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Polimeri innovativi per fotovoltaico organico polimerico

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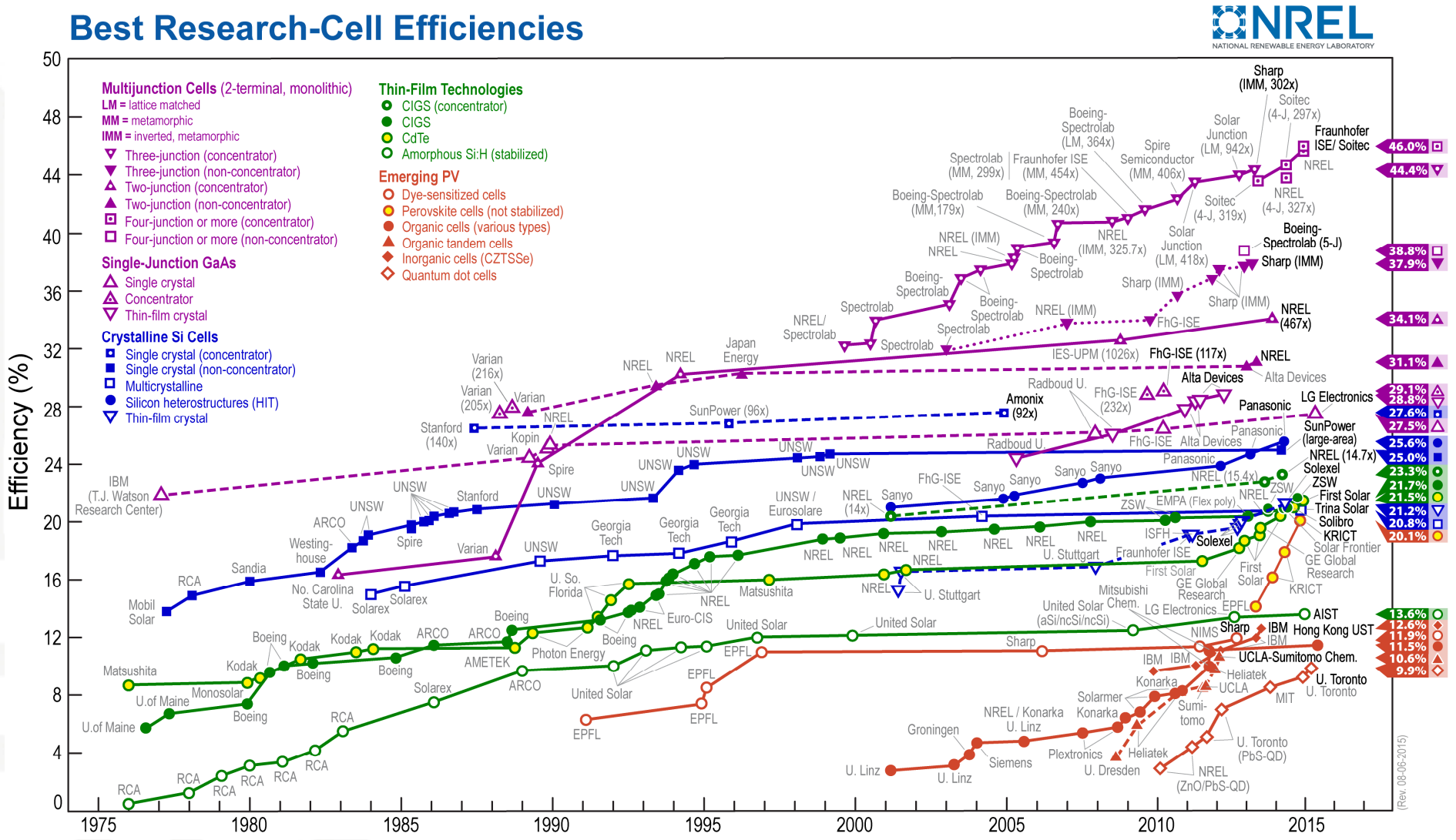
Speaker
Dario Pasini

7/10/2015

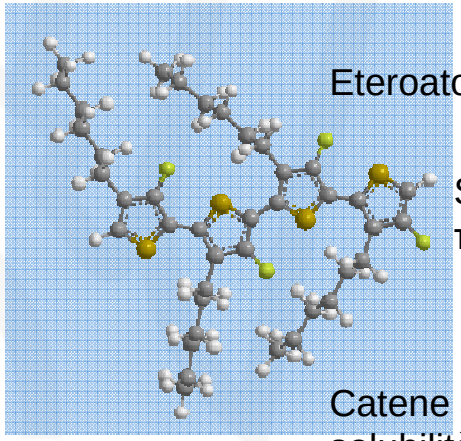
ASSOLOMBARDA FAR VOLARE MILANO

Sistemi Fotovoltaici: NREL Chart



Fotovoltaico Organico Polimerico

Le celle fotovoltaiche convertono radiazione luminosa in elettricità tramite effetto fotovoltaico

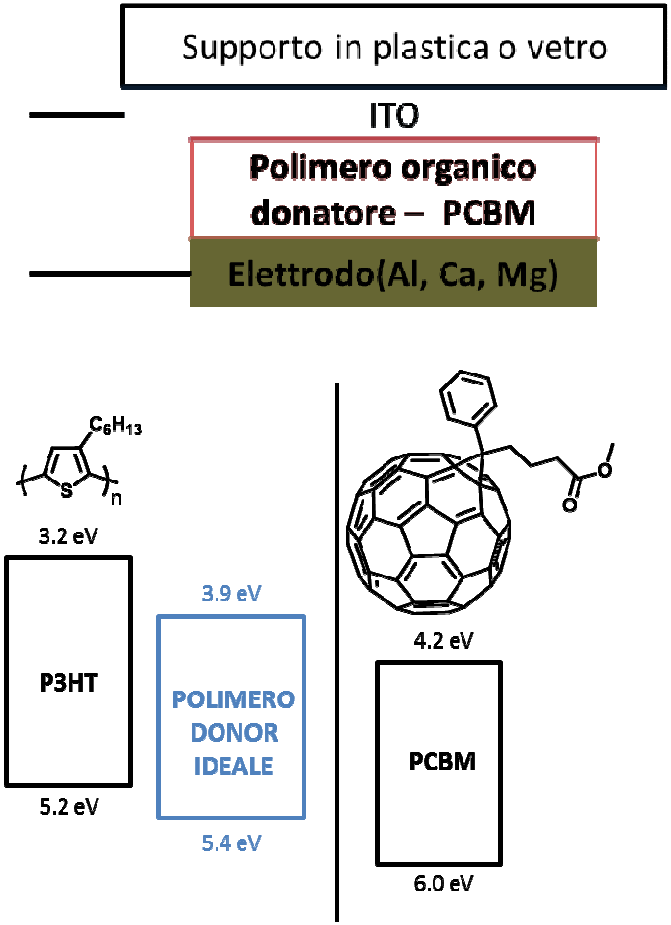


Eteroatomi

Scheletro carbonioso π-coniugato

Catene alifatiche per solubilità

Devices più studiati (OPV): architettura Bulk-Heterojunction (BHJ)



Vantaggi e Svantaggi OPV vs Si

Svantaggi:

- ***Efficienze più basse***
- ***Ridotta stabilità temporale***

Vantaggi:

- ***Costi inferiori per la produzione del materiale attivo (polimero vs cristallo di silicio)***
- ***Flessibilità meccanica***

Grado di Maturità della Tecnologia

- ***Infinity OPV: recente startup (Technical University of Denmark). Una delle tre industrie a livello mondiale che vende celle OPV***
- ***Prodotto garantito due anni. Efficienze tra il 2 e il 4%***

Integrabilità in Tessuti

ChemPubSoc Europe

DOI: 10.1002/cssc.201403377

CHEMSUSCHEM Highlights

The Solar Textile Challenge: How It Will Not Work and Where It Might

Frederik C. Krebs* and Markus Hösel[a]

Solar textiles are highlighted as a future technology with transformative power within the fields of both textiles and solar cells provided that developments are made in critical areas. Specifically, these are fundamental solutions to materials and material combinations with mechanical stability and flexibility imposed by textile architectures, scientific solutions to achieve high carrier transport efficiency and optical transmission in a textile topology, technical solutions to controlling the physical disposition of the anode and cathode along with their specific and error-free contacting and, finally, practical solutions to fast and efficient manufacture and integration. The areas of application and the penetration of solar textiles into our everyday life are expected to be explosive pending efficient developments within these four key areas. A shortcoming in one or more of these will, however, lead to the solar textiles being banned to academic existence.

[a] Dept. of Energy, Solar Energy Section, Technical University of Denmark

Integrabilità in Tessuti

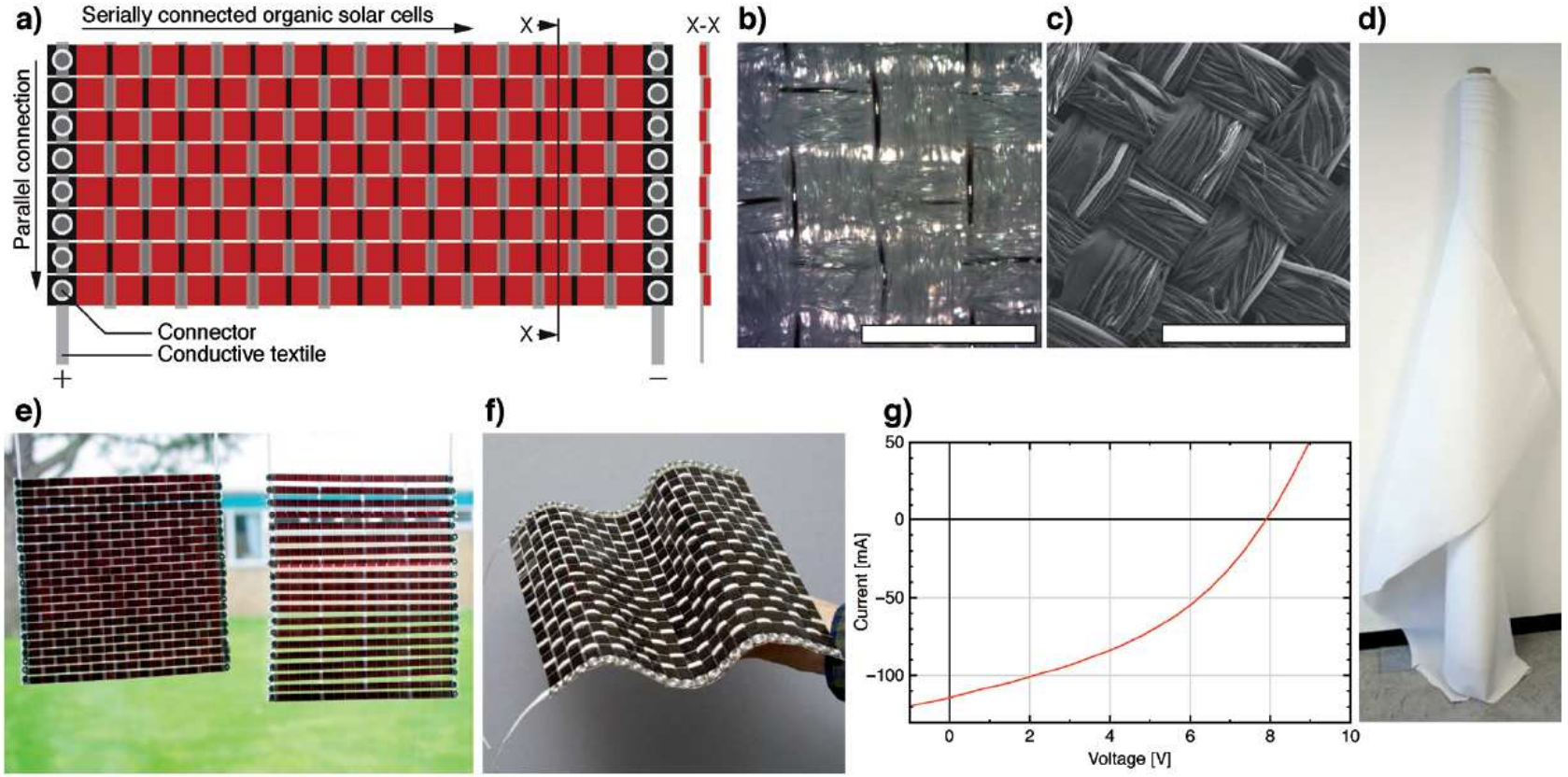


Figure 2. An illustration of a tape-weaved solar cell textile that efficiently takes advantage of the inherent directionality of the textile approach such that the positive and negative electrode are separated. Shown here schematically as a) solar cell tape as weft and conducting woven polyester material as warp, shown as an optical micrograph in (b) and as a scanning electron micrograph in (c) [scale bar in (b) and (c) corresponds to 10 mm], with a roll of woven polyester fabric with embedded silver wires shown in (d). The warp is used as electrical bus bar at the edges of the textile along the web direction for large-area (25×25 cm^2) examples shown in (e) and (f). An *I–V* curve is shown in (g) with the solar cell comprising tapes of indium-tin-oxide-free polymer solar cells prepared entirely by R2R processing.[1] The solar tapes have 16 serially connected single junctions and an active area of 368 cm^2, a power conversion efficiency of ~1%, open circuit voltage (V_{oc}) = 7.9 V, short circuit current (I_{sc}) = 114 mA, and a fill factor (FF) = 40%.

I Materiali

Architettura dello strato fotoattivo:

- ***Bulk Heterojunction (BHJ): miscela bicontinua sulla nanoscala***

Parametri importanti → Domini cristallini bicontinui di 10-20 nm: organizzazione sulla scala nanometrica → Self-assembly e stabilità

Fattori che influenzano la morfologia finale:

- Natura dei componenti D ed A
- Miscibilità intrinseca tra D ed A
- Solvente usato e condizioni di *solvent annealing*
- Peso molecolare medio e regioregolarità dei polimeri
- Natura e lunghezza delle catene laterali solubilizzanti

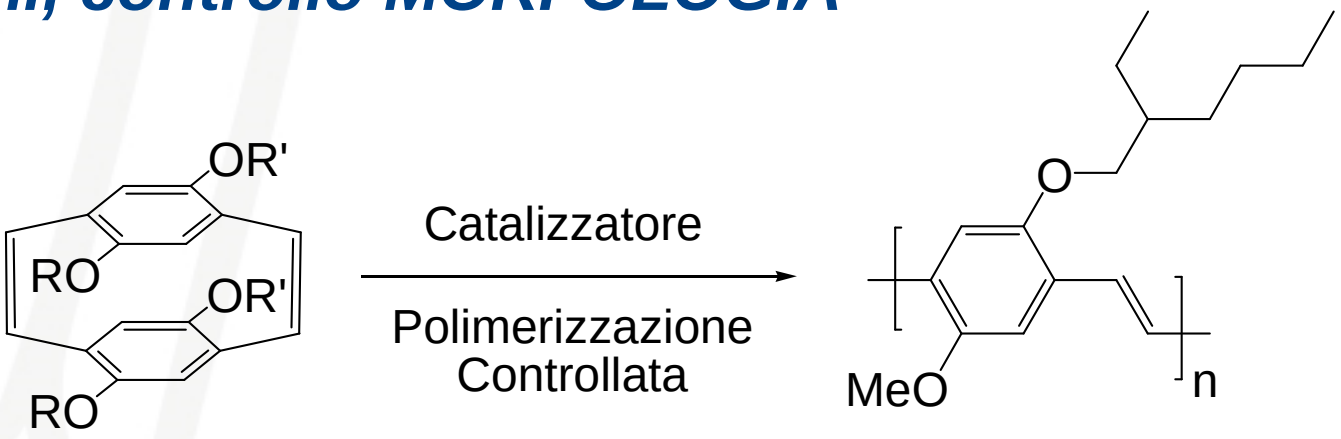
Approccio iniziale UNIPV

Polimeri coniugati tramite polimerizzazioni controllate

Vantaggi:
a) controllo polidispersità;

b) controllo funzionalità endcapping;

c) Possibilità di reiniziare polimerizzazione: copolimeri a blocchi, controllo MORFOLOGIA

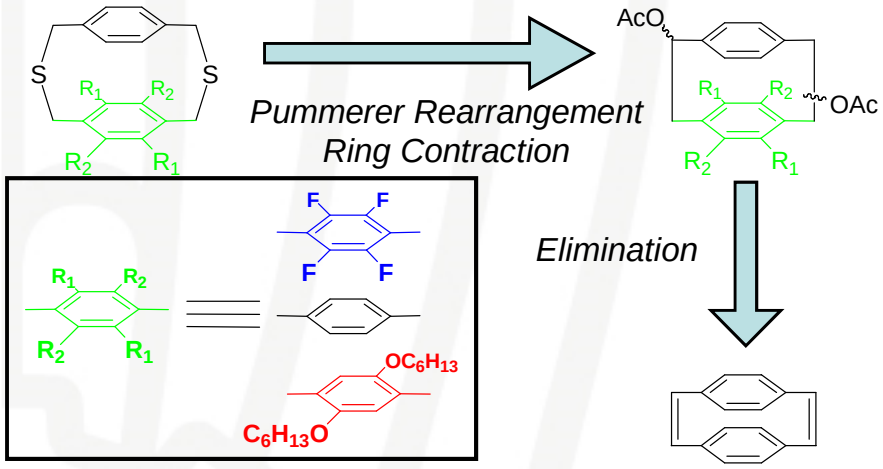


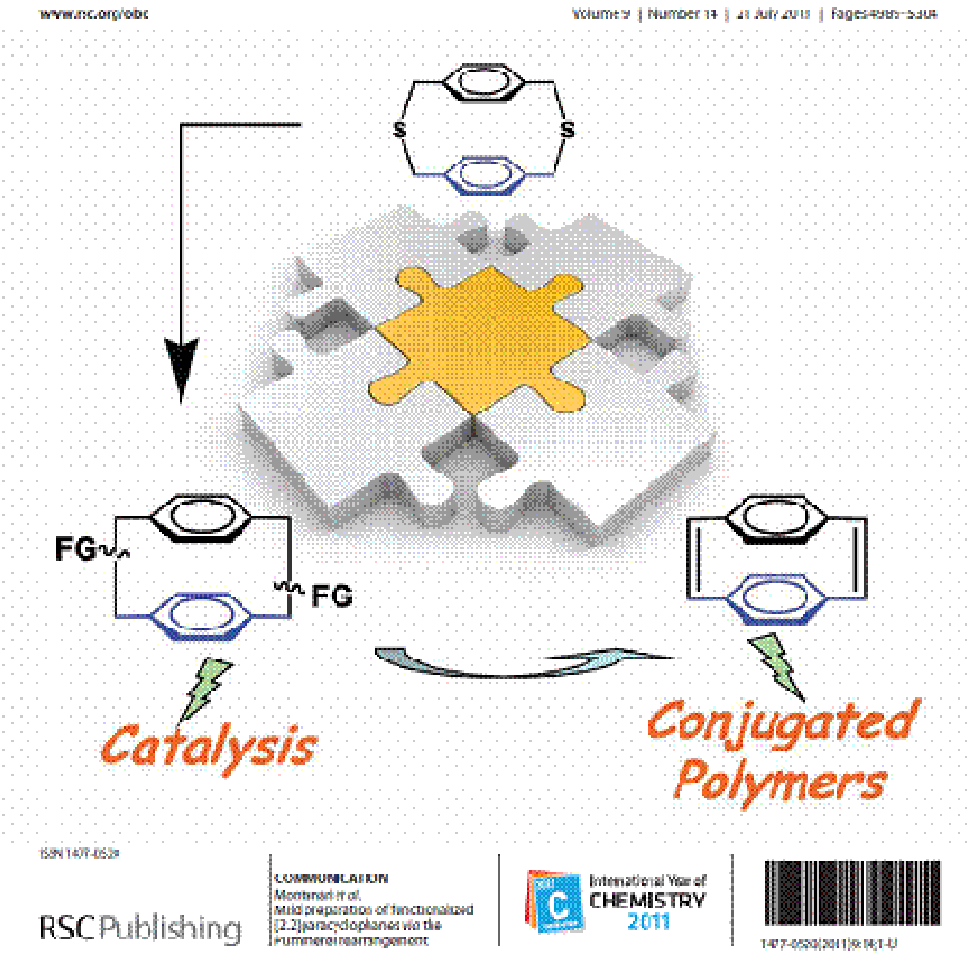
R = C_8H_{17}
R' = CH_3

MEH-PPV

M. L. Turner et al, *Macromolecules*, **2010**, *43*, 222–232

Sintesi Monomeri Innovativa





M. Montanari, A. Bugana, A. K. Sharma, D. Pasini,* *Org. Biomol. Chem.*, **2011**, *9*, 5018-5020

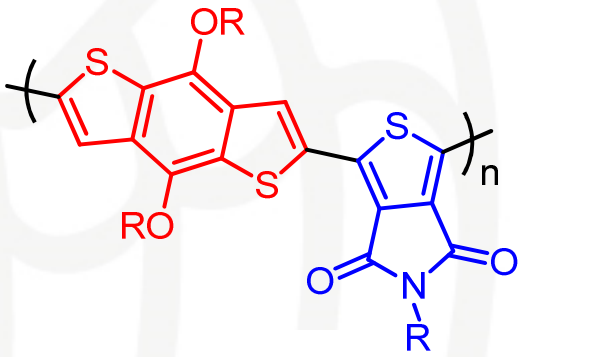
Collaborazione con ENI

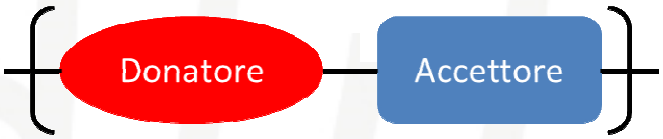
- ***Centro di ricerca ENI Donegani (Novara) Research Center for Renewable Energies & Environment (Riccardo Po')***

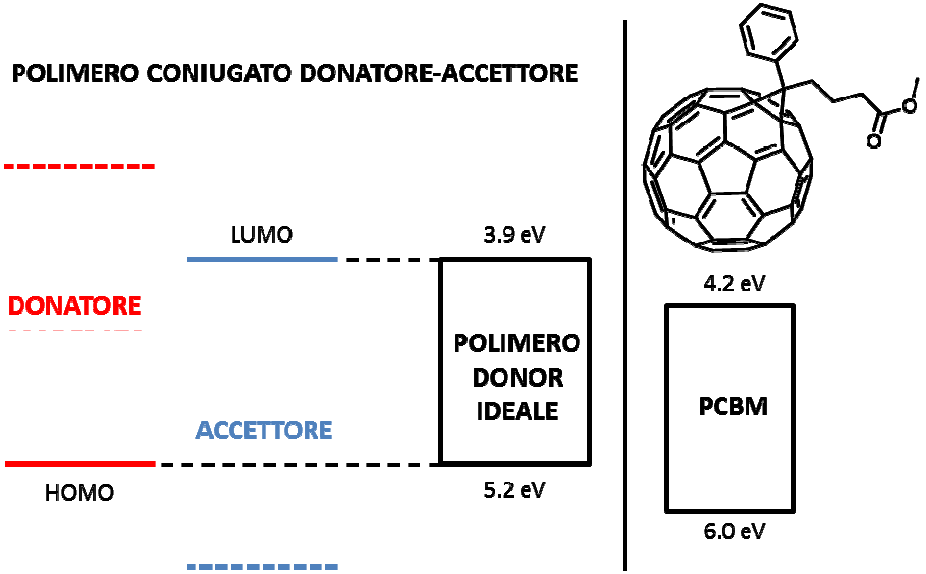
- ***Finanziamento di una borsa di Dottorato + materiale di laboratorio (70.000 Euro) in corso***

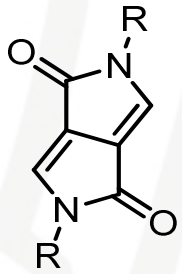
- ***Ricerca comune con accordi precisi a tutela della proprietà intellettuale ENI***

Conjugated Donor-Acceptor Polymers

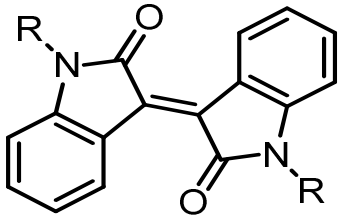






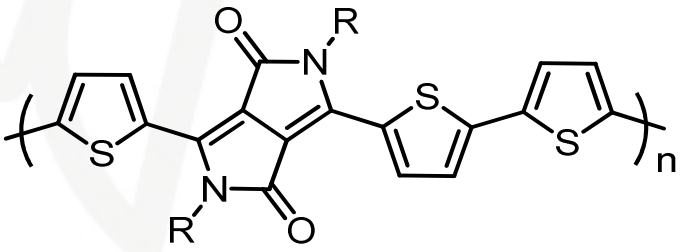


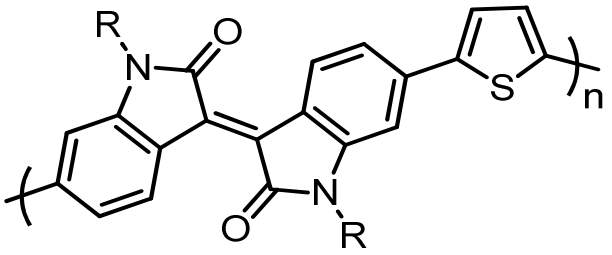
DPP



II

Concetti chiave: monomeri industrialmente scalabili, derivati da coloranti naturali, sintesi polimeriche industrialmente scalabili



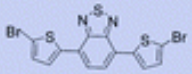
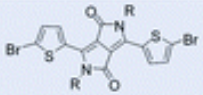
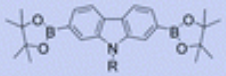
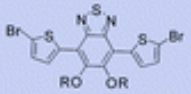
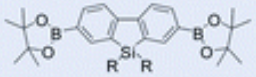
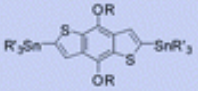
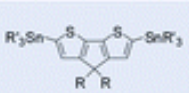
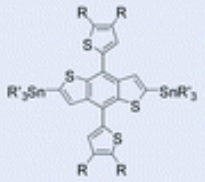


Y. Zou, A. Najari, P. Berrouard, S. Beaupré, B. Rèda Aich, Y. Tao, M. Leclerc, *J. Am. Chem. Soc.* **2010**, *132*, 5330

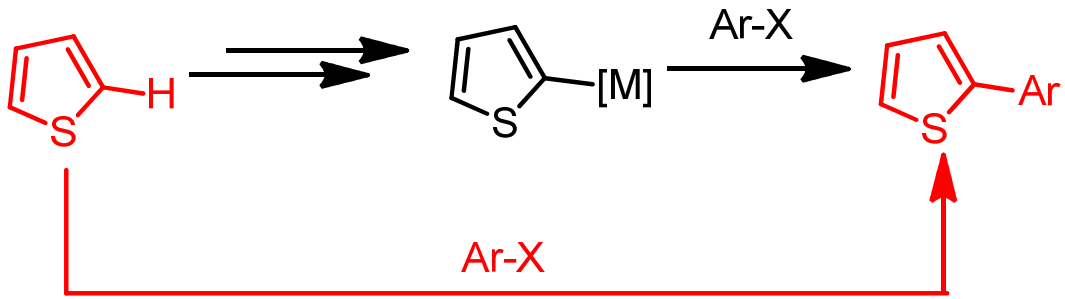
Principali metodi di Polimerizzazione

Sintesi Monomeri richiede reagenti poco scalabili industrialmente (organometallici)

Sottoprodotti stechiometrici di reazione non ecofriendly (sali di stagno o boronati)

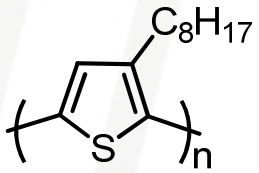
		Electronic properties	Number of synthetic steps
		Acceptor	3
		Acceptor	3
Suzuki coupling		Donor	4
		Acceptor	4
		Acceptor	5
Suzuki coupling		Donor	5
Stille coupling		Donor	5
Stille coupling		Donor	6
		Acceptor	7
Stille coupling		Donor	7

Direct Hetero Arylation Polymerization

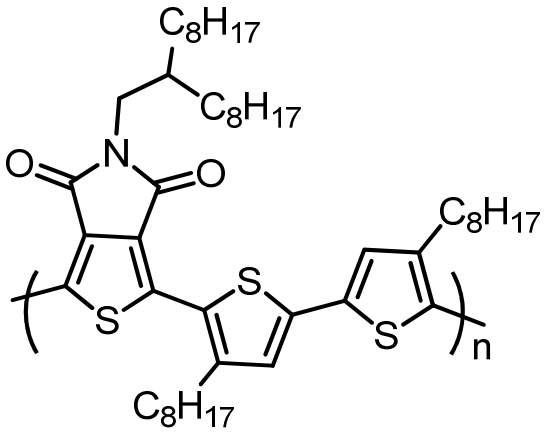


Direct Arylation

Concept: Catalitica, economica, eco friendly, scalabile industrialmente



M_n 30.6 KDa, PDI 1.6
rr 98%



M_n 56 KDa, PDI 2.6

L. G. Mercier, M. Leclerc, *Acc. Chem. Res.* **2013**, *46*, 1597

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