NEXT GENERATION OF GREEN OPV CELLS BASED ON WATER-SOLUBLE PHOTO-ACTIVE MATERIAL

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INTRODUCTION

In the last years, in order to avoid the decrease of fossil resources, the attention has been focused on alternative, renewable and low environmental impact energy, such as solar energy. In this context, water-soluble polymeric solar cells (WSCPs) are very promising solutions, due to their excellent optoelectronic properties combined with unique solubility in green solvents such as water and alcohols. Besides, the possibility to obtain a water processable single material as photo-active layer in solar cell could be translate in next generation of solar cells.

SYNTHESIS OF WATER-SOLUBLE DOUBLE-CABLE MATERIAL

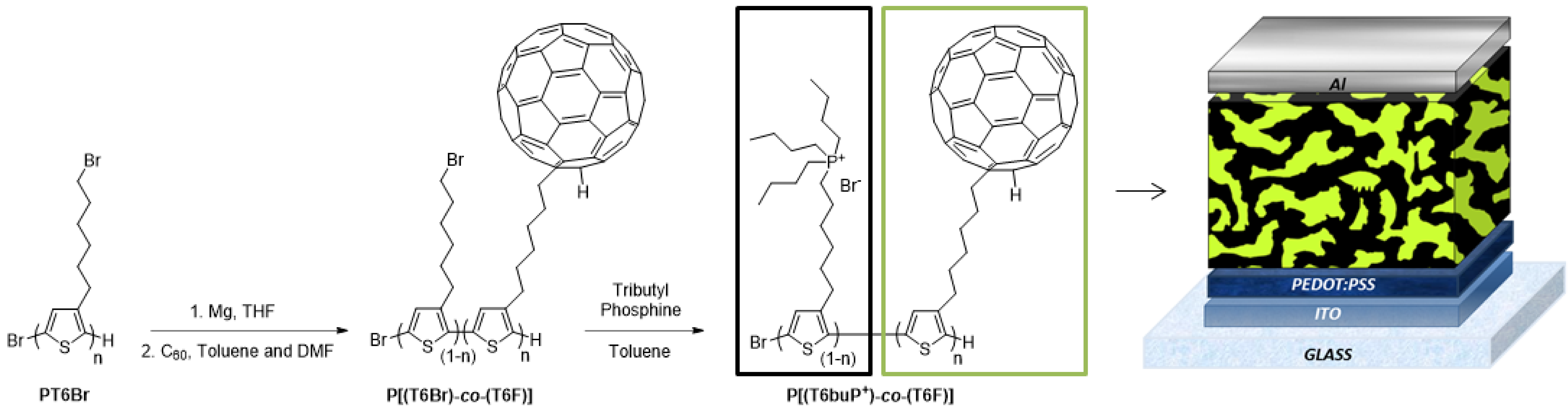

Figure 1. Synthesis of water-soluble photo-active material (P[(T6buP$^+$)-*co*-(T6F)]).

CHARACTERIZATIONS

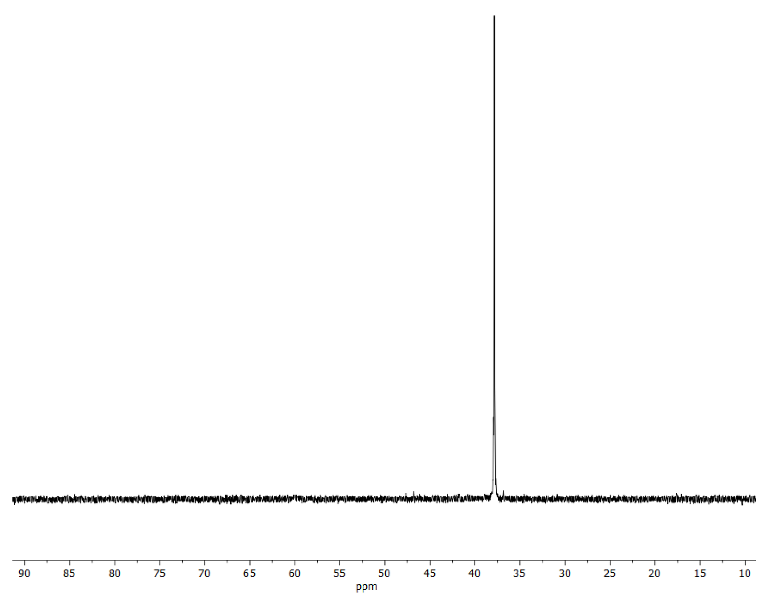

Figure 2. ^{31}P-NMR of P([T6buP$^+$)-*co*-(T6F)].

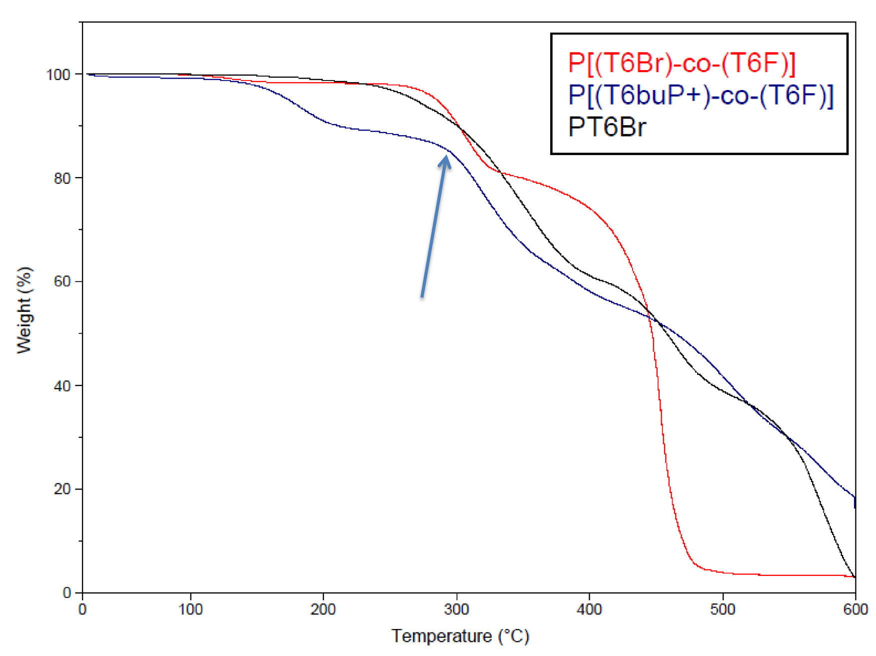

Figure 3. Thermograms of polymers.

Table 1. Characteristics of polymeric precursors and final material.

	Reaction Yield (%)	Ionic group content (% mol) [a]	C_{60} content (% mol) [a]	Mn (kDa)	PDI	T_g (°C) [d]	T_d (°C) [e]
PT6Br	21	-	-	14.9[b]	1.15[b]	55	282
P[(T6Br)-*co*-(T6F)]	85	-	7	17.6[c]	1.15[c]	77	260
P[(T6buP$^+$)-*co*-(T6F)]	78	93	7	29.1[c]	1.15[c]	27	296

[a] Determined by ^{1}H-NMR; [b] Determined by GPC relative to polystyrene standards; [c] Calculated from the molecular mass of the precursor; [d] Glass-transition; [e] Initial decomposition temperatures.

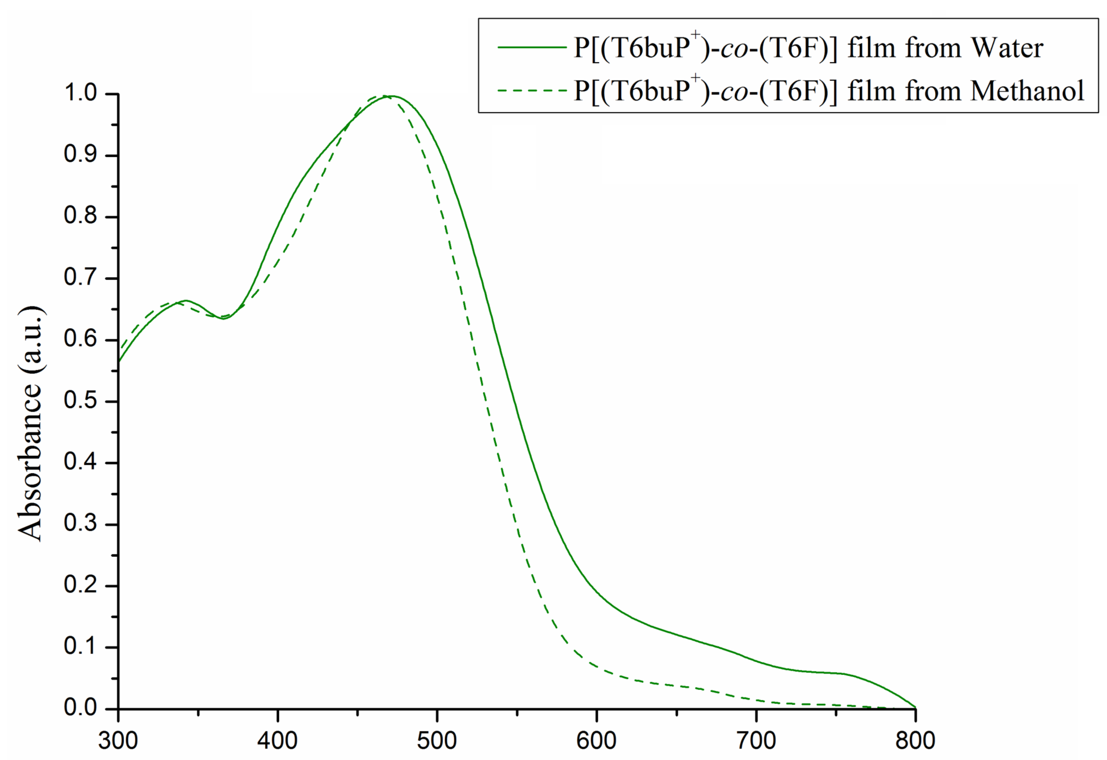

Figure 4. UV-Vis spectra of copolymer films.

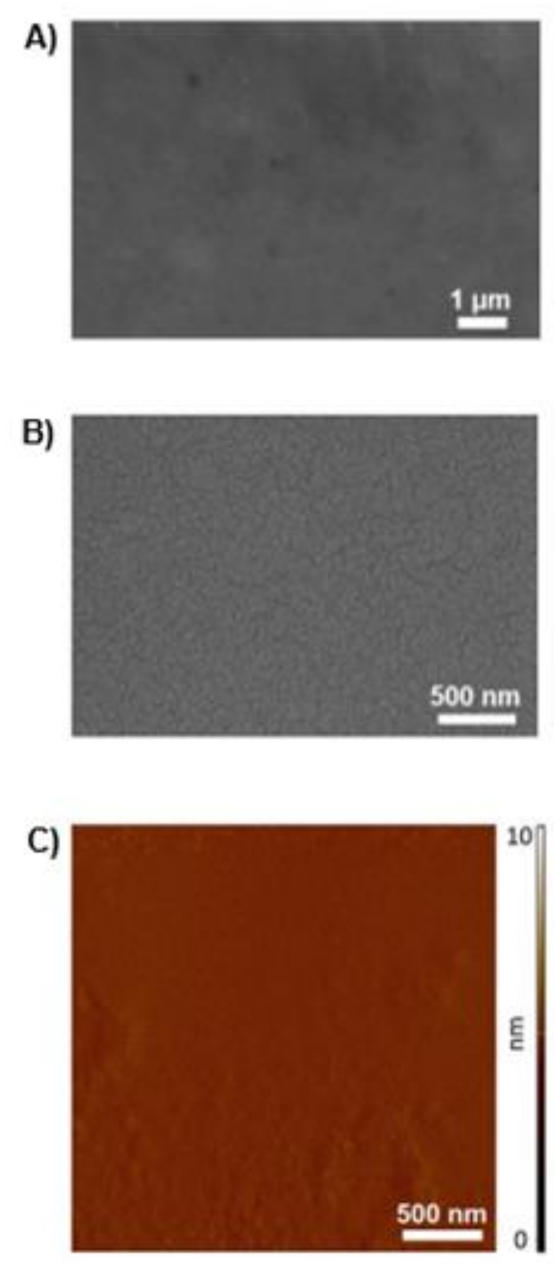

Figure 5. FE-SEM (A,B) and AFM (C) topographical images of the active layer material.

PHOTOACTIVE LAYER OF SOLAR CELL

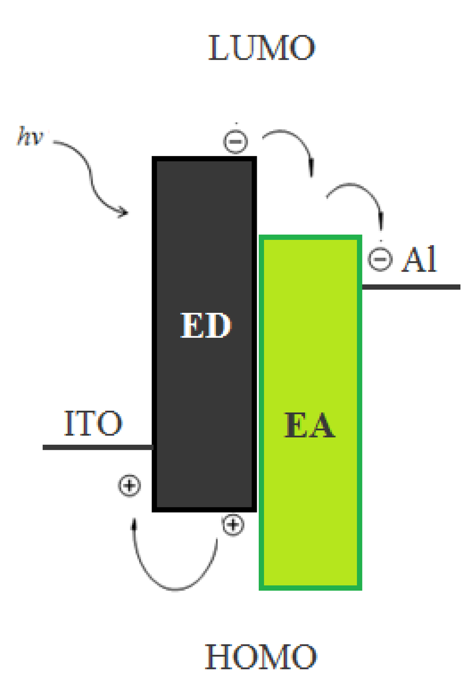

Figure 6. Photoconversion mechanism.

The synthesized polymeric material was tested as photo-active layer in air-processed organic solar device (Table 2).

Table 2. Properties of solar cell.

	J_{sc} [a] (mA/cm²)	J_{sc} [b] (mA/cm²) EQE	V_{oc} [c] (V)	FF [d] (%)	PCE [e] (%)
P[(T6buP$^+$)-*co*-(T6F)]	8.51	8.78	0.61	0.60	3.11

[a] Short circuit current ; [b] Short circuit current from EQE measurements; [c] Open circuit voltage; [d] Fill factor; [e] Photovoltaic cell efficiency.

CONCLUSIONS

The ionic copolymer P[(T6buP$^+$)-*co*-(T6F)] has been successfully synthesized, characterized and tested as photo-active layer in a photovoltaic cell with bulk-heterojunction (BHJ) architecture. The photoconversion performance of the prepared device open up new possibilities for novel more environmental-friendly organic solar cells.

M. Lanzi, D. Quadretti, M. Marinelli, Y. Ziai, E. Salatelli, F. Pierini, *Polymers* **2021**, 13, 1640, 1-20.