-development
with industry

2005



Country's first
major programme on
Printable Electronics



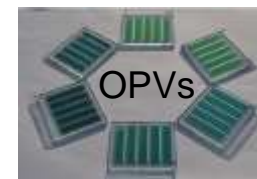
Demonstrated –
Country's first passive
matrix OLED display
meeting industry standards



2007



Other
Technology
Programmes



Sensors



OLED Lighting

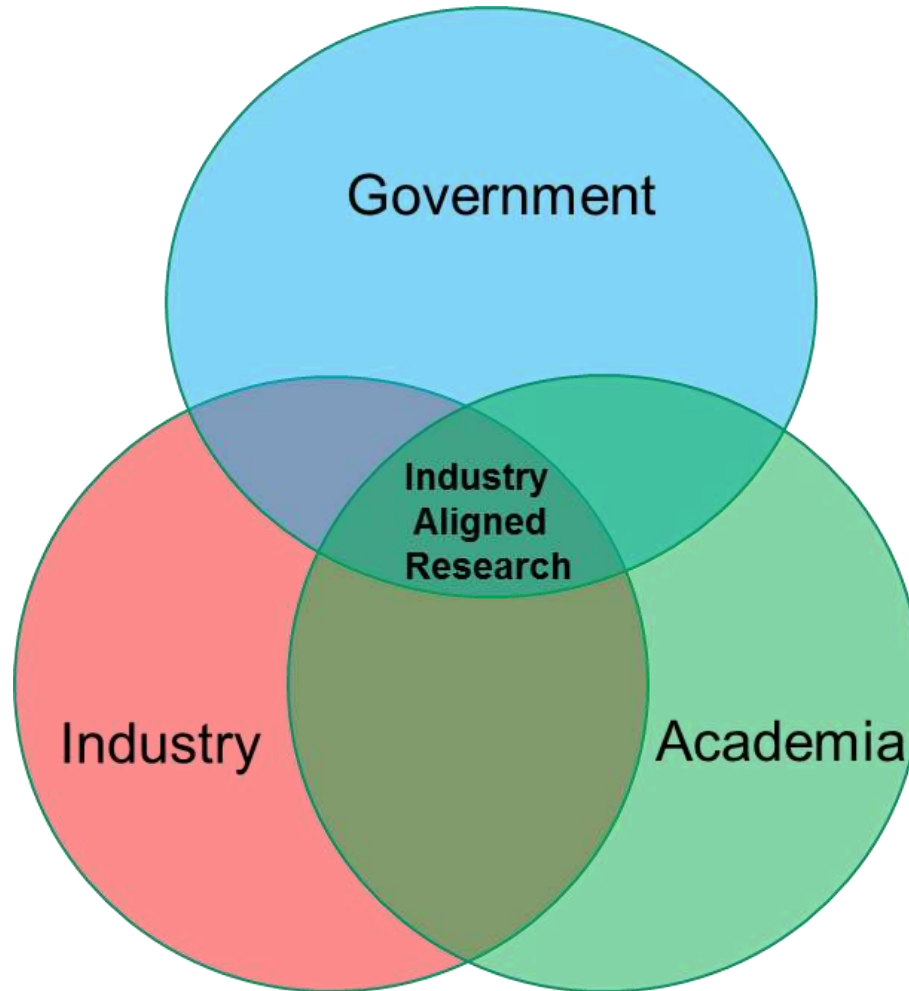
2014



National Centre for
Flexible Electronics



FlexE Centre – Tripartite Partnership



PAMEX 2020



Vision

Conduct research and development in large area flexible electronics that serves as a foundation for development of domestic industry in this field.

Objectives

R&D: In the field of large area flexible electronics

Manufacturing: Partnership with industry leading to manufacturing

Ecosystems: Facilitate formation of industrial ecosystem

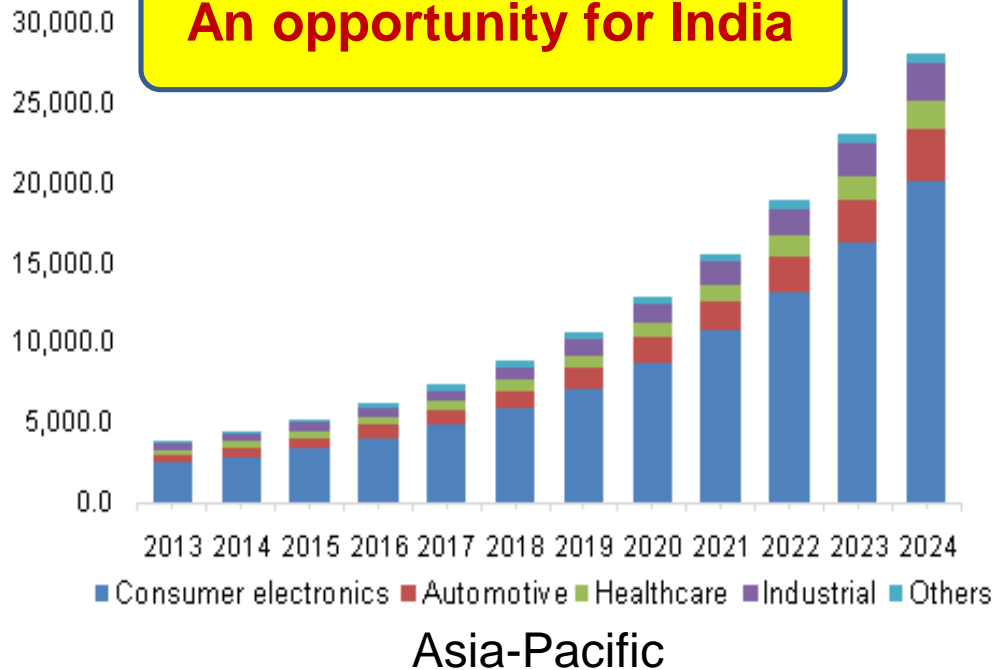
Entrepreneurship: Incubate small scale industry

International Partnerships: Build strategic partnerships

Human Resources: Skill development

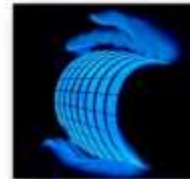
Flexible Electronics

An opportunity for India



2015 – ESDM
World 2T USD
India 88B USD

LEDs



New York Times (2009)

Imperceptible electronics



Kaltenbrunner et al., Nature (2013)

RFID-tags



Kelley et al., Chem. Mater. (2004)

Electronics become flexible

Phone



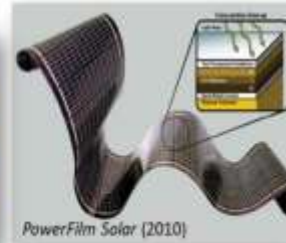
LG Electronics (2013)

Smart watch



Samsung (2013)

Solar cells



PowerFilm Solar (2010)

India's strengths

Chemicals

Printing

Vision and Objectives

Vision : Conduct R&D in large area flexible electronics that serves as a foundation for development of domestic industry in this field.

Objectives

R&D: In the field of large area flexible electronics

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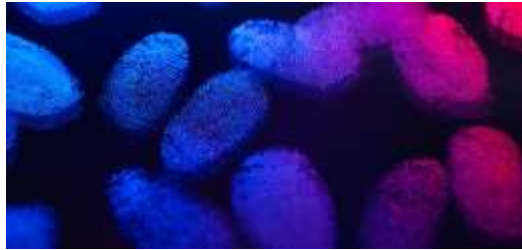
International Partnerships: Build strategic partnerships

Human Resources: Skill development

Canvas: The Indian Context

Unmet technological needs

- Anti-counterfeiting Technologies
- Point of Care Diagnostics (Healthcare)
- Food safety (Healthcare)
- Portable photovoltaic systems (Energy)
- Signage (indigenization)
- Defense components (indigenization)
- Educational kits





Building and Facilities

People

- Faculty members
 - Research Engineers
 - Project staff
 - Industry personnel
- ~ 100

Industry Focus

Industry members – 20
NDAs - 74

Technology platform

Components and Systems

Skill Development

Facilities

A. Processing and device fabrication

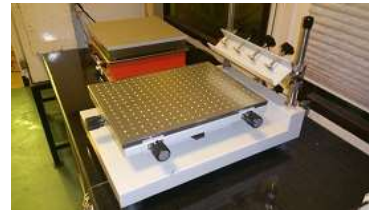
Lab scale



Solution processing
(primary)

Vacuum processing
(in addition)

Prototyping/industry scale



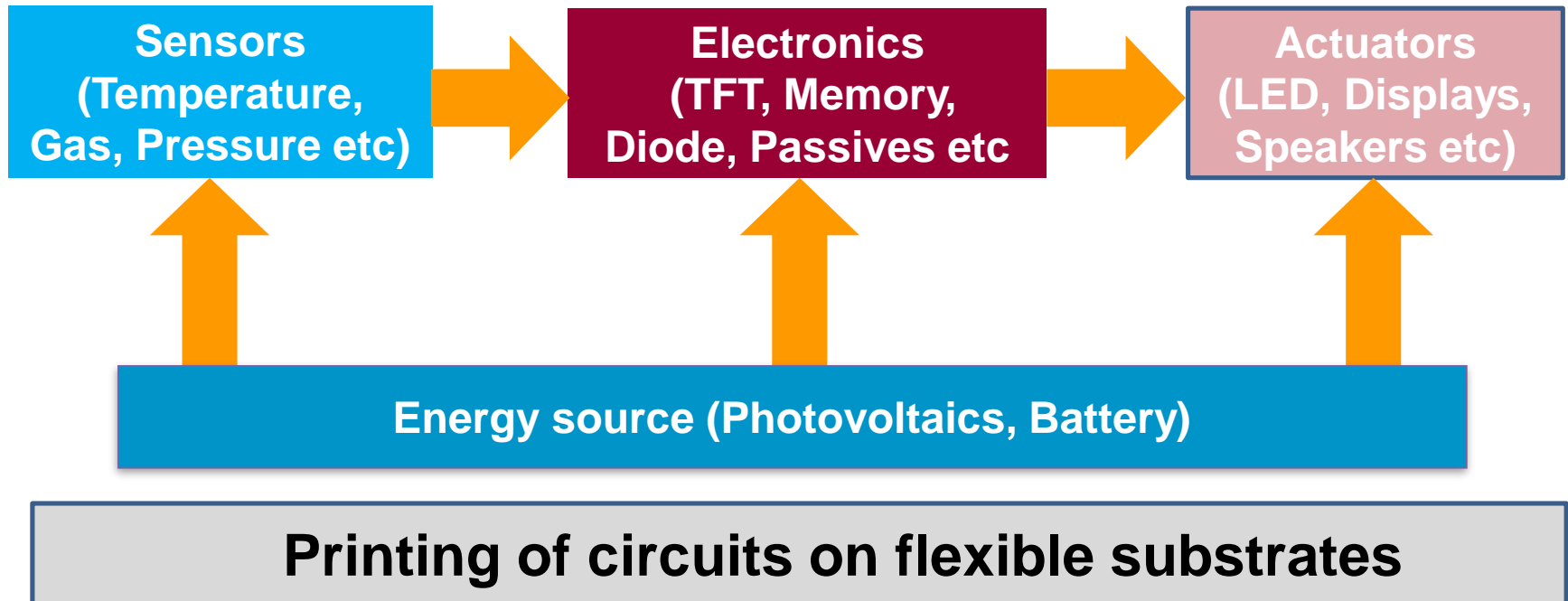
Industry scale



B. Materials and Electrical characterization

Technology Platform

System on Plastic/Paper/Cloth

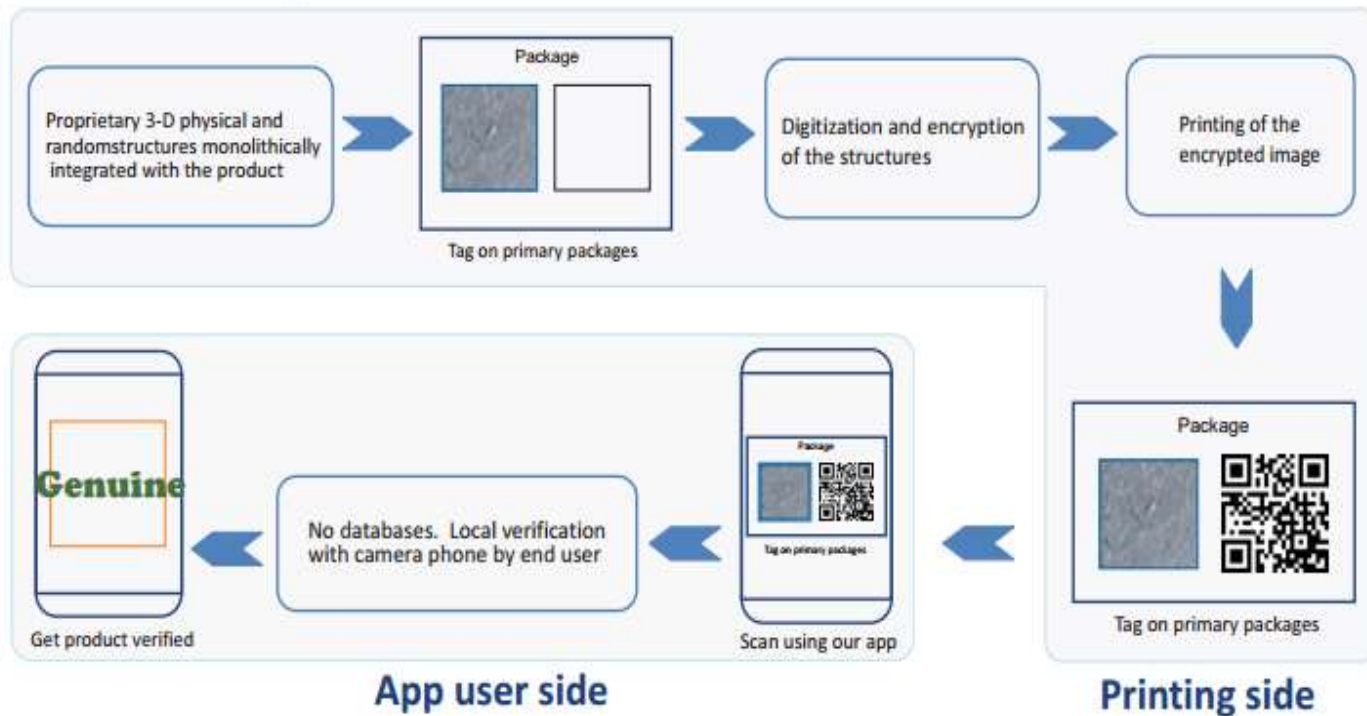


NCFlexE Technology Matrix

Technology Integration				Memory and logic circuits	Flexible solar modules	Anti-counterfeiting	Healthcare devices	Flexible Displays	Smart Packaging
Technology Platforms									
Large area printing and coating	Substrates and encapsulation	Patterning technologies	TFT	√		√	√	√	√
			OLED					√	√
			OPV		√				√
			Sensors			√	√		√
			Inks		√	√	√		√
			Battery	√	√	√	√		√
Common platforms				Passive components					
				Electronics and device integration					

Incubation

1. Anti-counterfeiting Tags



2. Inks Development

Ag inkjet ink



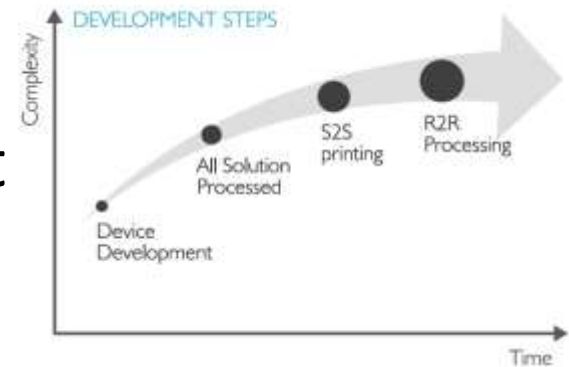
Cu inkjet Ink



Printing

Technology development

- Printing of functional inks
 - metallic, dielectric, organic, semiconductor etc.
- Printing technology established:
 - Inkjet, SlotDie, Screen printing, Wirebar, Doctorblade, Flexo, Gravure
- Advanced curing technology established:
 - Flash Sintering, NIR drying, UV
- Printing of functional devices
(in group and process support for other groups)
 - OLED
 - OPV
 - Heater
 - RFID
 - Resistive and conductive structures
 - Circuitry
 - Battery



4 PHASES

1. Device Development
Standard Semiconductor Processing
2. All Solution Processed
Spin Coating
Subtractive Patterning
3. Sheet-to-sheet Printing
Industrial compatible
Technology on Sheet-to-sheet level
4. Roll-to-roll Printing
High throughput

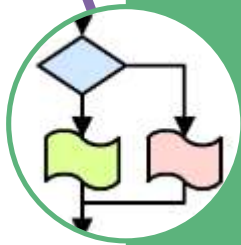


Printing Expertise



Dedicated Team

Project engineers, Technicians with printing degree/experience



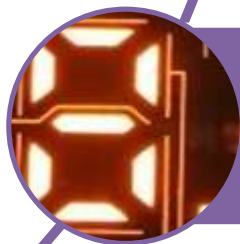
Theoretical understanding

Predicting & Modeling printing behavior
Ink characterization
Resolving Printing issues



Printing process development

Printing of functional inks
Printing parameters for different printing technologies
Pre- and Post-treatment



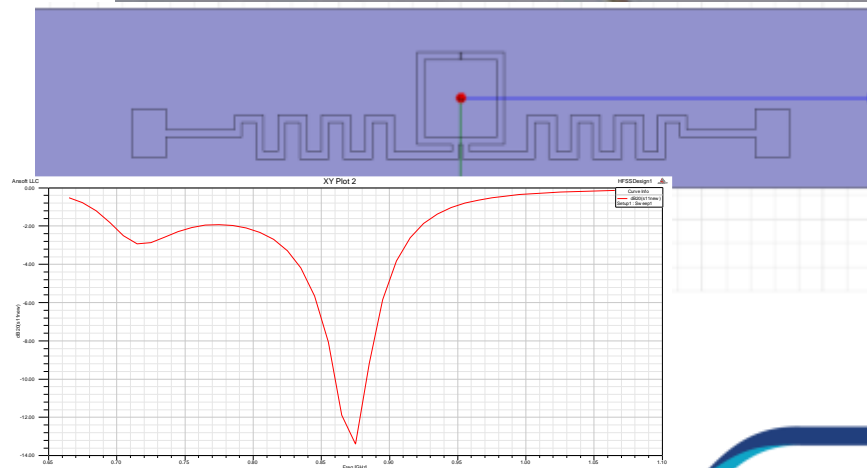
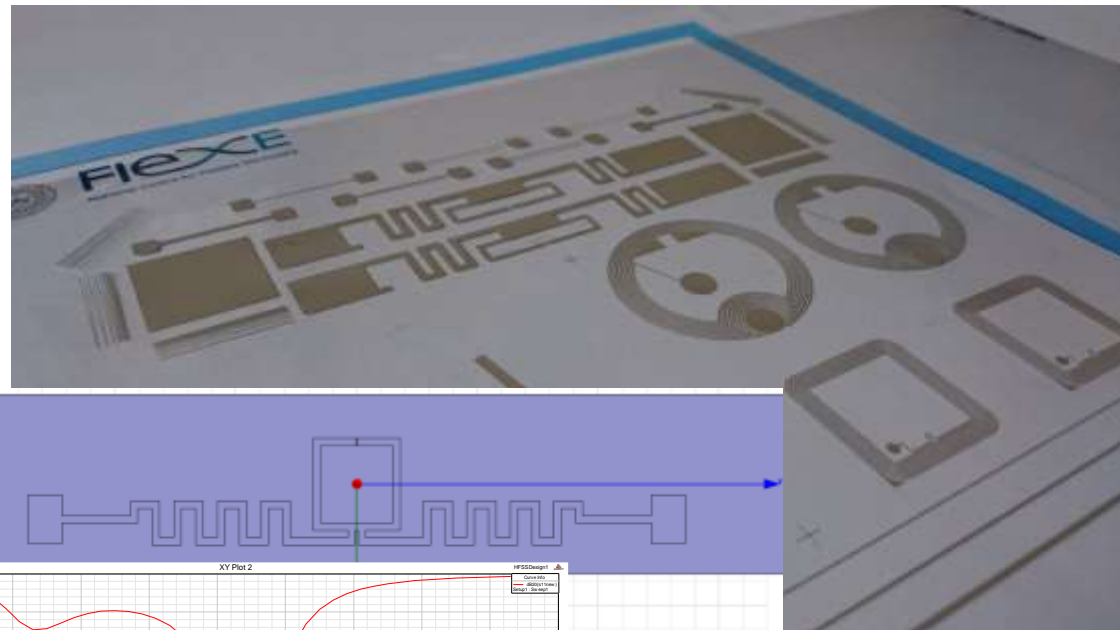
Printing of functional devices

Printing process according to device requirements
Choice of technology and ink vs. functionality

Printed Heater



Printed RFID Antenna



Sensors

Thermal sensors

- smart packaging
- medical diagnostics
- wearable electronics

Biomarker sensors

- medical diagnostics

Gas sensors

- smart packaging
- medical diagnostics
- wearable electronics
- environmental

Aqueous metal ion sensors

- medical diagnostics
- wearable electronics
- environmental

Round Tables and Road Shows

4 (Delhi, Ahmedabad, Hyderabad, Bangalore)

Industry tradeshow (selected)

Make in India

IESA

SID Display Week

ASSOCHAM

LOPEC

PAMEX

Screen Printers Association

CeBIT

Indo-Japan JWG

Industry associations

IESA, AIMED, FICCI, ASSOCHAM, CII, CEAMA, MAIT

IDTechEx, FlexTech Alliance, Fraunhofer

Skill Development

Technical project staff: 136

Students: Ph.D. (50), M.Tech. (90)

Post-doctoral: 4

Faculty exchange: 2 (TEQIP)

Graduate level course: “Introduction to Flexible Electronics” (EE698N)

Annual Short Course on Flexible Electronics (1st full week of July)

Year	Research Scholar	Faculty/ Scientist	Industries	Total
2019	2 (Meity Intern)		23	25
2018	32	5	6	43
2017	42	5	5	52
2016	34	6	5	45
2015	18	5	4	27

Instructors from:

* IIT Kanpur * Institutes in India * Institutes outside India

Summary

Intent

- Flexible Electronics - An opportunity for India
- Unmet technological needs

Context

- Industry aligned research
- Bridge between academia and industry

Achievement

- Building/infra in place, Team in place
- Competency building – components/systems
- Industry projects, incubation

Set to accelerate the activities

Thank you