Supplementary Material

Helical SiNW design with dual-peak response for broadband scatting in translucent solar cells

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1. Detailed geometric parameters used in calculations

The geometric parameters of silicon nanowires (SiNWs) are divided according to the figure, as shown in Table S1.

Table S1. Detailed geometric parameters of SiNWs.

	Types of SiNWs (nm)	Cylindrical radius (nm)	Cylindrical height (nm)	Helical radius (nm)	Helical radial distance (nm)
Fig. 2(a), (b)	Cylindrical SiNW V	40	3000	-	-
	Cylindrical SiNW H	40	1689	-	-
	Helical SiNW	-	-	120	240
Fig. 3(a), (b), (c)	Helical SiNW	-	-	120	From 160 to 800
Fig. 3(d), (e), (f)	Helical SiNW	-	-	From 80 to 180	240
Fig. 4(a)	Helical SiNW	-	-	120	From 160 to 800
	Cylindrical SiNW H	40	1689	-	-
	Cylindrical SiNW V	40	3000	-	-
Fig. 4(b)	Helical SiNW	-	-	From 80 to 180	240
	Cylindrical SiNW H	40	1689	-	-
	Cylindrical	40	3000	-	-

	SiNW V				
Fig. 6(b)	Cylindrical SiNW V array	40	3000	-	-
Fig. 6(c)	Cylindrical SiNW H array	40	1689	-	-
Fig. 6(d)	Helical SiNW array	-	-	120	240

2. Optical calculation model

Fig. S1 is a model for calculating the scattering, extinction and absorption properties of a single SiNW. The outermost layer is a perfect matching layer (PML), the inner layer is an air domain, and he middle is single SiNW. The thickness of the PML is greater than half the length of the wavelength, and the distance between the air domain and the middle SiNW is also greater than half the length of the wavelength. The calculation method is finite element method (FEM), and the maximum value of the mesh is less than one sixth of the wavelength in the medium. The light source is a background plane wave, and the incident direction is consistent with the radial direction of SiNW. The six surfaces of the air domain are set as the far-field domain to calculate the light scattering. Through the obtained scattering and absorption results, the extinction results can be obtained.

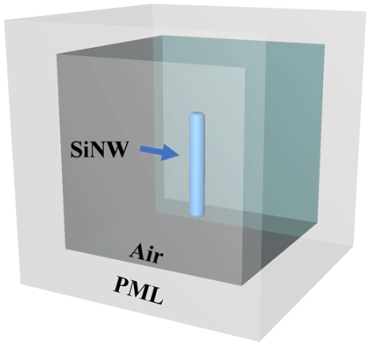

Fig. S1. Schematic diagram of optical calculation model for scattering, extinction and absorption of single SiNW.

Fig. S2 is an optical model for calculating the reflectivity, absorptivity and transmittance of SiNW arrays, which is one of the periods. The upper and lower parts are PML layer and air domain respectively. Then there are PEDOT:PSS layer, PML layer and ITO layer. The SiNWs are in the PML layer, and the PEDOT:PSS layer and ITO layer at the upper and lower ends are in contact. The thickness of PML layer and air domain should be greater than the length of half wavelength. The port is set at the place where the PML layer contacts the air domain. The incident light direction is from top to bottom, and the polarization direction is parallel to the port, which is set according to the demand. The FEM is used in the calculation, and the maximum mesh is set to be less than one sixth of the wavelength in the medium. The light absorption of ITO and PEDOT:PSS layers are calculated based on the light loss of these two layers. The calculation formula is as follows,

$$A(\lambda)=\frac{\int_V Q_h(\lambda)dv}{Q_{in}(\lambda)}$$

where $A(\lambda)$ is the light absorptivity at a certain wavelength, Q_h is the lost energy density at PEDOT:PSS or ITO layers, and Q_{in} is the energy density of incident light. Through this formula, the light absorption of ITO and PEDOT:PSS layers in Fig. 6 can be obtained.

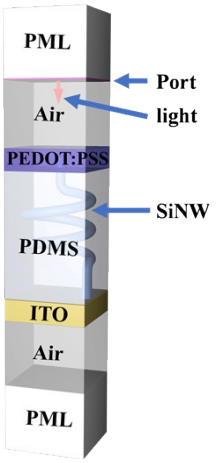

Fig. S2. Schematic diagram of optical calculation model of reflectivity, transmittance and absorptivity of SiNW array.

3. Semiconductor calculation model

Fig. S3 shows the electrical calculation model of translucent SiNW array solar cells. Other materials not related to electricity are simplified, and only PEDOT:PSS and Si materials are retained. The part with SiNWs is trapped in PEDOT:PSS film, and the contact position between SiNWs and PEDOT:PSS is set as heterojunction. The top of PEDOT:PSS and the bottom of SiNWs are set as metal ohmic contact.

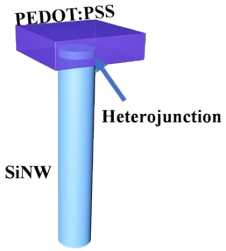

Fig. S3. Schematic diagram of electrical calculation model of translucent SiNW array solar cells.

4. Optical properties of other cylindrical SiNW arrays

Fig. S4 is the reflectivity, absorptivity and transmittance spectra of cylindrical SiNW arrays at different periods.

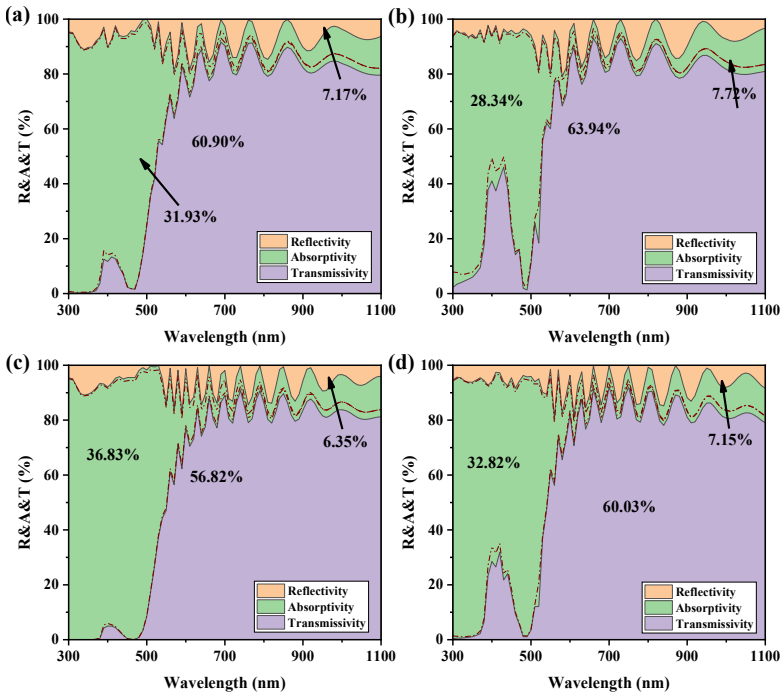

Fig. S4. The reflectivity, absorptivity and transmittance spectra of cylindrical SiNW arrays at different periods. (a) The radius of cylindrical SiNWs is 40 nm, the height is 1689.68 nm, and the distance between SiNWs is 200 nm. (b) The radius of cylindrical SiNWs is 40 nm, the height is 1689.68 nm, and the distance between SiNWs is 300 nm. (c) The radius of cylindrical SiNWs is 40 nm, the height is 3000 nm, and the distance between SiNWs is 200 nm. (d) The radius of cylindrical SiNWs is 40 nm, the height is 3000 nm, and the distance between SiNWs is 300 nm.