Supporting Information

Ionic Conductivity of Vanadium-Doped Tin Disulfide for Photovoltaic Applications.

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Supporting Information

Tables SI1 and SI2. Figures SI1, SI2, SI3, SI4, SI5, SI6 and SI7.

Table SI1. Values of the conductivity for all the samples studied from 20ºC to 200ºC in steeps of 20ºC.

T (ºC)	σ (S/cm) SnS_2-V **2%**	σ (S/cm) SnS_2-V **4%**	σ (S/cm) SnS_2-V **6%**	σ (S/cm) SnS_2-V **8%**	σ (S/cm) SnS_2-V **10%**
20	3.34×10^{-4}	4.81E-04	6.04E-04	8.02E-07	5.91E-07
40	3.96×10^{-4}	5.33E-04	5.88E-04	1.26E-06	1.25E-06
60	2.73×10^{-4}	3.54E-04	4.15E-04	1.35E-06	1.26E-06
80	1.34×10^{-4}	1.60E-04	2.64E-04	5.41E-07	4.93E-07
100	4.35×10^{-5}	5.96E-05	9.15E-05	4.70E-08	3.98E-08
120	9.10×10^{-6}	2.13E-05	3.63E-05	1.23E-08	2.70E-08
140	1.83×10^{-6}	6.80E-06	8.63E-06	1.18E-08	2.73E-08
160	1.05×10^{-6}	1.74E-06	1.89E-06	2.48E-08	5.59E-08
180	1.38×10^{-6}	1.74E-06	2.02E-06	7.76E-08	1.74E-07
200	2.25×10^{-6}	2.42E-06	3.73E-06	2.13E-07	5.07E-07

Table SI2. Values of the parameters $\Delta\varepsilon_{EP}$, α and τ_{EP} obtained from the fit to the experimental data by means of the equation (1) for SnS_2-V-2%, SnS_2-V-4%, SnS_2-V-6%, SnS_2-V-8%, and SnS_2-V-10% samples, respectively, are given. In addition, in the last column, the free charge density is also given.

Sample	**T (ºC)**	$\Delta\varepsilon_{EP}$	α	τ_{EP} **(s)**	**M**	**n (cm^{-3})**
SnS_2-V-2%	**20**	3.77×10^{9}	0.91	0.90	1.22×10^{8}	5.29×10^{24}
	40	5.41×10^{9}	0.92	1.38	1.96×10^{8}	1.37×10^{25}
	60	6.67×10^{9}	0.93	2.46	2.98×10^{8}	2.43×10^{25}
	80	5.49×10^{9}	0.93	4.13	2.77×10^{8}	2.04×10^{25}
	100	2.23×10^{9}	0.92	4.88	1.36×10^{8}	4.08×10^{24}
	120	4.61×10^{8}	0.92	4.64	3.35×10^{7}	2.10×10^{23}
SnS_2-V-4%						
	20	4.07×10^{8}	0.93	1.72	1.30×10^{7}	8.60×10^{23}
	40	6.80×10^{8}	0.93	1.78	1.86×10^{7}	1.33×10^{24}
	60	1.25×10^{9}	0.93	2.07	3.06×10^{7}	1.91×10^{24}
	80	1.95×10^{9}	0.93	2.35	5.01×10^{7}	2.40×10^{24}
	100	2.06×10^{9}	0.94	3.08	6.66×10^{7}	1.53×10^{24}
	120	8.72×10^{8}	0.94	3.19	3.93×10^{7}	3.92×10^{23}
SnS_2-V 6%						
	20	4.78×10^{6}	0.93	0.003	1.45×10^{5}	3.75×10^{19}
	40	1.06×10^{7}	0.94	0.004	3.34×10^{5}	2.29×10^{20}
	60	2.12×10^{8}	0.94	0.128	1.04×10^{7}	2.09×10^{23}
	80	6.94×10^{7}	0.94	0.076	4.26×10^{6}	2.98×10^{22}
	100	2.32×10^{9}	0.94	5.793	1.60×10^{8}	3.84×10^{25}
	120	1.11×10^{9}	0.95	6.068	8.35×10^{7}	7.89×10^{24}
SnS_2-V 8%						
	20	9.79×10^{7}	0.92	16.00	7.82×10^{6}	7.11×10^{21}
	40	1.41×10^{8}	0.91	9.77	1.13×10^{7}	1.43×10^{22}
	60	8.43×10^{7}	0.91	6.01	6.82×10^{6}	5.63×10^{21}
	80	2.56×10^{7}	0.96	4.46	2.12×10^{6}	6.50×10^{20}
	100	4.89×10^{6}	0.96	4.59	4.24×10^{5}	2.38×10^{19}
	120	2.22×10^{6}	0.95	6.62	1.95×10^{5}	4.49×10^{18}
SnS_2-V 10%						
	20	1.70×10^{8}	0.96	9.24	1.23×10^{7}	2.20×10^{22}
	40	1.52×10^{8}	0.97	7.78	1.17×10^{7}	1.99×10^{22}
	60	7.13×10^{7}	0.92	4.98	5.74×10^{6}	4.51×10^{21}
	80	1.42×10^{7}	0.92	3.93	1.20×10^{6}	1.91×10^{20}
	100	2.07×10^{6}	0.93	4.03	1.85×10^{5}	4.30×10^{18}
	120	6.52×10^{5}	0.95	5.37	5.96×10^{4}	4.28×10^{17}

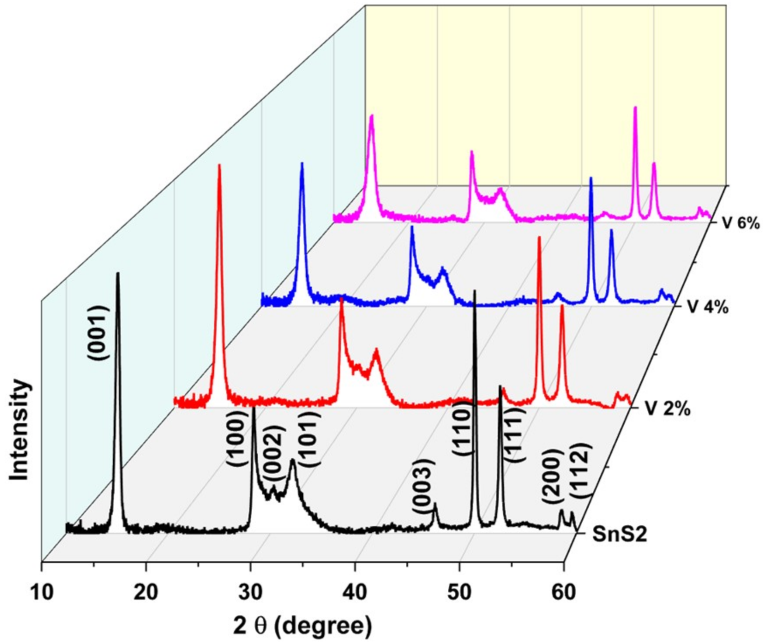

Figure SI1. X-ray diffraction (XRD) spectra of vanadium-doped SnS_2.

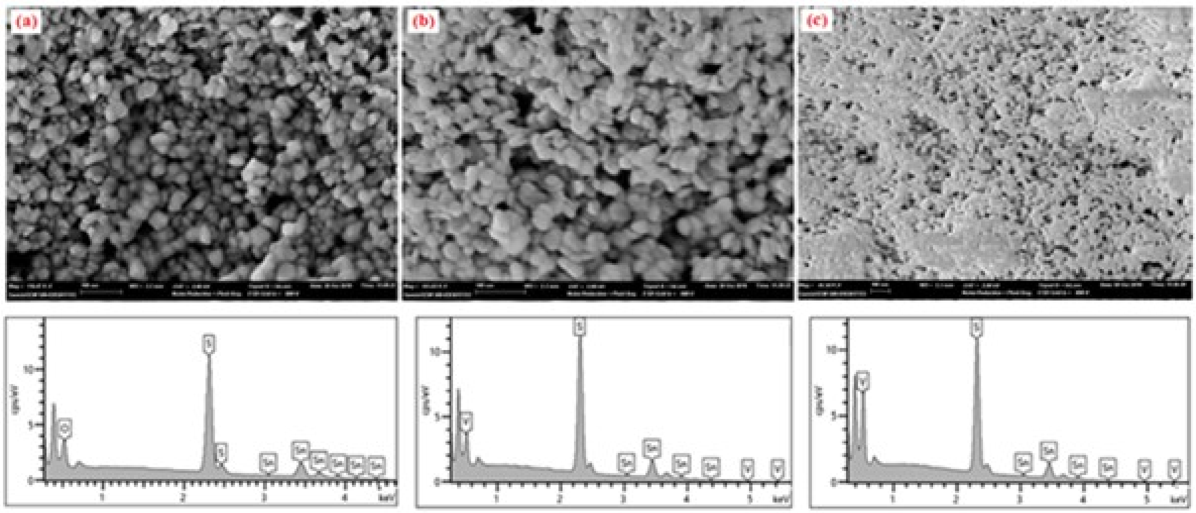

Figure SI2. SEM images of the superficial of vanadium-doped SnS_2, accompanied by EDS. a) SnS_2. b) SnS_2-V4%. c) SnS_2-V6%.

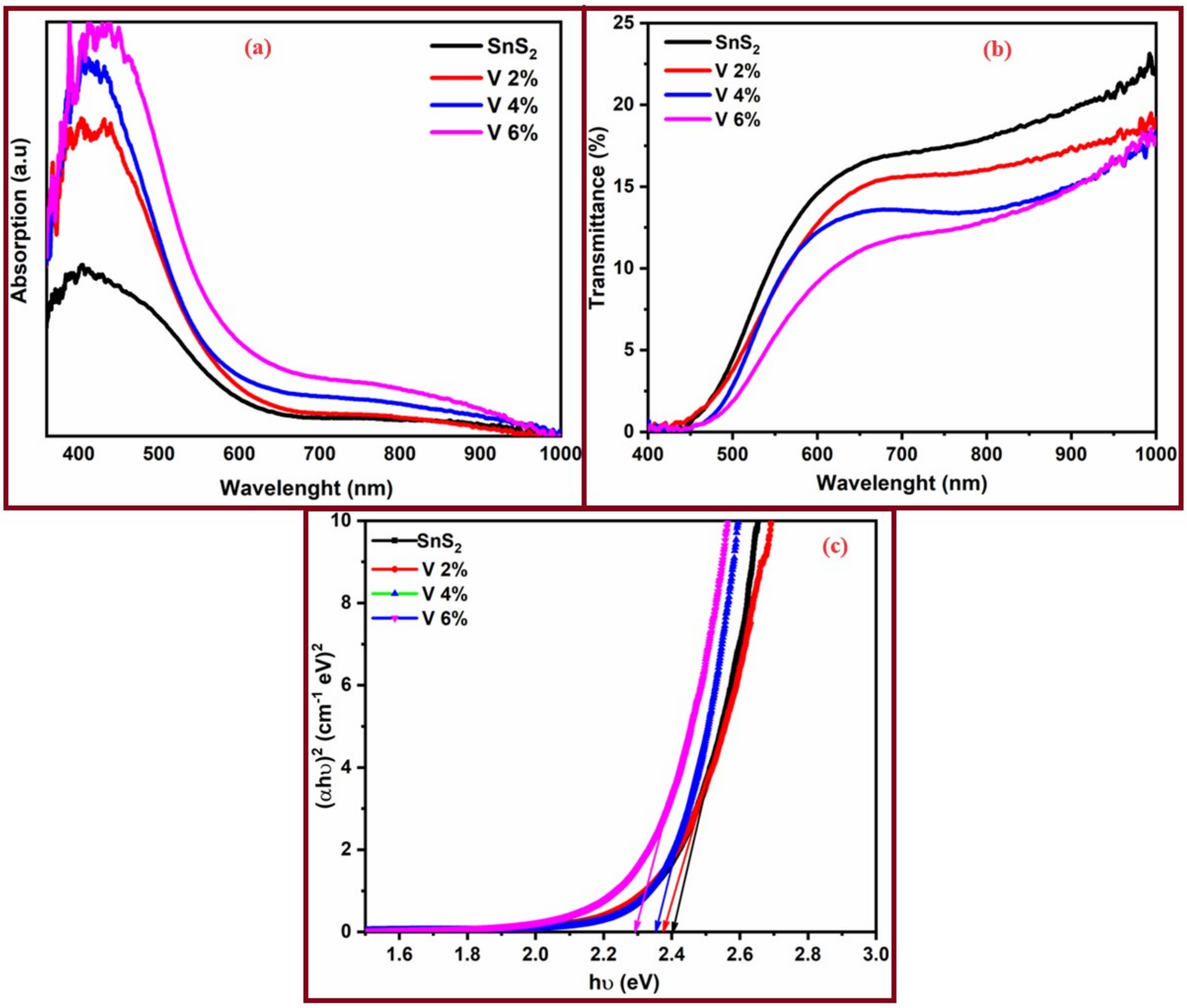

Figure SI3. (a) Optical absorption spectra, (b) transmission spectra, and (c) energy bandgap of vanadium-doped SnS_2.

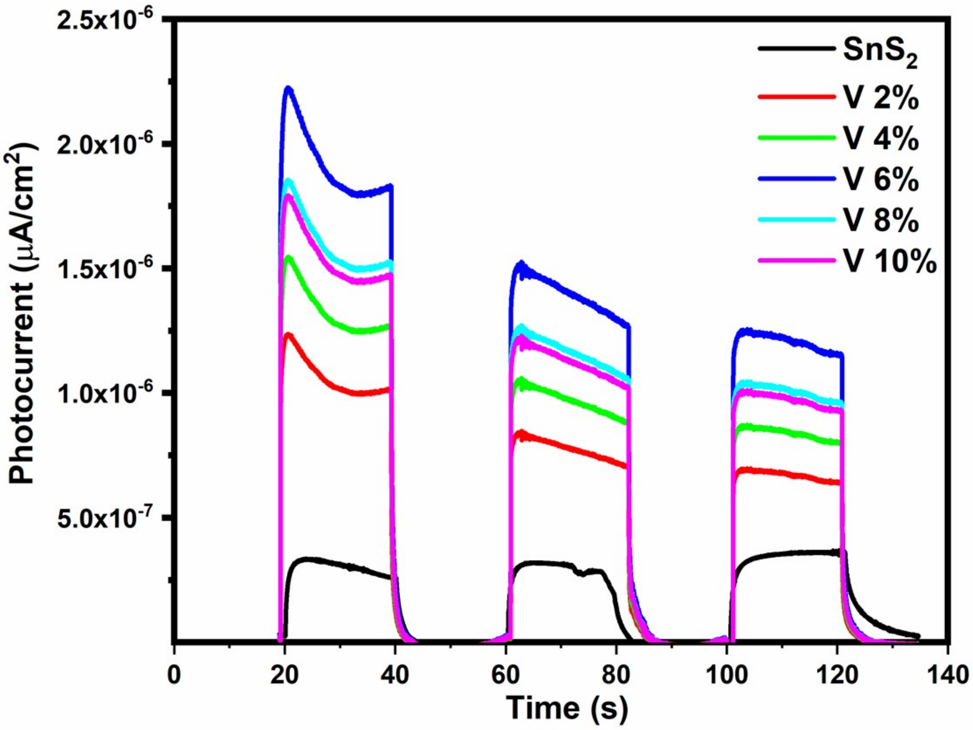

Figure SI4. Photocurrent response of SnS_2 and vanadium-doped SnS_2 with varying V concentrations (0%, 2%, 4%, and 6%).

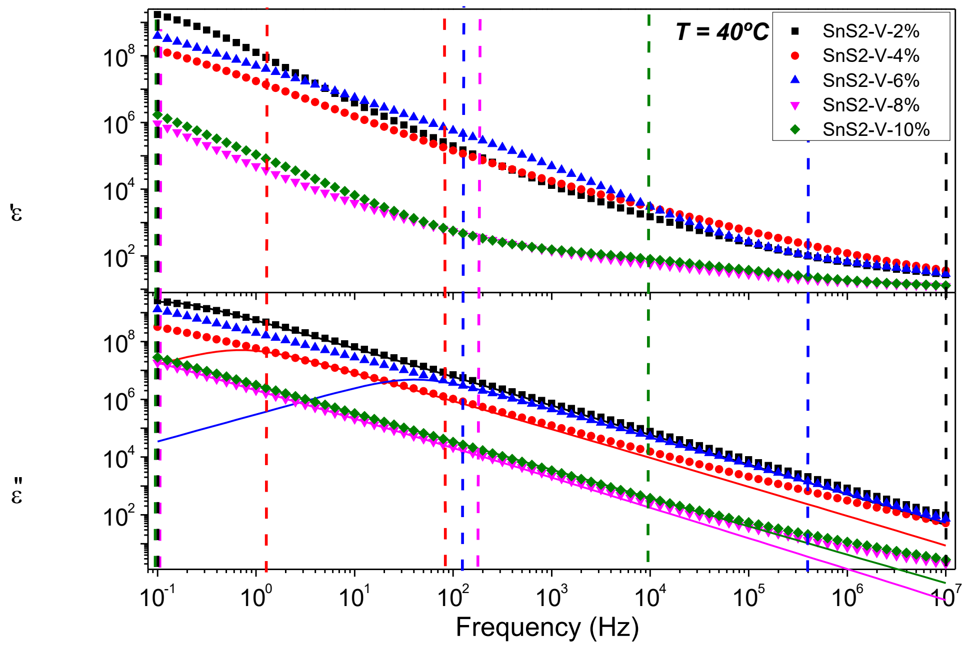

Figure SI5. Dielectric spectra for SnS_2-V-2% (black), SnS_2-V-4% (red), SnS_2-V-6% (blue), SnS_2-V-8% (magenta) and SnS_2-V-10% (olive) at 40˚C. The solid line in the spectrum indicates the value of the fitted curve of the loss permittivity, and the vertical dashed lines indicate the frequency range where the fitting has been made: SnS2-V 2.5% from 0.1 to 10^7 Hz, SnS2-V 5% from 1.5 to 80 Hz, SnS2-V 7.5% from 125 to 4×10^5 Hz, SnS2-V 10% from 0.1 to 200 Hz and SnS2-V 15% from 0.1 to 10^4 Hz.

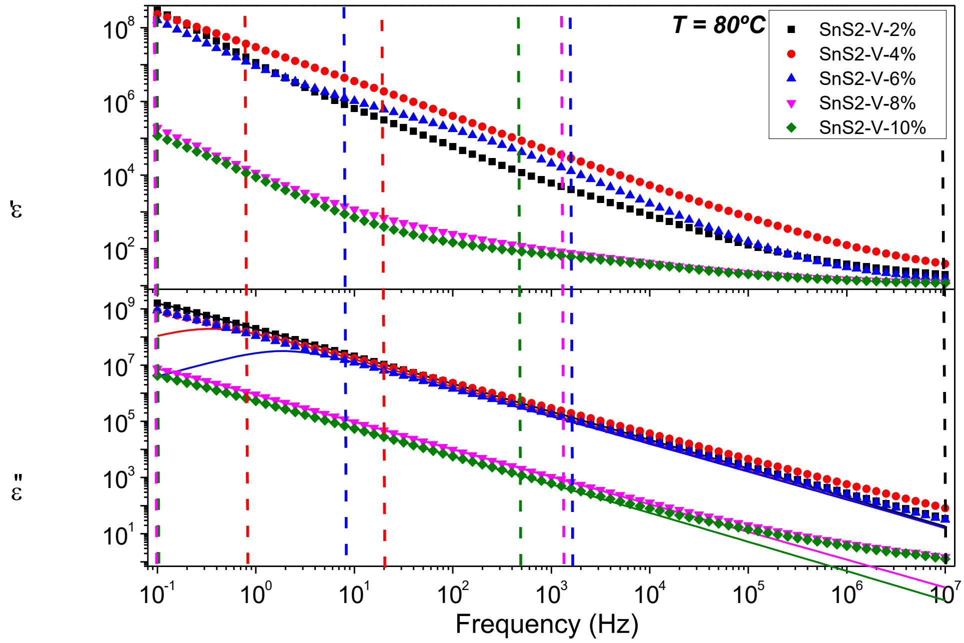

Figure SI6. Dielectric spectra for SnS_2-V-2% (black), SnS_2-V-4% (red), SnS_2-V-6% (blue), SnS_2-V-8% (magenta) and SnS_2-V-10% (olive)at 80˚C. The solid line in the spectrum indicates the value of the fitted curve of the loss permittivity, and the vertical dashed lines indicate the frequency range where the fitting has been made: SnS2-V 2.5% from 0.1 to 10^7 Hz, SnS2-V 5% from 0.8 to 20 Hz, SnS2-V 7.5% from 8 to 1600 Hz, SnS2-V 10% from 0.1 to 1250 Hz and SnS2-V 15% from 0.1 to 500 Hz.

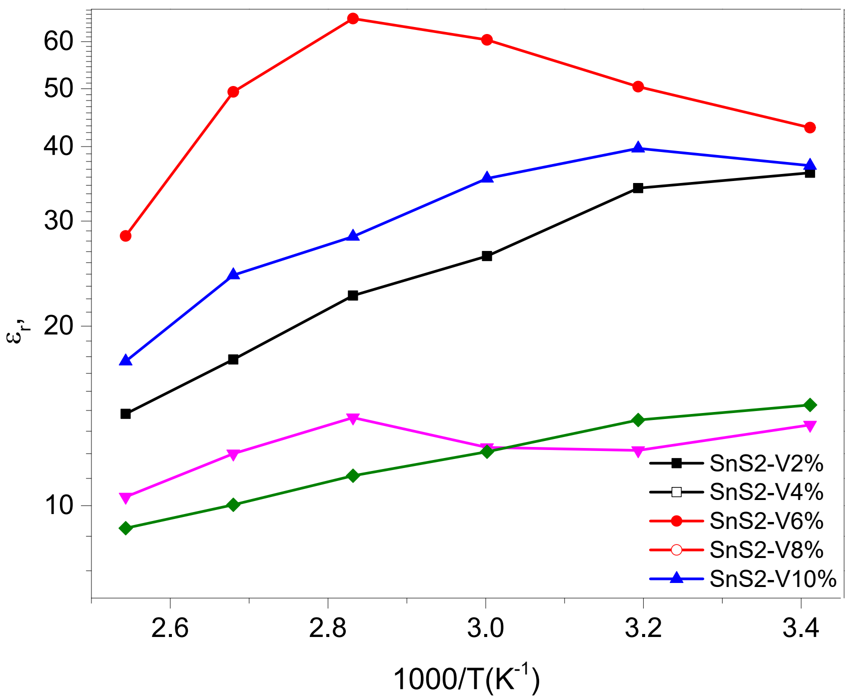

Figure SI7. Temperature dependence of the dielectric permittivity for SnS_2-V2% (■), SnS_2-V4% (●), SnS_2-V6% (□), SnS_2-V8% (□) and SnS_2-V10% (◆).