面向可穿戴电子的微能源技术开发
Development of micro energy for wearable electronics

Dr. Zhengxin Liu, VP, SITRI

上海微技术工业研究院 (SITRI)

Outline

- **Background**
- **Micro energy for wearable electronics**
- **Integration of micro energy system**
- **Approaches at SITRI**
- **Conclusion**

SITRI

Background

Smart …

Hearing Aids

Mobile Phone

Smart Glass

Smart Watch

Life Vest

Activity Monitor

Smart Shoes

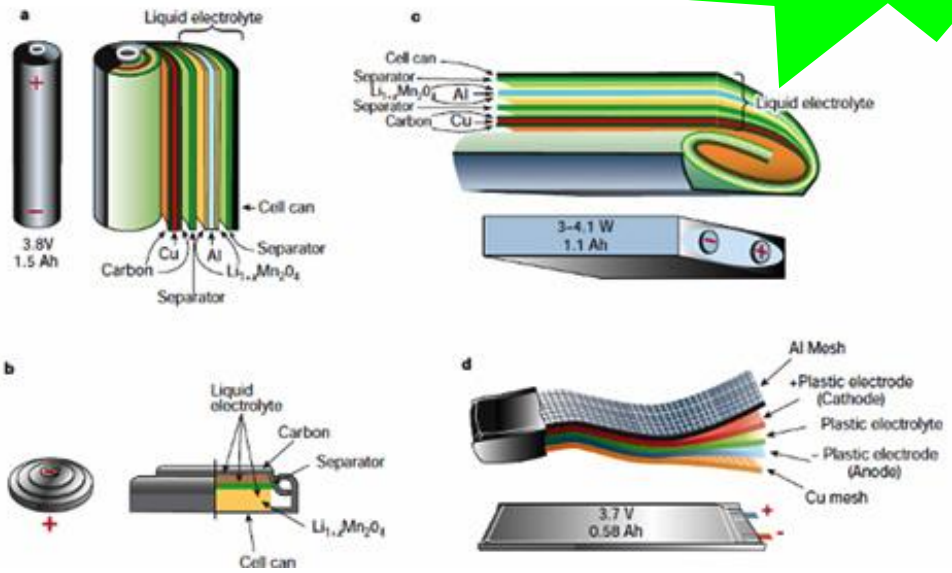
Wearable …

Power supply: batteries

Battery Life ?
Large Size
non-flexibility

Conventional Power supply：

Lithium ion battery (LiB)



Super capacitor

Think about the batteries

- Lifetime: replace, charge …
- Size
- Flexibility
- Environment issues: pollution, recycle, …
- ……

Micro energy for wearable electronics

Solutions:

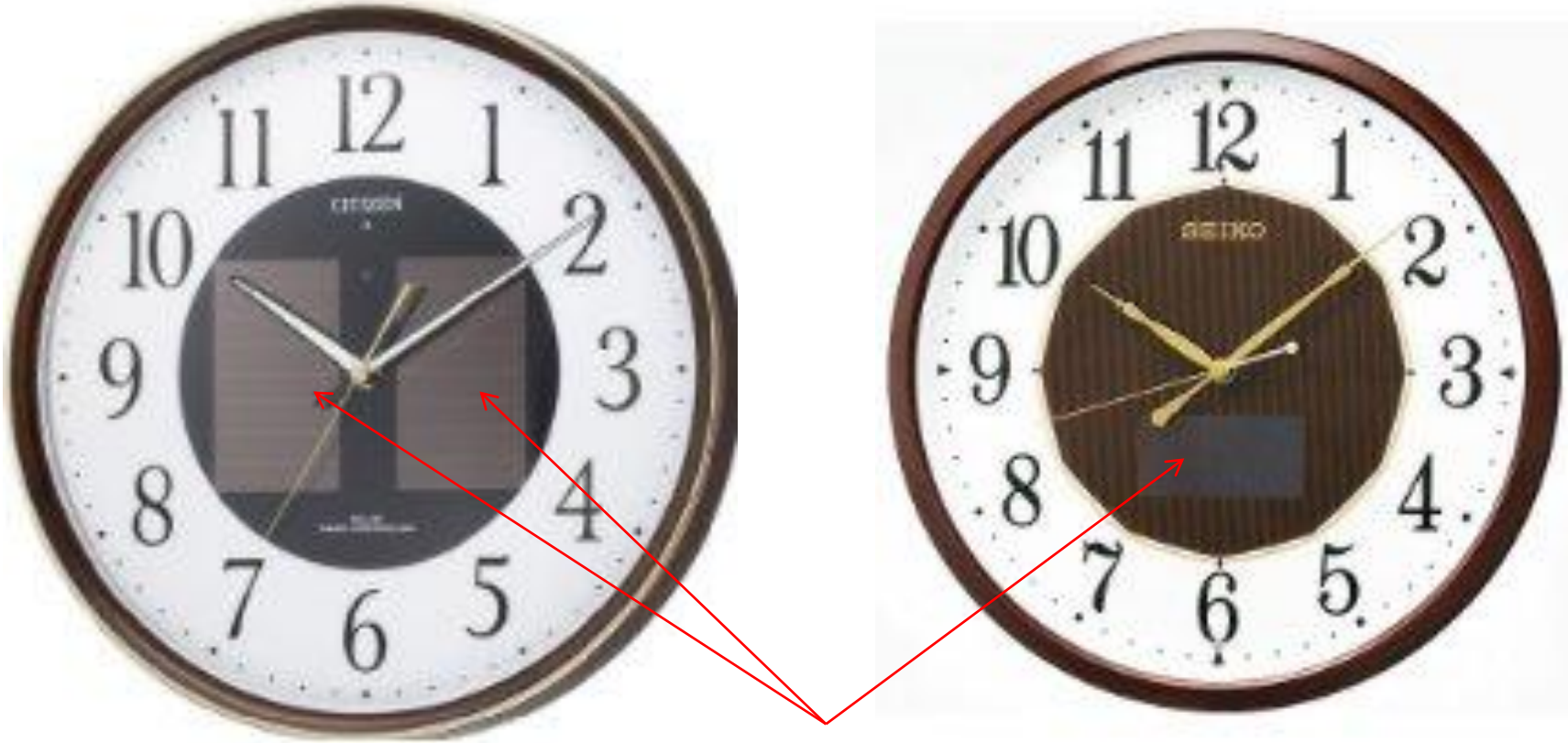
- **Get energies from the environment --- Battery life**
- **Microminiaturization**
- **flexible**

composition of micro energy system for wearable electronics

Micro energy for wearable electronics

Power generator:

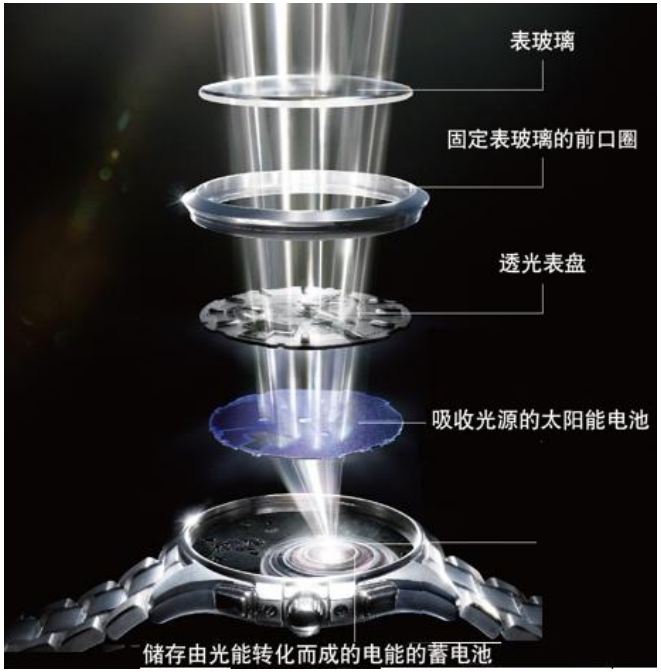
- **Solar powered well-clock**



Solar cells

Solar powered watches

Solar powered watch



Silicon Labs solar energy source

Micro energy for wearable electronics

➢Thermoelectric generator

KAST flexible thermoelectric generator

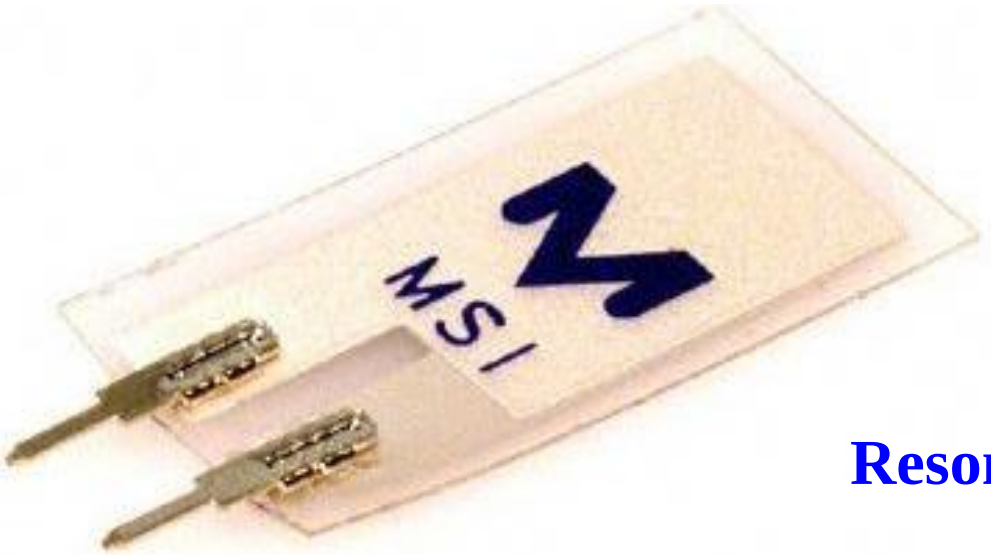
Weight： 0.13g/cm^2

Size: 10cm×10cm

Power: 40mW

Micro energy for wearable electronics

- **piezoelectric generator**



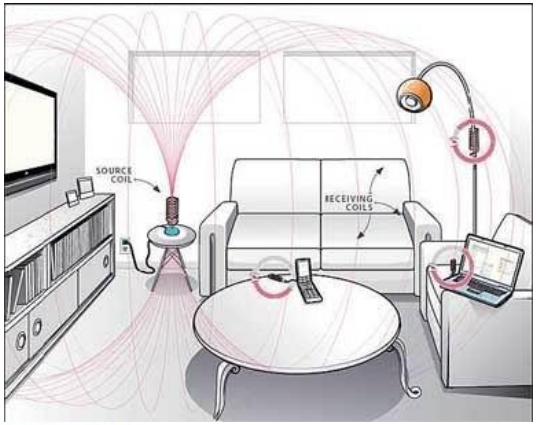
Resonance frequency :100Hz

Measurement Specialties piezoelectric generator

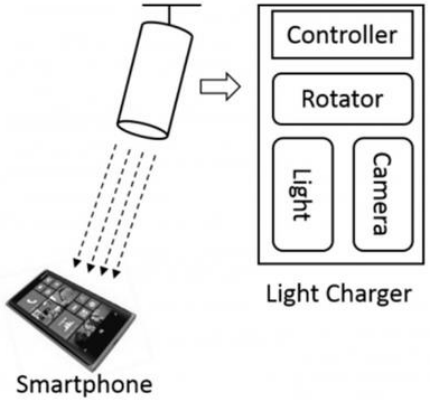
Micro energy for wearable electronics

➢Wireless charging

●Remote wireless charging



Beamed Ultrasound Cherging



Microsoft light Charging

Micro energy for wearable electronics

Comparation of wireless charging technology

Wireless Charging Technologies	Advantages	Shortages
Electromagnetic induction	simple principle, easy fabrication	limited transmitting range
Magnetic resonance	long transmitting range, high efficiency	difficult to make frequency modulation
Light / Laser	long transmitting range	easy to be blocked
Wifi	charging anywhere	difficult to locate charging objects, energy dissipation

Micro energy for wearable electronics

Selection of micro energy

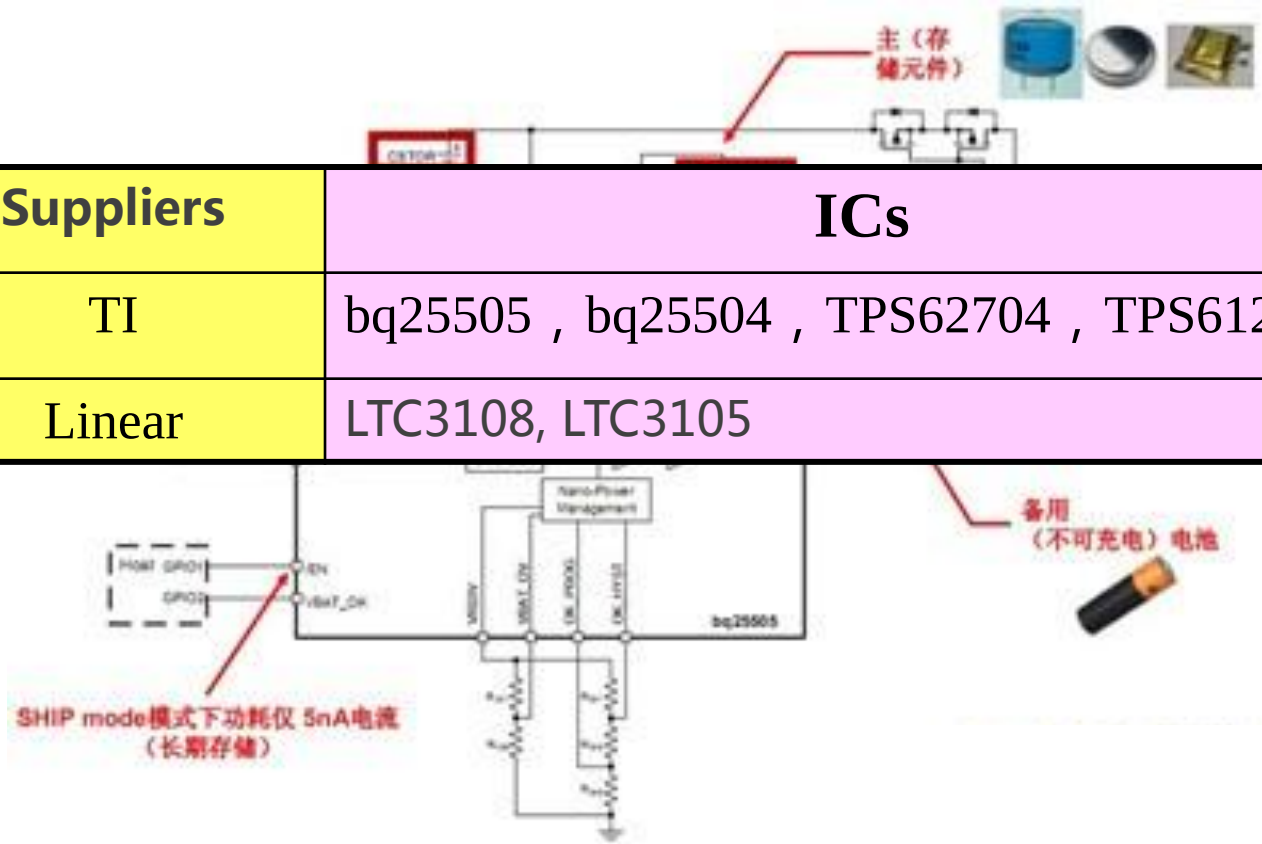
Energy	Characteristics	Power
Light	Outdoors	100 mW/cm^2
	Indoors	100 uW/cm^2
Thermal	Human body	60 uW/cm^2
	Industry	1~100 mW/cm^2
Vibration	Hz - Human body	~4 uW/cm^3
	kHz - Machine	~800 uW/cm^3
RF	GSM 900MHz	0.1 uW/cm^2
	Wifi	0.001 uW/cm^2

Micro energy for wearable electronics

Power management circuits

- **Ultra low power**

Suppliers	ICs
TI	bq25505，bq25504，TPS62704，TPS61202
Linear	LTC3108, LTC3105



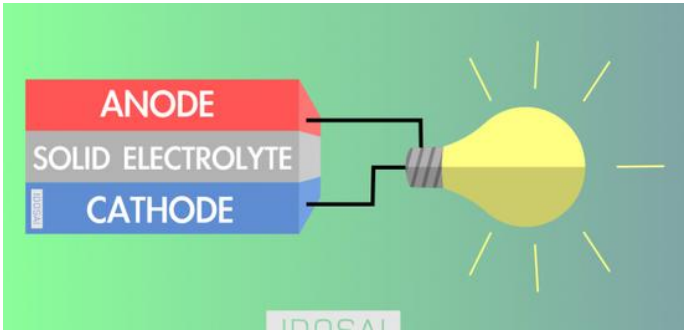
TI bq25505 Solar Application Circuit

Micro energy for wearable electronics

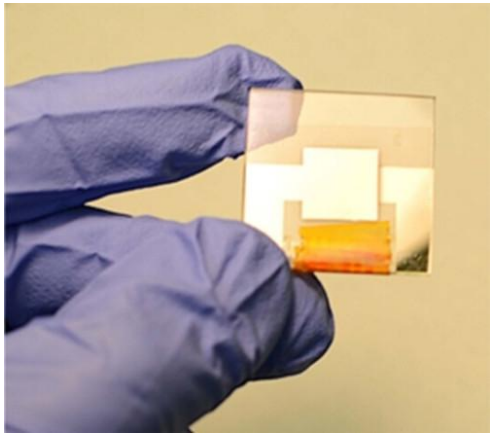
Power storage devices

- **high-capacity, Small size, flexible**

- **Solid cells**



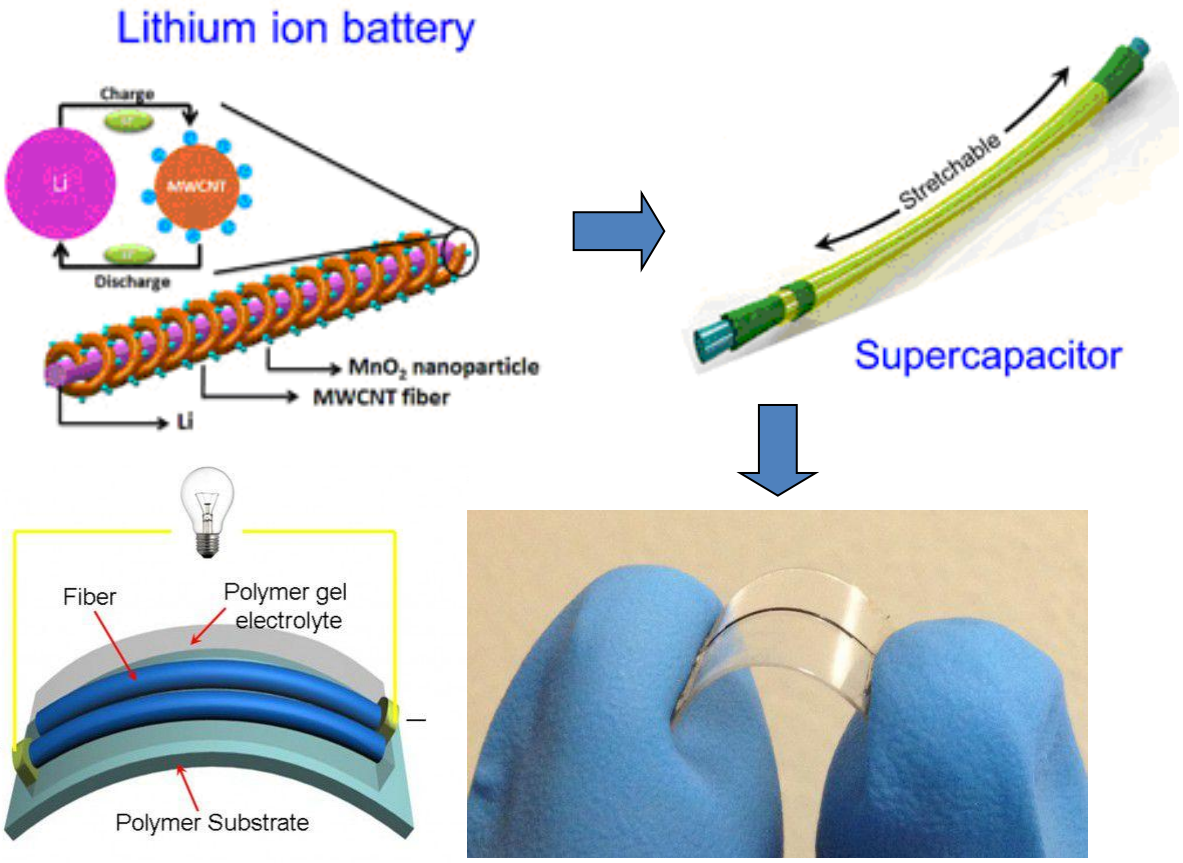
Sakti3 sample



Prologium Lithium-Ceramic solid cell

Micro energy for wearable electronics

- **Flexible micromation super capacitor**
  - **Fiber type supercapacitor**

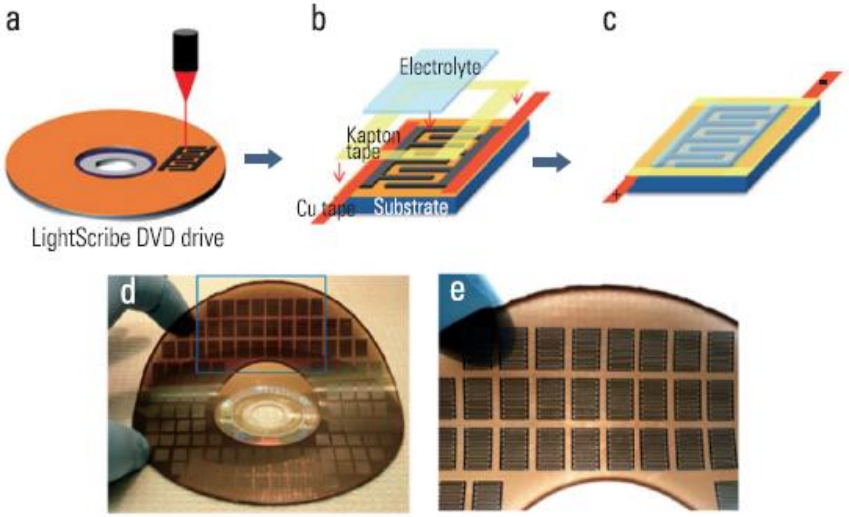


Fabricated by a pair fiber with power density of 6.3uWh/mm^3

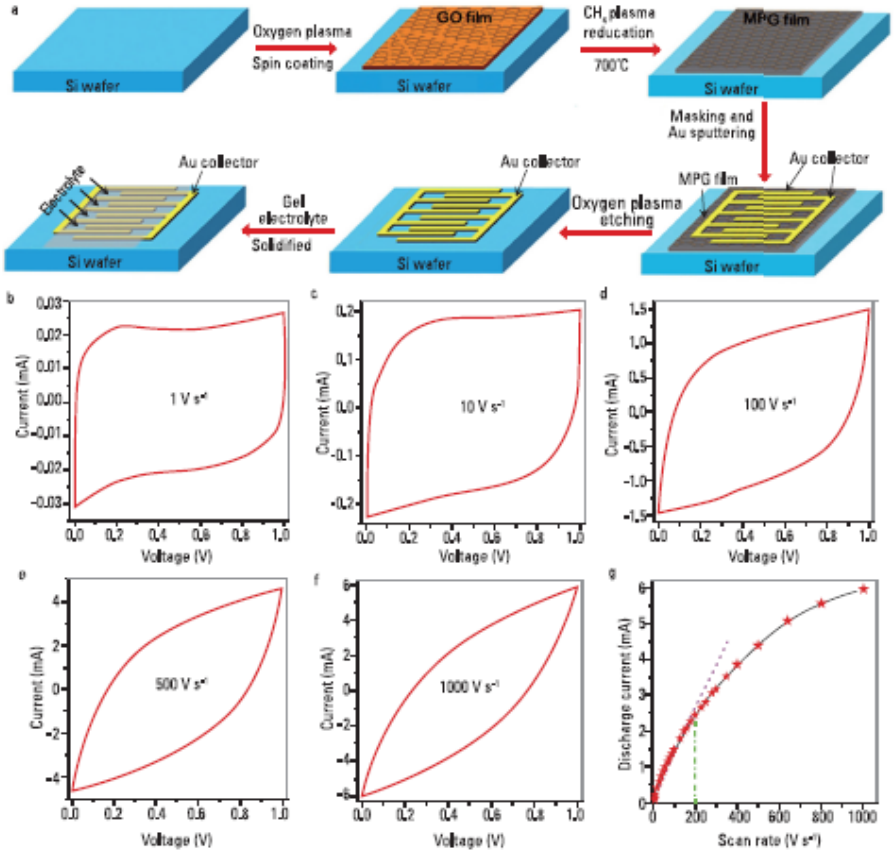
Micro energy for wearable electronics

➢Graphene-based planar micro-supercapacitors

iPhone charging only during 5s



the fabrication process for LSG-MSCs



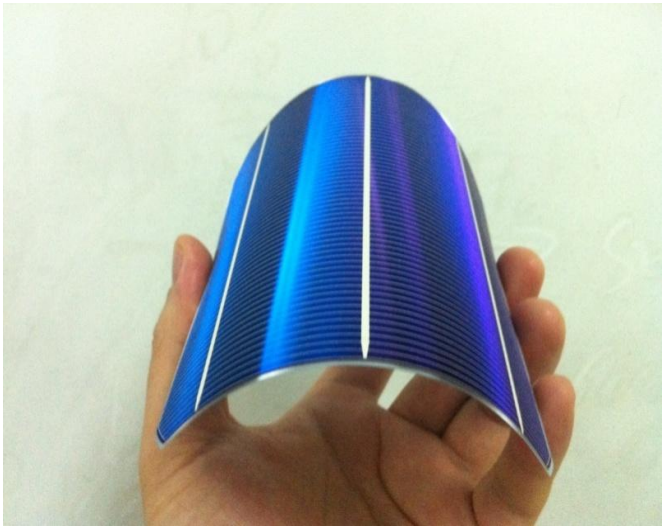
all-solid-state interdigital graphene-based MSCs integrated onto a silicon wafer

*EI-Kady, et al. Nat Commun 2013; **4**: 1475.*

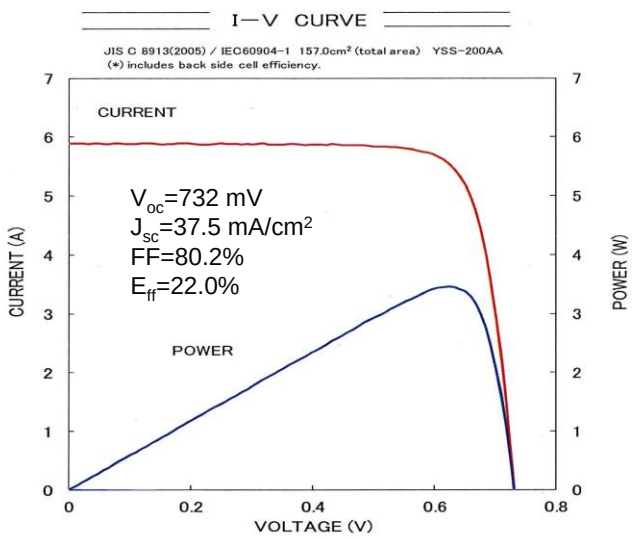
*Wu, et al. Nat Commun 2013; **4**: 2487.*

Approaches at SITRI

Thin, pseudo-flexible, high-efficiency HIT solar cell in SIMIT

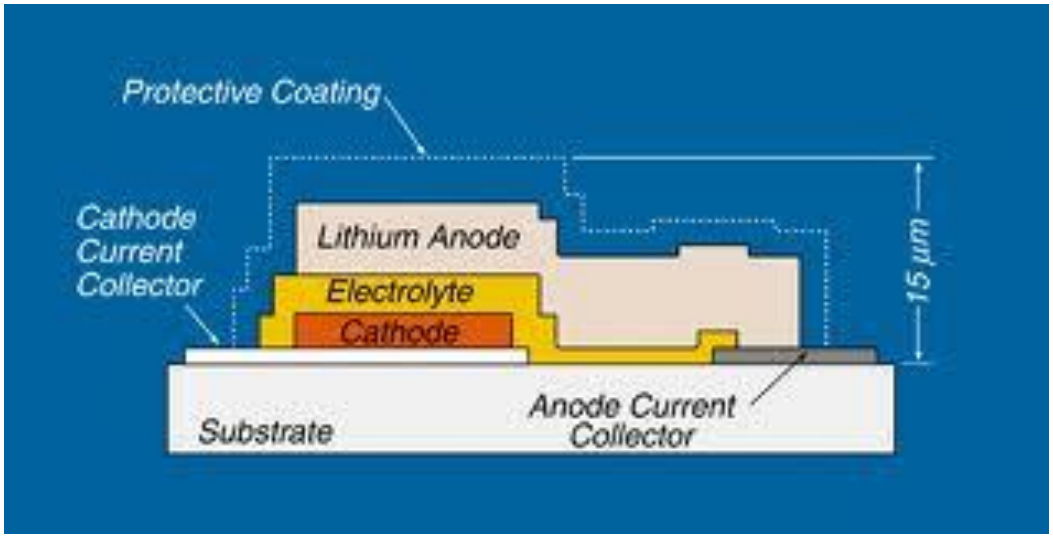


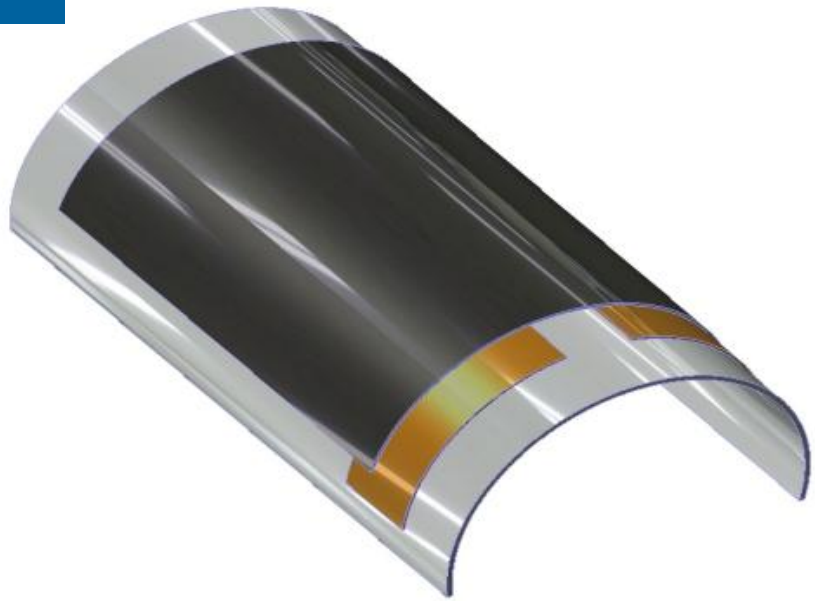
Eff>22%, t=100um



Date :	2015/2/20
Type:	125 thick
Sample No. :	SIMIT-125-thick-1
Repeat Times. :	10
Isc	5.89 [A]
Voc	0.732 [V]
Pmax	3.45 [W]
Ipmax	5.54 [A]
Vpmax	0.624 [V]
F.F.	80.2 [%]
Eff.(T) (*)	22.0 [%]
M.Temp	25.0 [°C]
D Irr.	100.0 [mW/cm²]
M Irr.	99.5 [mW/cm²]
Ref. Device No.	JETp-C01W
Cal. Val. Of Ref.	123.21 [mA at 100mW/cm²]
Scan Mode	Isc to Voc

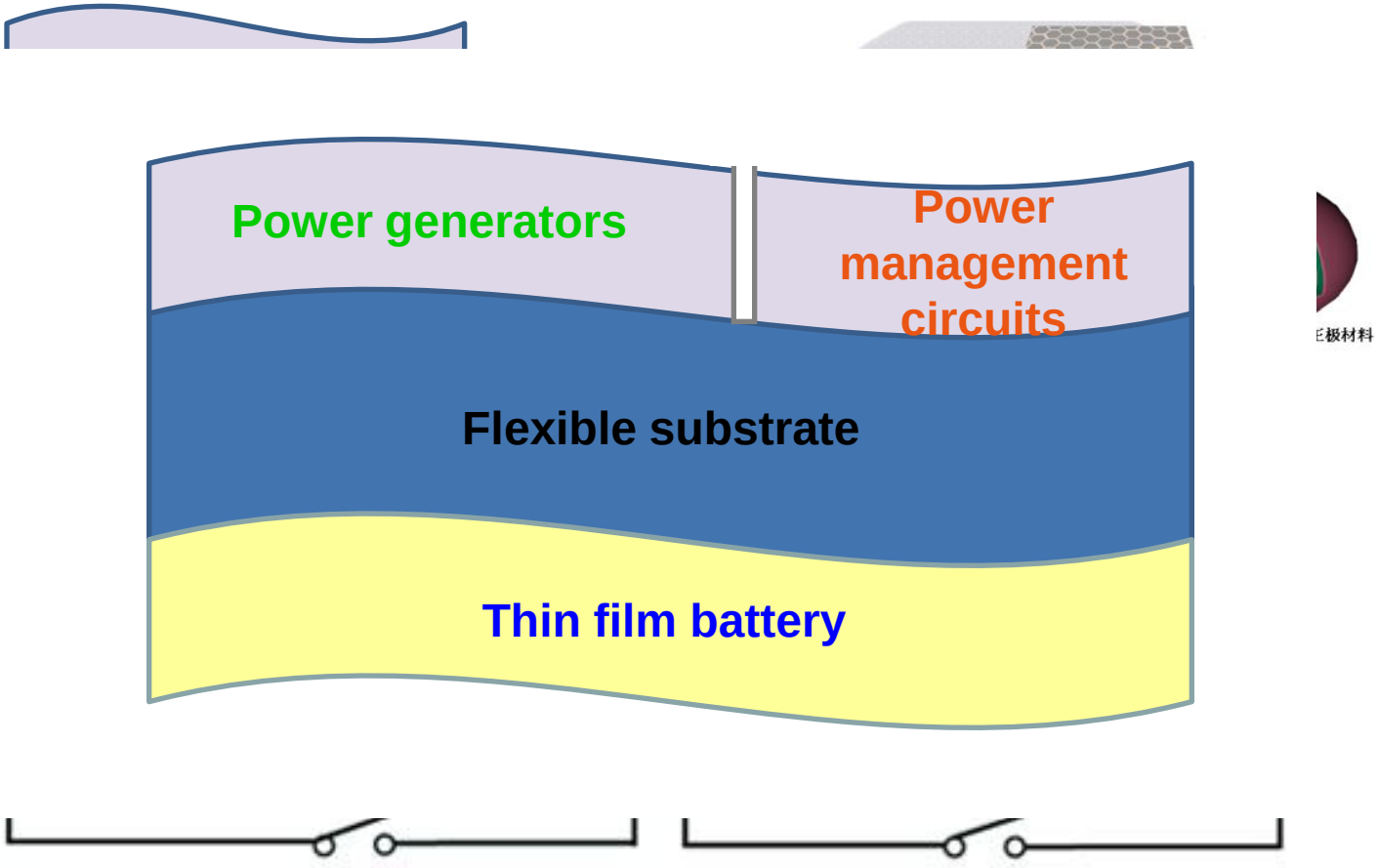
Flexible (paper) battery





Integration of micro energy system

- Combination of thin film solar cell and thin film battery



Angew. Chem. Int. Ed.2014, 53, 6110

Conclusion

Challenges:

- **High efficiency power generator**
- **ULP power management circuits**
- **High performance power storage system**
- **Size of energy collection system (portable, micromation, integration)**
- **Cost**

SITRI