Mechanism study of efficiency-improved silicon-based hybrid solar cells

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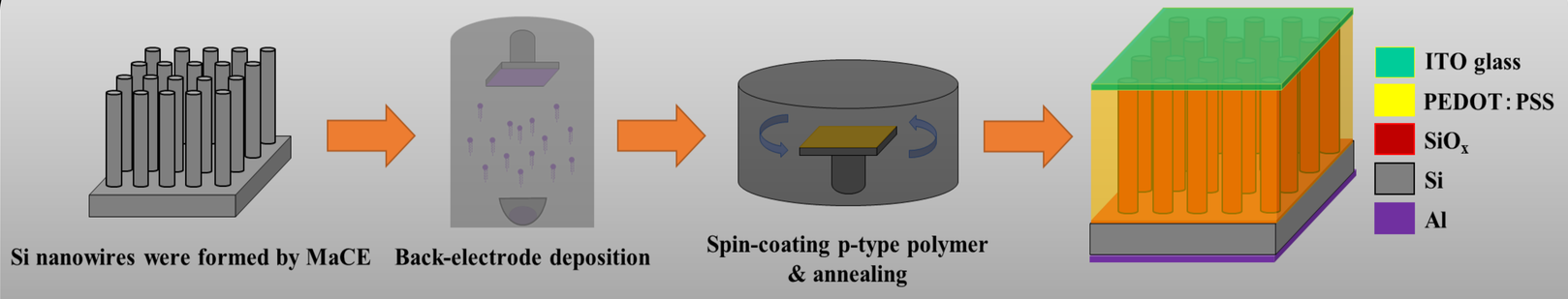
Abstract

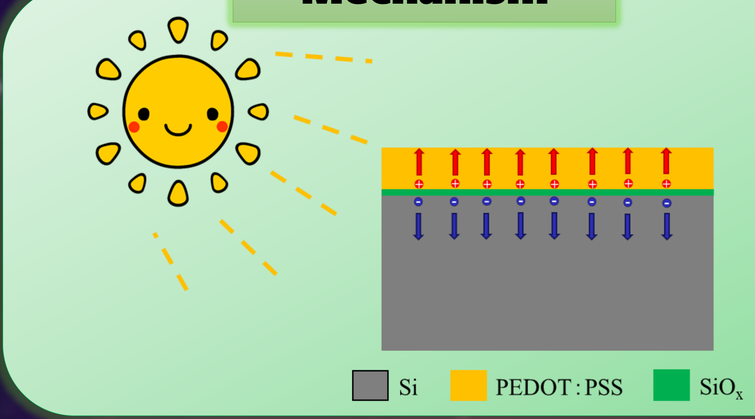
Solar energy conversion has attracted worldwide attraction due to the abundance of light source. So far, the vast majority of commercial photovoltaic cells is based on crystalline silicon solar cells, yet the involving manufacturing cost is still very high. In this study, the controlled incorporation of low-cost organic polymers and silicon nanowires was realized to construct hybrid solar cells through a facile, inexpensive and reliable process. In addition, Explorations of using different surfactants for improving the efficiency of hybrid solar cells were performed, Furthermore, various solvents (DMSO, ethylene glycol, polyethylene glycol) were added to the polymer precursors to study the optimum addition of solvents for reducing the sheet resistance of polymer films. It was found that the use of ethylene glycol to reduce the polymer resistance and further leads to the improved conversion efficiency of hybrid solar cells. Finally, Systematic investigations on the employment of surface-controlled silicon nanowires were performed, demonstrating the optimized power conversion efficiency of 10.16%.

Keywords: silicon, light absorption, conductive polymer, hybrid solar cells

Experimental

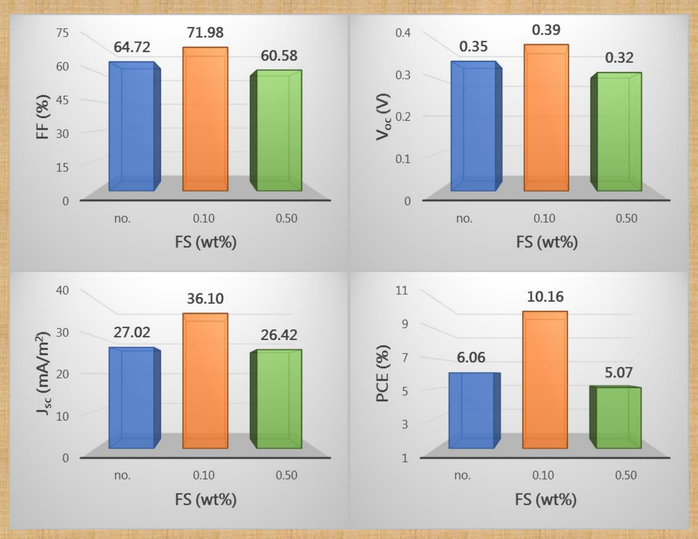


Mechanism

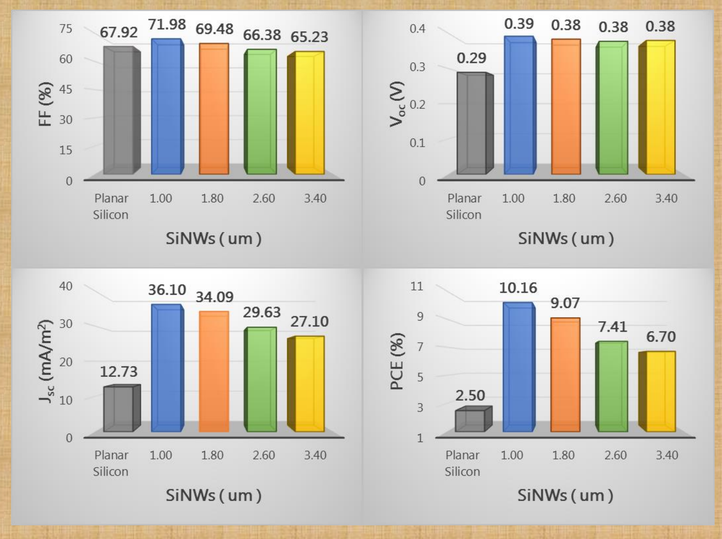


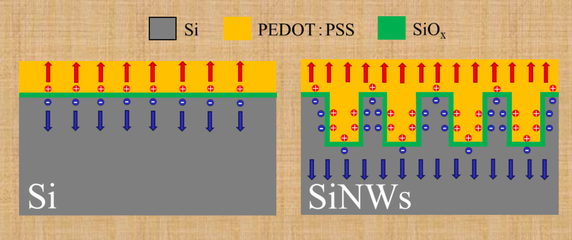
Results and Discussion

☀ Effects of surfactant

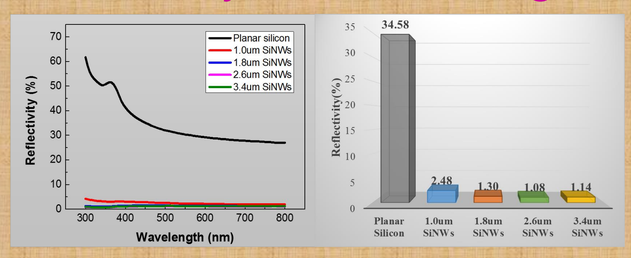


☀ Effects of nanowire lengths on photovoltaic performance

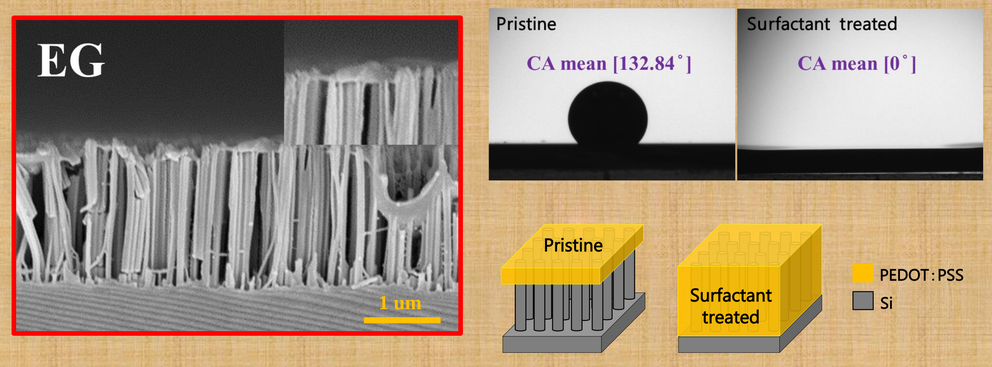




☀ Reflectivity of nanowire lengths



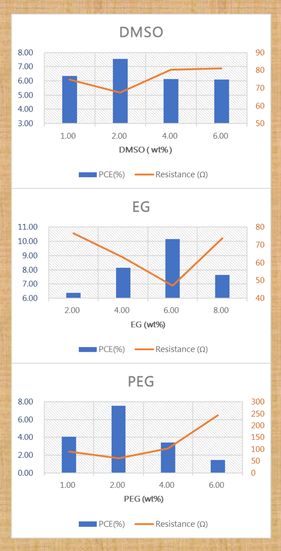
☀ Effects of surfactants: SEM investigation and contact-angle measurement



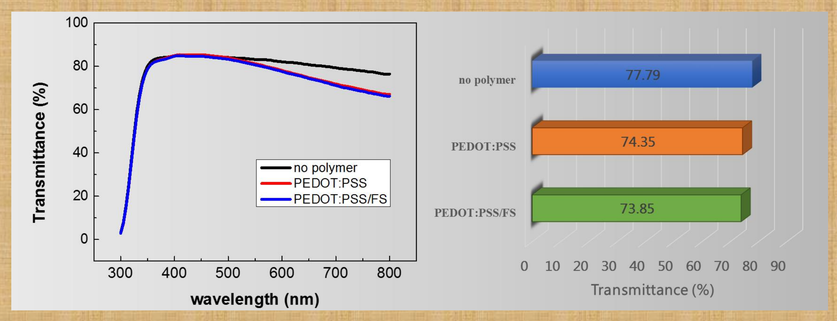
☀ Effects of solvents on photovoltaic performance

solvents	wt%	FF(%)	Voc(V)	Jsc(mA/m^2)	PCE(%)
DMSO	1.0	62.04	0.3780	27.01	6.34
	2.0	69.18	0.4039	27.07	7.56
	4.0	54.24	0.3884	29.06	6.12
	6.0	51.15	0.3960	30.08	6.09
EG	2.0	70.79	0.3350	26.80	6.36
	4.0	69.48	0.3580	32.80	8.15
	6.0	71.98	0.3910	36.10	10.16
	8.0	62.04	0.3780	32.50	7.63
PEG	1.0	54.49	0.2788	26.70	4.06
	2.0	62.58	0.3020	40.11	7.58
	4.0	44.20	0.3760	20.60	3.43
	6.0	31.00	0.4159	14.30	1.43

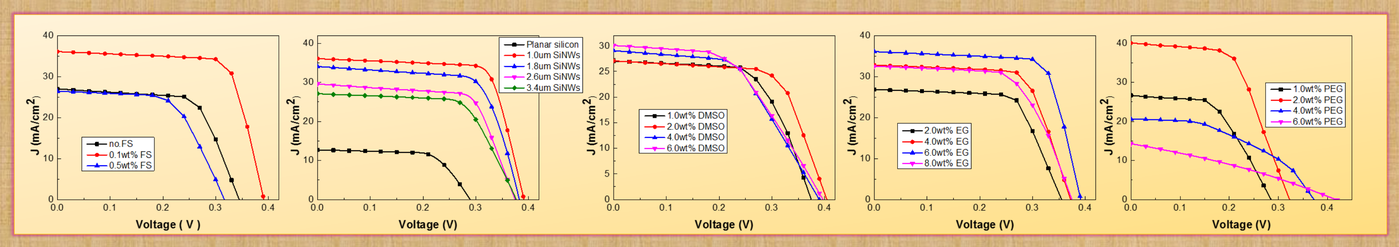
☀ Sheet resistance of polymer layer



☀ Transmittance of ITO glass



☀ Current density-voltage measured results



Conclusions

In-depth studies of the employment of surface-controlled silicon nanowires for photovoltaic were performed. The improvement of cell performance with the addition of Si nanowires was evidenced. With the continuous investigations of material interfaces as well as the optimization of device construction, it is anticipated that silicon nanowires may be practically applied for the high-performance and advanced energy devices.

Acknowledgment

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