Flexible Optoelectronic Materials & Devices Lab
Science that Brings Solutions to Society

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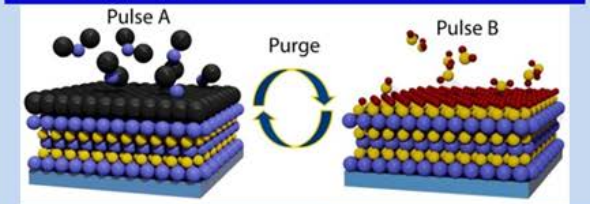
可撓式光電材料之開發、表面改質與元件應用

1 Å → 1 nm → 1 μm → >1 mm

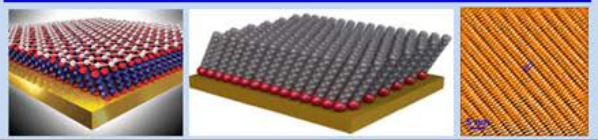
基礎 Atoms, Radicals, Ions → Nanomaterials → 3D System 應用

表面化學與官能化

原子層與分子層沉積技術

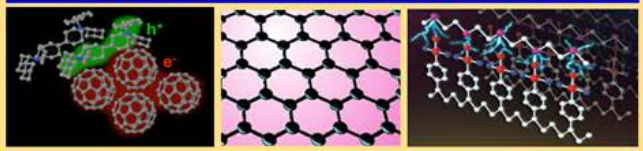


自組裝單分子層

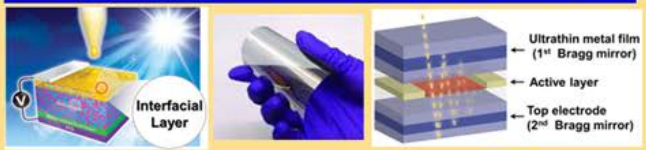


碳材料、功能性薄膜與奈米材料

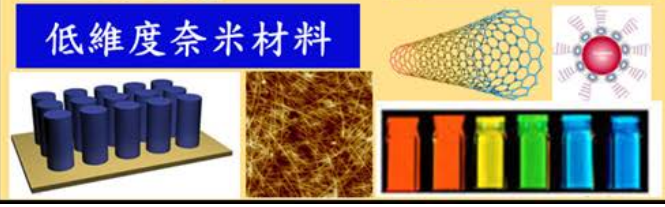
碳材料（有機半導體、離子化合物）



薄膜（界面修飾、透明導電、封裝）



低維度奈米材料



前瞻光電元件開發與應用

高分子與鈣鈦礦光驅動電池

光學/壓力/氣體感測元件

其他（發光二極體、電晶體）

本團隊結合材料開發與元件工程，致力研製新世代可撓式光電材料與元件

The emerging field of flexible electronics

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Flexible & wearable physical sensing platforms

Flexible template materials

Liquid-state

Solid-state

Sensing elements

Sensor materials

Pressing

Stretching

Sensing mechanisms

Bending

Twisting

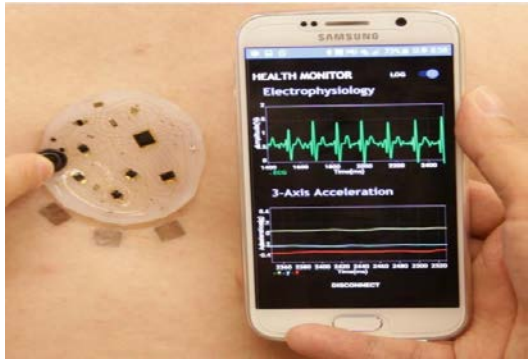
Sensor applications

Artificial electronic skin

Therapeutic & drug delivery platforms

IoT

Physiological monitoring & assessment systems



Innovative Process

Films, interfaces & Processing Techniques

Device

FLEXIBLE WEARABLE DEVICES
Fundamental Research

Material

Interface

Nanomaterials
0D to 3D Nanomaterials,
Organic Semiconductors

Nano-Bio interfaces
Interactions,
Biocompatibility

An integrated approach to achieve high efficiency & stable polymer photovoltaics

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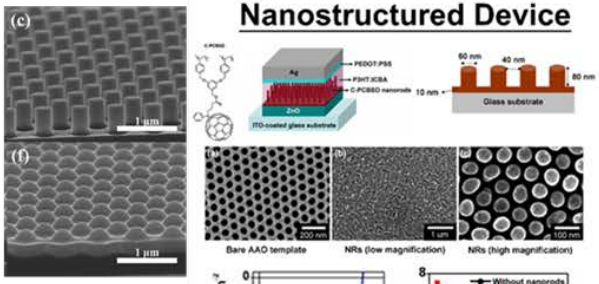
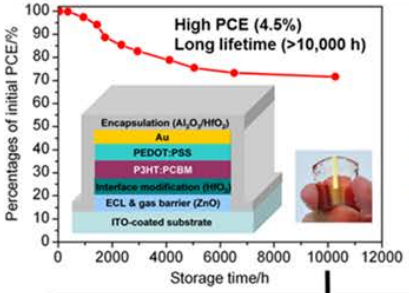
Approach: morphological (or structural) manipulation + interfacial engineering

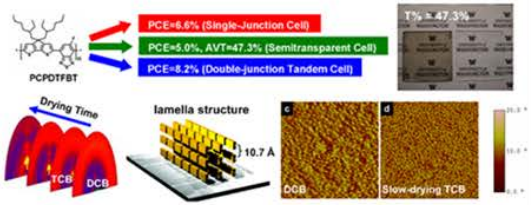
Nanostructured Device



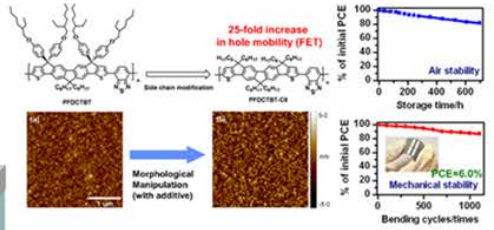
Air-Stable Flexible Solar Cell



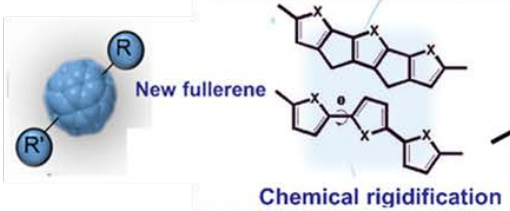
Tandem Solar Cell

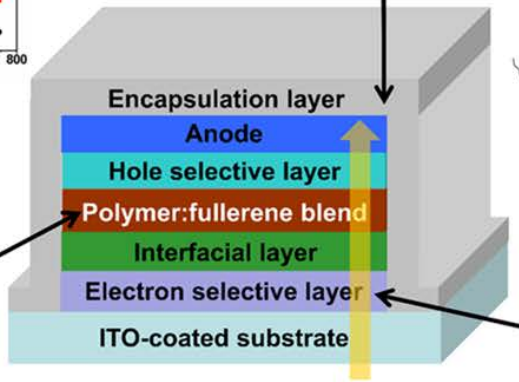


Integrated Approaches for Flexible Solar Cell

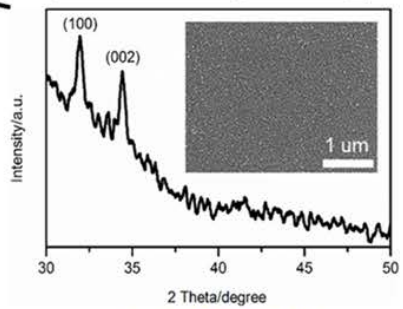


Materials Development

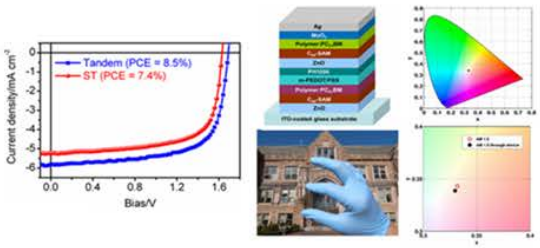




Interface Engineering



Semitransparent Solar Cell



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Important breakthroughs in improving practicality of perovskite photovoltaics

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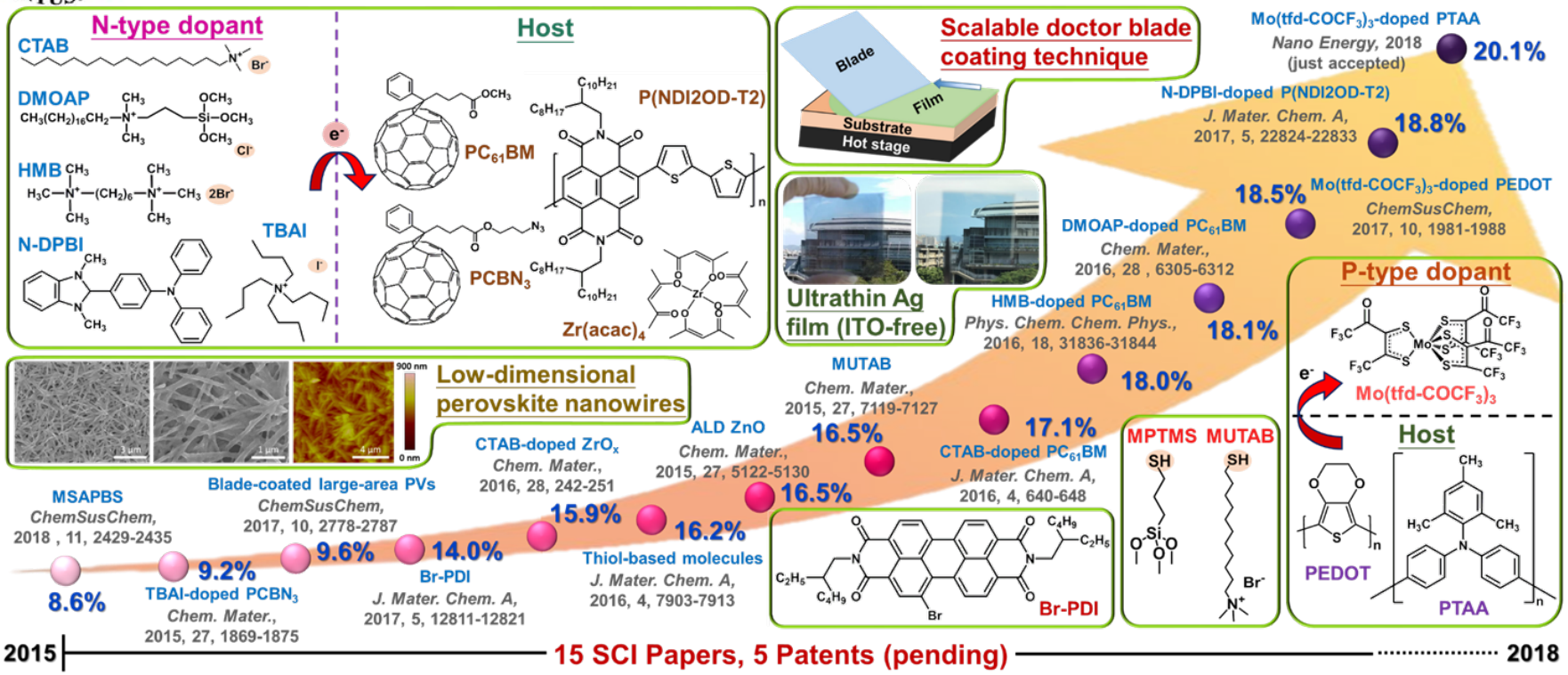

- Our strategies focus on **Materials Functionalization** + **Device Engineering**:
  - Interfacial materials: doped organic molecules, metal oxides, thiols
  - Perovskites: mixed Sn-Pb perovskites, Pb-free perovskites
  - Transparent electrode (replacement for ITO): ultrathin Ag film
  - Scalable fabrication: doctor blade, vacuum-free, module development
  - Stability improvement: thin-film encapsulation

Amine-based conjugated molecules as spacer for low-dimensional perovskites

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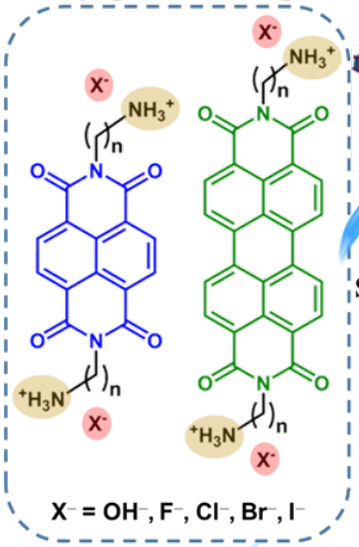
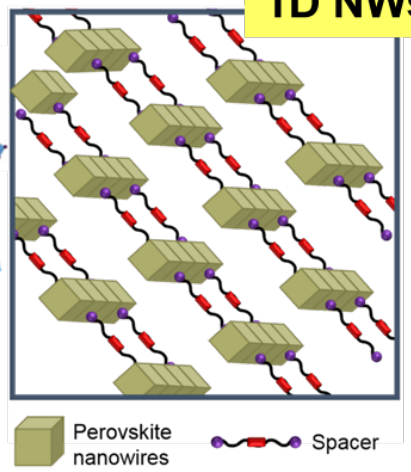
π-conjugated core spacer材料

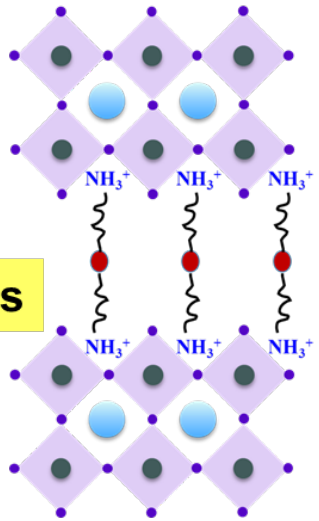


Self-assembly



1D NWs

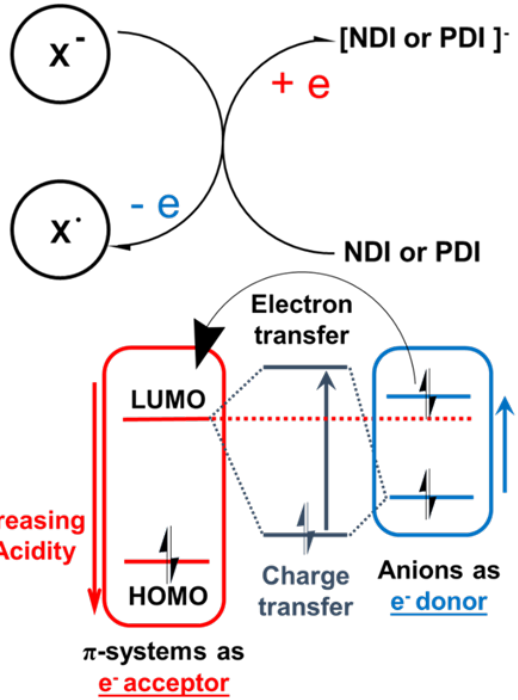
Self-assembly



2D layered structures

● : NDI or PDI conjugated core structure

Anions-induced self n-doping



NH_2-H^+ on diamine forms hydrogen bonds with halogen of perovskites
⇒ formation energy ↑ , stability ↑

- **Conjugated structure + n-doping**
  ⇒ charge transport properties ↑

Molecularly surface engineering of self-powered triboelectric nanogenerators

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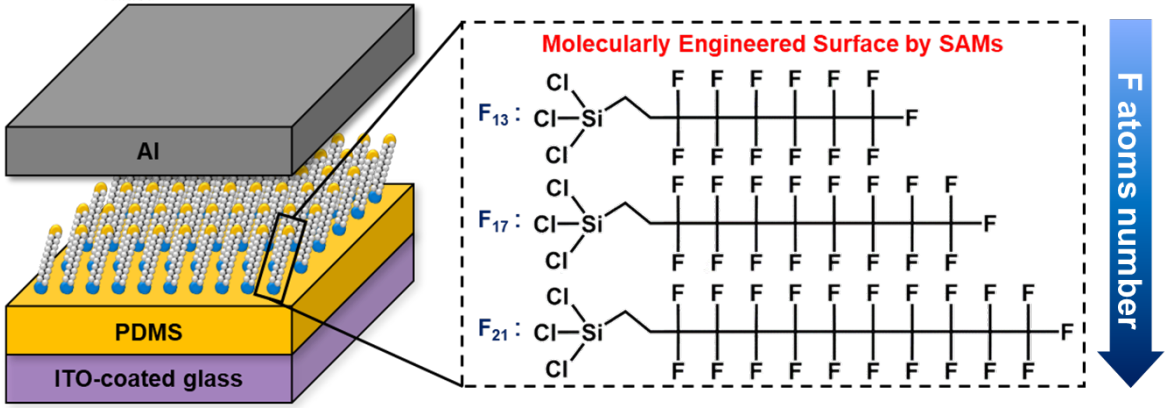

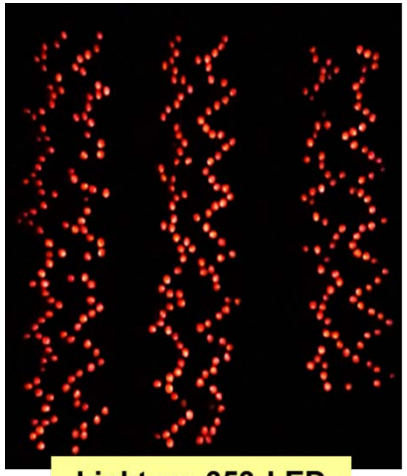

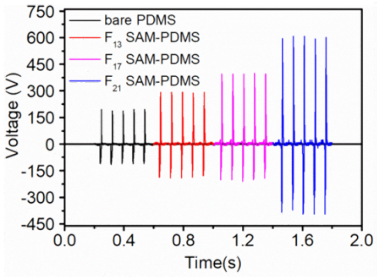

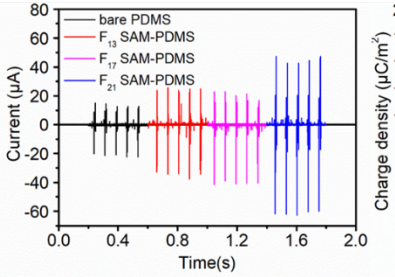

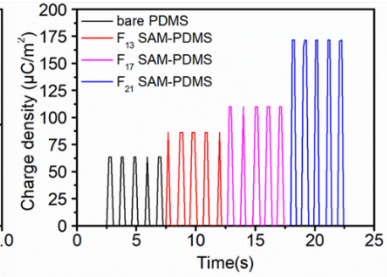

Friction layer	Surface Potential [V]	V_{oc} [V]	I_{sc} [μA]	Δσ [μC/m²]
Bare PDMS	-0.11	200	20	64
F_{13} SAM-PDMS	-1.01	300	70	87
F_{17} SAM-PDMS	-1.10	400	80	113
F_{21} SAM-PDMS	-1.36	600	120	175

- The number of F atoms ↑, charge density ↑, output performance ↑
- TENGs exhibited the maximum open-circuit voltage (V_{oc}) and short-circuit current (I_{sc}) of 600 V and 120 μA, respectively
- Record-high performance for SAM-modified TENGs