2015 中技社科技研究獎學金

CTCI Science and Technology Research Scholarship

功能性碳六十衍生物其合成以及有機光電元件之應用

The Syntheses and Applications for Functional Materials of Fullerene Derivatives

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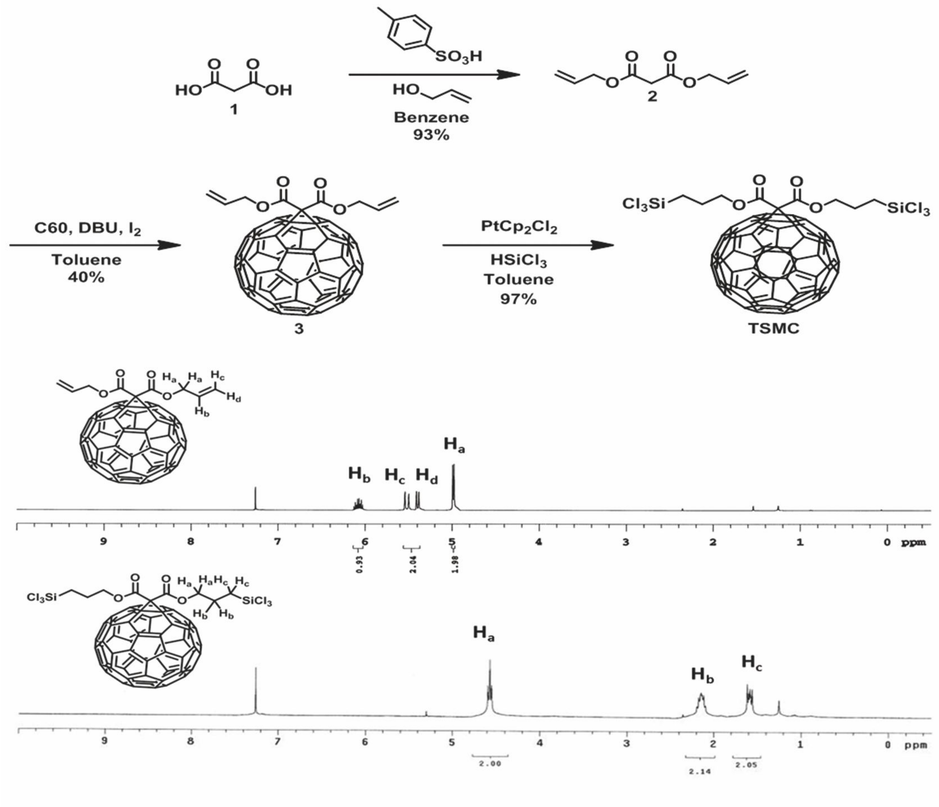
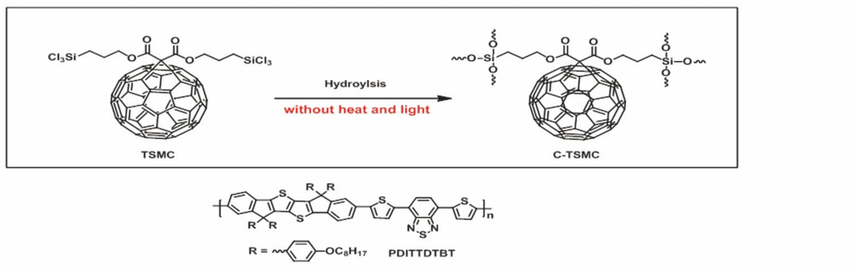
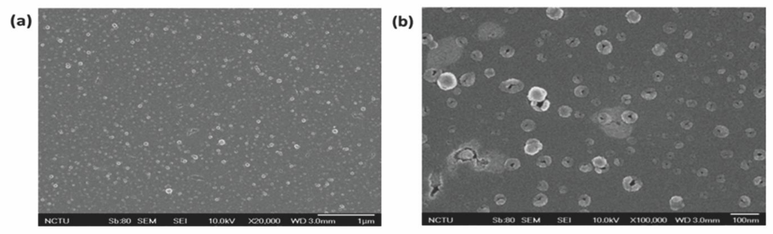
研究重點

A new cross-linkable fullerene material, bis(2-(trichlorosilyl)propyl)-malonate C60 (TSMC), functionalized with two trichlorosilane groups, was easily synthesized by Pt catalyzed olefin hydrosilylation. By making use of facile hydrolysis of the trichlorosilyl moieties, TSMC can be spontaneously self-assembled and cross-linked on the TiOx surface by a simple spin-coating processing without the aid of photoirradiation or post-thermal treatments. The rapid formation of self-assembled and crosslinked TSMC (SA-C-TSMC) effectively passivates the residual hydroxyl groups on the TiOx surface. More significantly, the solvent-resistant TSMC network features a nanostructured surface to provide extra charge generating interfacial area and straight electron transport pathways. The device (ITO/TiOx/SA-C-TSMC/P3HT:PC61BM (1:1, w/w)/PEDOT:PSS/Ag) with this C60 interlayer exhibited an efficiency of 3.9% which greatly outperformed the device without this layer. Furthermore, the strategy can also be effectively applied to the device (ITO/TiOx/PDITTDTBT:PC71BM(1:4, w/w)/MoOx/Ag) incorporating a conjugated polymer, poly(diindenothiophene-alt-dithienylbenzothiadizole) copolymer (PDITTDTBT). This device delivered a high efficiency of 5.8% which represents a 35% enhancement over the device without SA-C-TSMC. This new generation of trichlorosilane-based fullerene offers an easy and accelerated processing technique to produce efficient and cost-effective inverted solar cells.

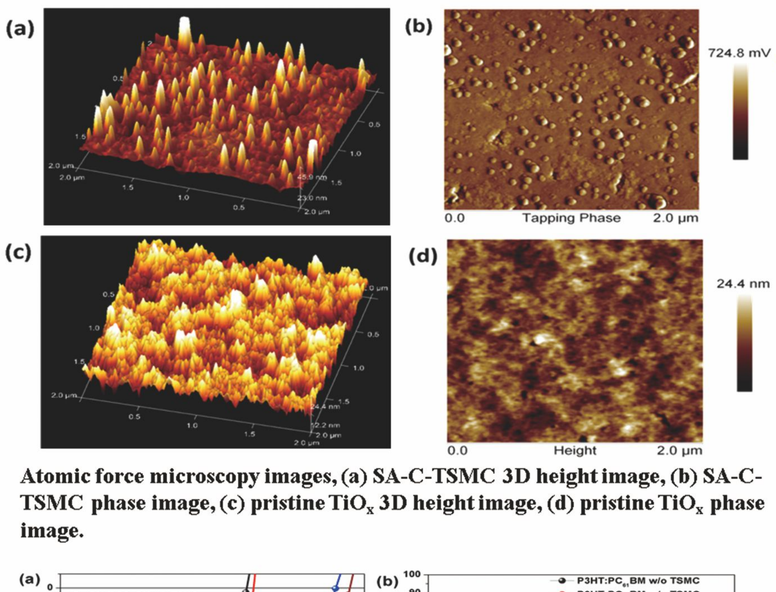
研究成果



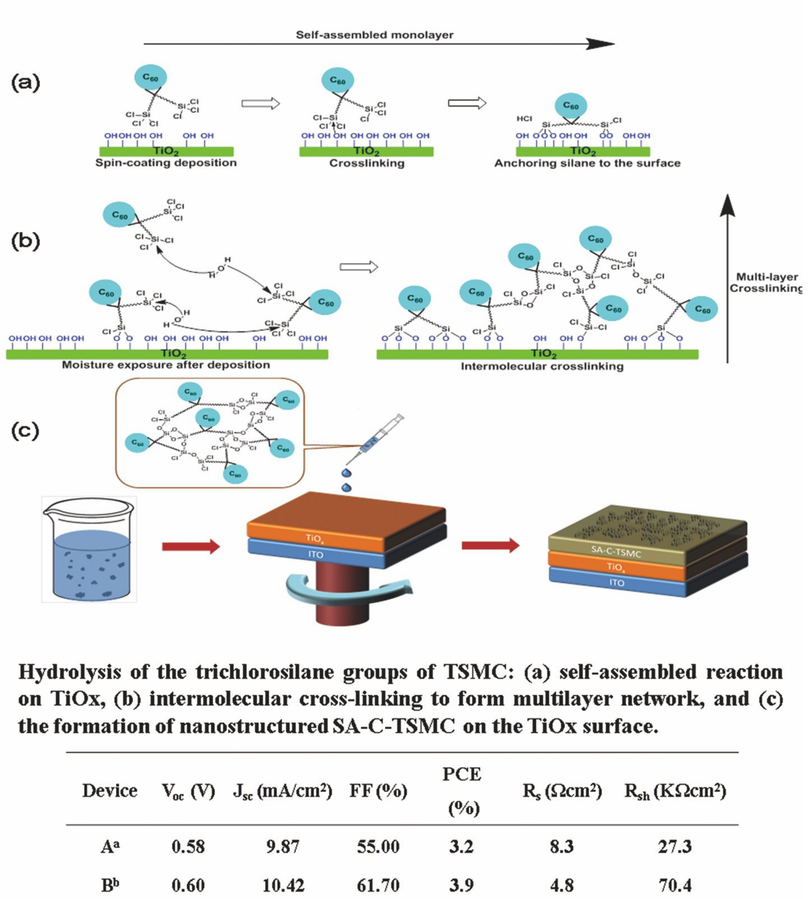




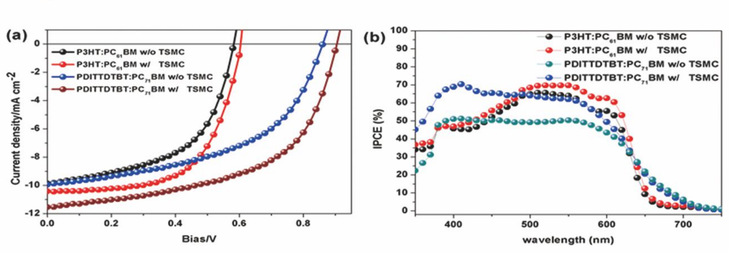
Scanning electron microscope images for the SA-C-TSMC surface at an original magnification of 20000x (a), and 100000x (b).



Atomic force microscopy images, (a) SA-C-TSMC 3D height image, (b) SA-C-TSMC phase image, (c) pristine TiO_x 3D height image, (d) pristine TiO_x phase image.



Hydrolysis of the trichlorosilane groups of TSMC: (a) self-assembled reaction on TiOx, (b) intermolecular cross-linking to form multilayer network, and (c) the formation of nanostructured SA-C-TSMC on the TiOx surface.



Device	V_{oc} (V)	J_{sc} (mA/cm²)	FF (%)	PCE (%)	R_s (Ωcm²)	R_{sh} (KΩcm²)
A[a]	0.58	9.87	55.00	3.2	8.3	27.3
B[b]	0.60	10.42	61.70	3.9	4.8	70.4
C[c]	0.87	9.94	50.27	4.3	12.3	9.3
D[d]	0.91	11.54	55.02	5.8	8.7	192.3

[a]device A, ITO/TiO_x/P3HT:PC_{61}BM (1:1, w/w)/PEDOT:PSS/Ag; [b]device B, ITO/TiO_x/TSMC/P3HT:PC_{61}BM (1:1, w/w)/PEDOT:PSS/Ag; [c]device C, ITO/TiO_x/PDITTDTBT:PC_{71}BM (1:4, w/w)/MoO_x/Ag; [d]device D, ITO/TiO_x/TSMC/PDITTDTBT:PC_{71}BM (1:4, w/w)/MoO_x/Ag

研究生活與心得

此次獲獎要特別感謝鄭彥如教授，鄭教授不僅對我的研究方向上提供了啟發性的指引，同時也對於關鍵性的問題上給出適切的解決方案，藉此才能夠有如今豐碩的研究成果；另一方面，也要特別感謝中技社提供豐富獎項，讓各方傑出人才與研究能夠獲得鼓勵與肯定，不僅強調創新更著重於研究的深度，因而締造人才培育的正向良性循環，倘若我未來有能力，必定讓此善念得以延續，助長台灣科技研究的發展。

財團法人 中技社 CTCI FOUNDATION