

# Conjugated Polymer Coating for Nano-Structures: Chemical Vapor Deposition Polymerization for Excitonic Solar Cells

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# Answer for Ultimate Polymer Solar Cells ?

Ok. We have a 6% P3HT/PCBM bulk heterojunction solar cell. Now what?  
( Hats off to Dr. K. Kim from KIST & Dr. D. Carroll from Wake Forrest)



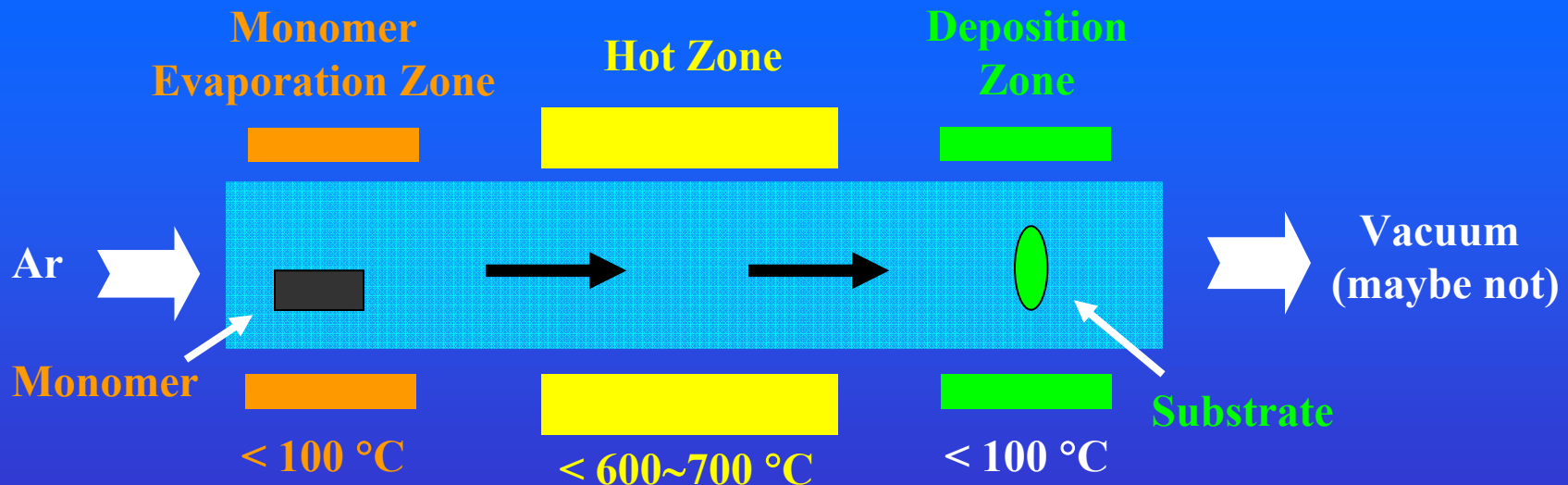
- Junction Architecture (for multijunction concept?)
  - Layered junction
  - Bulk heterojunction (nano required)
  - Ordered bulk heterojunction (more nano required)
  - Molecular engineering (copolymer, diads etc.)
  - ?
- Process
  - Spin coating
  - Screen Printing
  - Evaporation (small molecules)
  - PECVD
  - ?
- Materials (electron donors & acceptors)
  - Stable polymers
  - Bandgap engineering

# Thermal CVD Polymerization

(Under-explored for Conjugated Polymers)

- Great conformality – Nano, bi-facial, round, etc.
- Multi layer capability (easy)
- No catalysts and solvent
- Interesting new chemistry and new polymers

## Basic Thermal CVDP Set-up

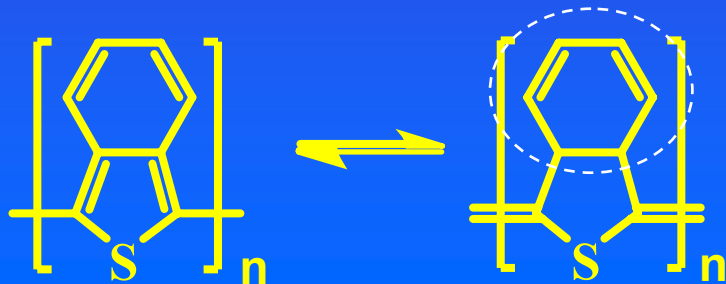


# Thermal CVDP of Poly(isothianaphthene)

(Motivation: Stable Low-Bandgap Conjugated Polymer)

## Bandgap Engineering of Conjugated Polymers

Conventional PITN: ~1.1 eV



$$E_g = E^{\delta r} + E^{\theta} + E^{\text{Res}} + E^{\text{Sub}} + E^{\text{Int}}$$

$E^{\delta r}$ : Bond length alternation

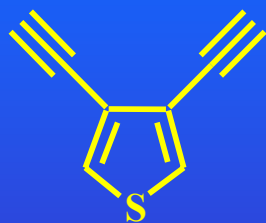
$E^{\theta}$ : Mean deviation from planarity

$E^{\text{Res}}$ : Aromatic resonance energy

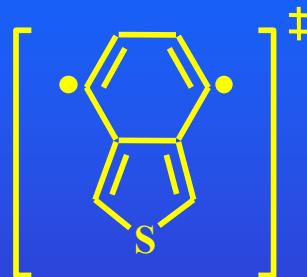
$E^{\text{Sub}}$ : Effect of substitution

$E^{\text{Int}}$ : Intermolecular or interchain coupling

## What we did with Thermal CVDP



3,4-diethynylthiophene



RT



Poly(3,6-isothianaphthene)