



English

Search Site



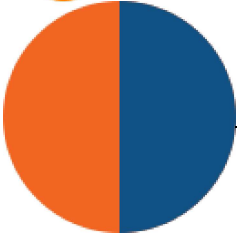
[\(/pvcdrom/contribute\)](/pvcdrom/contribute)



[\(/pvcdrom/materials/general-properties-of-silicon\)](/pvcdrom/materials/general-properties-of-silicon)



[\(/pvcdrom/materials/bismuth-trisulfide-bi2s3\)](/pvcdrom/materials/bismuth-trisulfide-bi2s3)



[\(/\)](#)

[Instructions \(/pvcdrom/welcome-to-pvcdrom/instructions\)](/pvcdrom/welcome-to-pvcdrom/instructions)

[Welcome \(/pvcdrom/welcome-to-pvcdrom\)](/pvcdrom/welcome-to-pvcdrom)

[1. Introduction \(/pvcdrom/welcome-to-pvcdrom/introduction\)](/pvcdrom/welcome-to-pvcdrom/introduction)

[2. Properties of Sunlight \(/pvcdrom/welcome-to-pvcdrom/properties-of-sunlight\)](/pvcdrom/welcome-to-pvcdrom/properties-of-sunlight)

[3. Semiconductors & Junctions \(/pvcdrom/welcome-to-pvcdrom/pn-junctions\)](/pvcdrom/welcome-to-pvcdrom/pn-junctions)

[4. Solar Cell Operation \(/pvcdrom/welcome-to-pvcdrom/solar-cell-operation\)](/pvcdrom/welcome-to-pvcdrom/solar-cell-operation)

[5. Design of Silicon Cells \(/pvcdrom/welcome-to-pvcdrom/design-of-silicon-cells\)](/pvcdrom/welcome-to-pvcdrom/design-of-silicon-cells)

[6. Manufacturing Si Cells \(/pvcdrom/welcome-to-pvcdrom/manufacturing-si-cells\)](/pvcdrom/welcome-to-pvcdrom/manufacturing-si-cells)

[7. Modules and Arrays \(/pvcdrom/welcome-to-pvcdrom/modules-and-arrays\)](/pvcdrom/welcome-to-pvcdrom/modules-and-arrays)

[8. Characterization \(/pvcdrom/welcome-to-pvcdrom/characterisation\)](/pvcdrom/welcome-to-pvcdrom/characterisation)

[9. Material Properties \(/pvcdrom/welcome-to-pvcdrom/materials\)](/pvcdrom/welcome-to-pvcdrom/materials)

[10. Batteries \(/pvcdrom/welcome-to-pvcdrom/batteries\)](/pvcdrom/welcome-to-pvcdrom/batteries)

[11. Appendices \(/pvcdrom/appendices\)](/pvcdrom/appendices)

[Korean Version PDF \(/pvcdrom/welcome-to-pvcdrom/korean-version-pdf\)](/pvcdrom/welcome-to-pvcdrom/korean-version-pdf)

[Equations \(/list-of-equations\)](/list-of-equations)

Optical Properties of Silicon

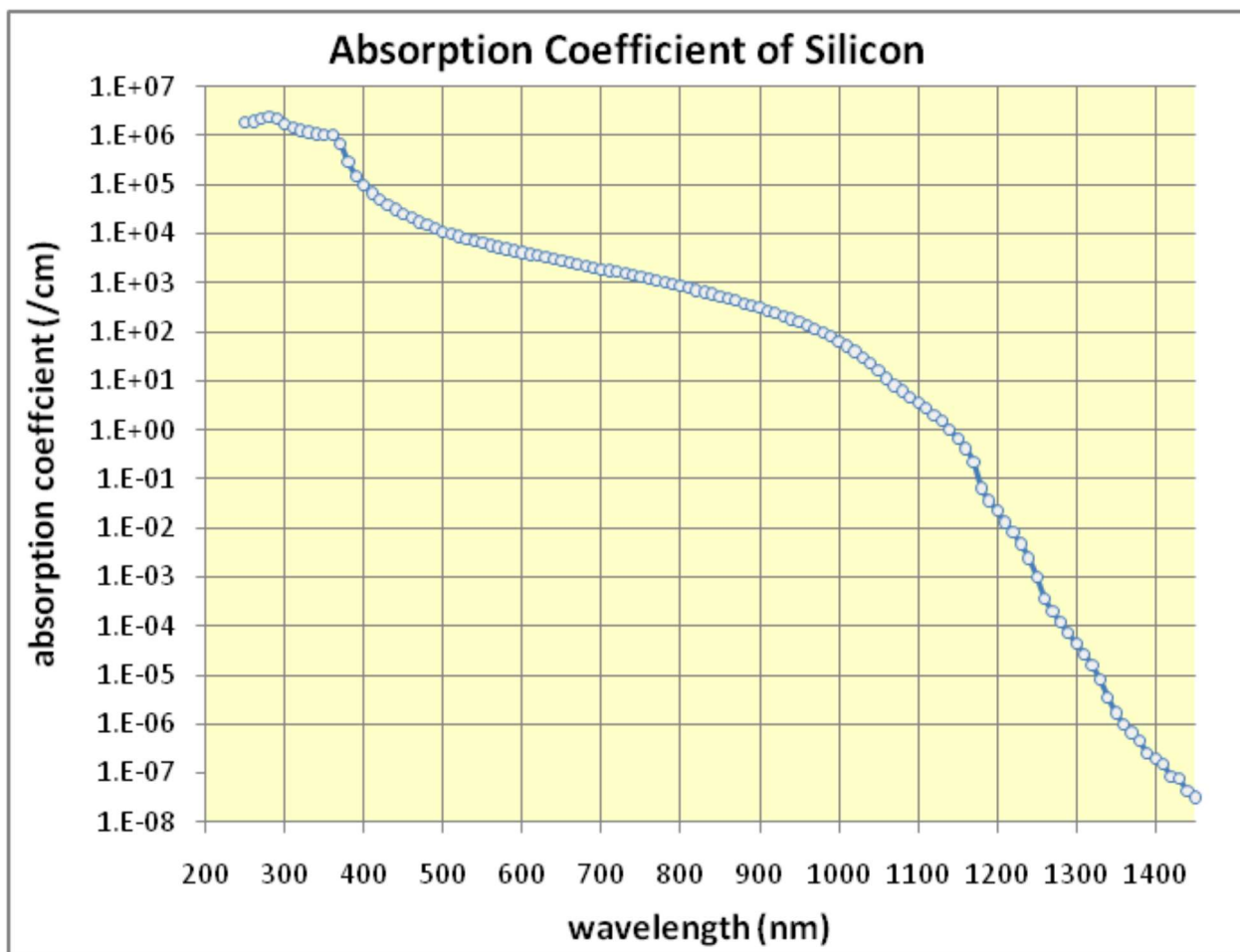
The optical properties of silicon measure at 300K ¹ . While a wide range of wavelengths is given here, silicon solar cells typical only operate from 400 to 1100 nm. There is a more up to date set of data in Green 2008 ² . It is available in tabulated form from pvlighthouse as [text](#)

(<http://www.pvlighthouse.com.au/Resources/Photovoltaic%20materials/Refractive%20index/Si%20-%20Crystalline%20%5BGre08%5D.txt>) and in graphical format

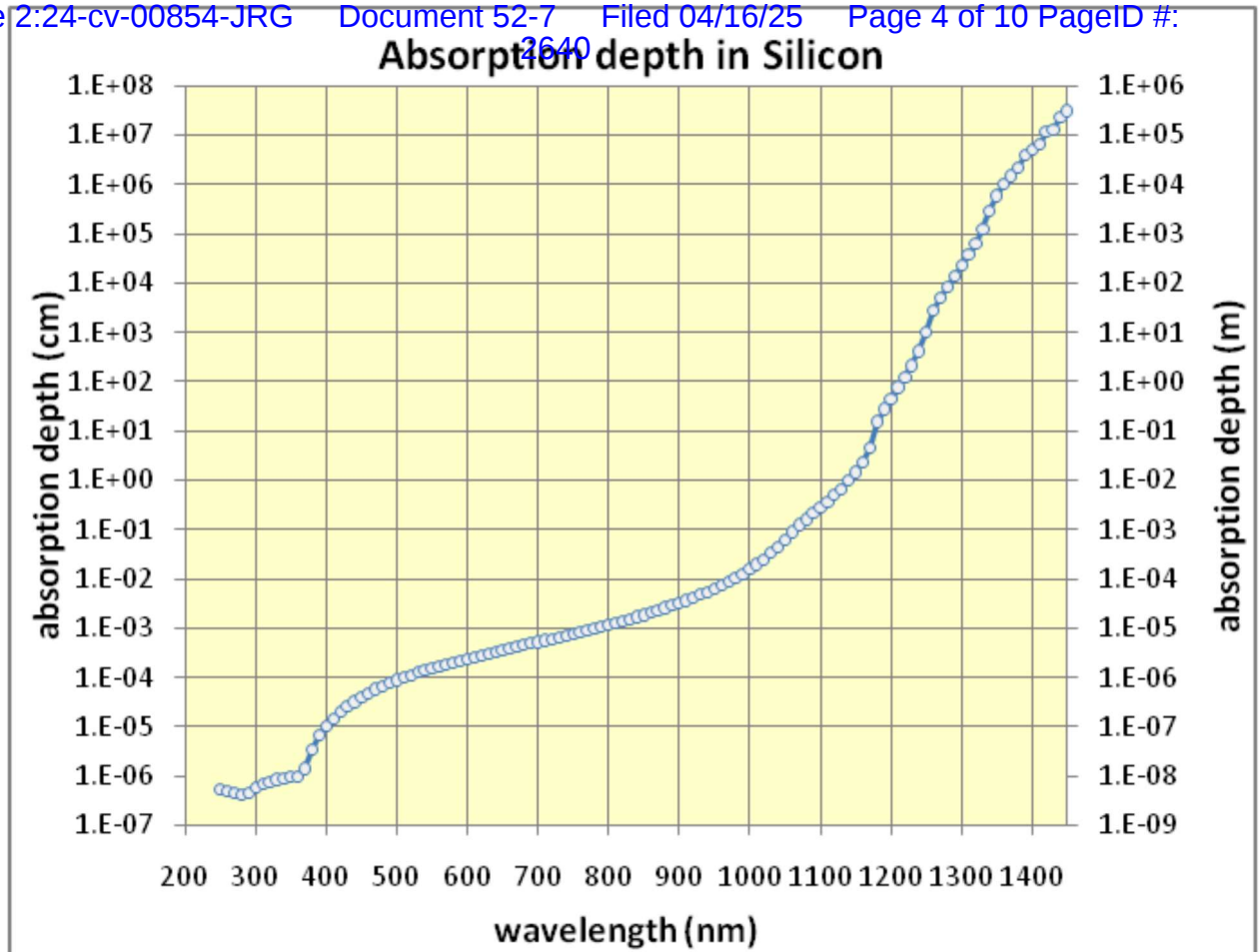
(<http://www.pvlighthouse.com.au/Resources/Photovoltaic%20materials/Refractive%20index/Refractive%20index.aspx>) .

The data on this page is also available as an [Excel spreadsheet](#).

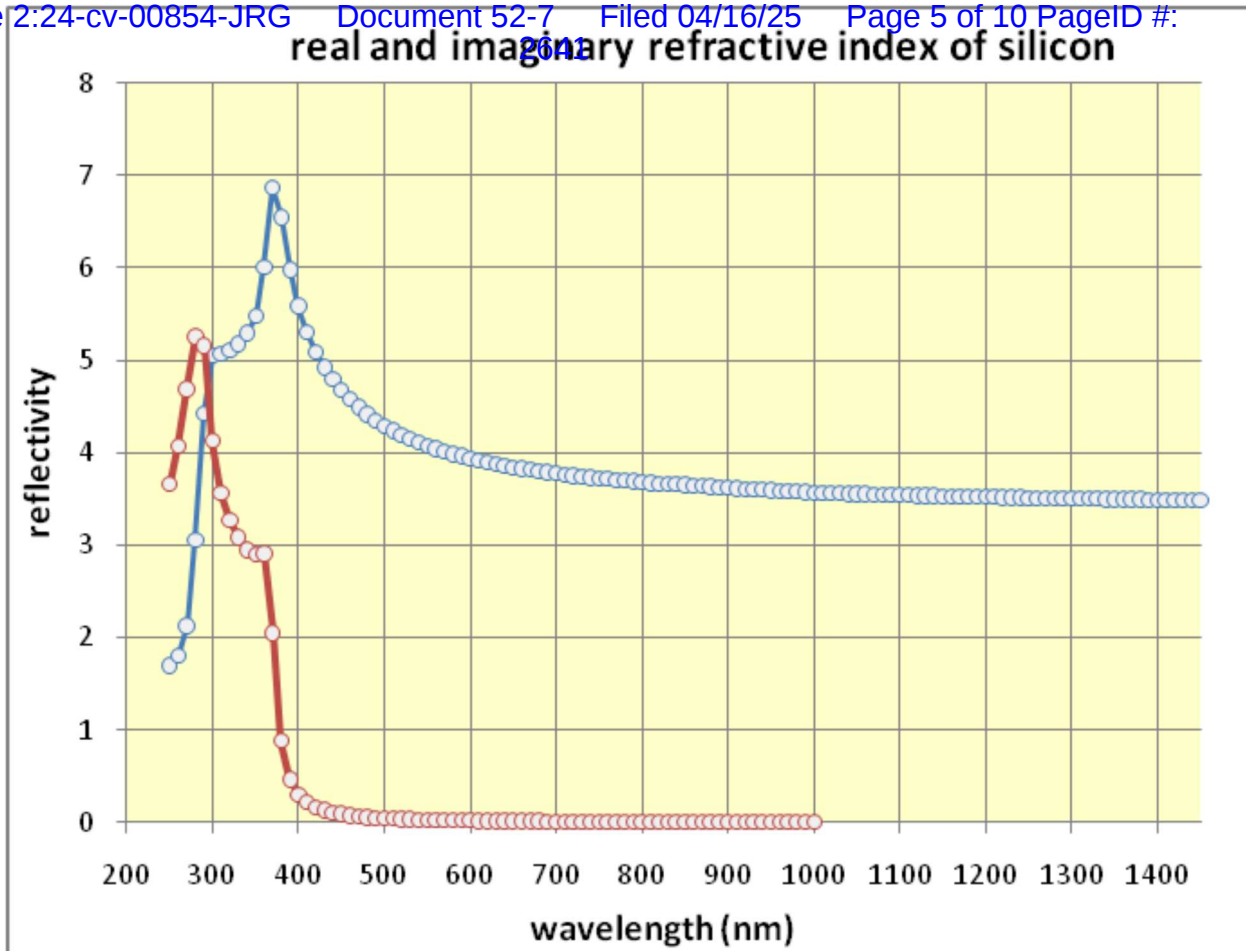
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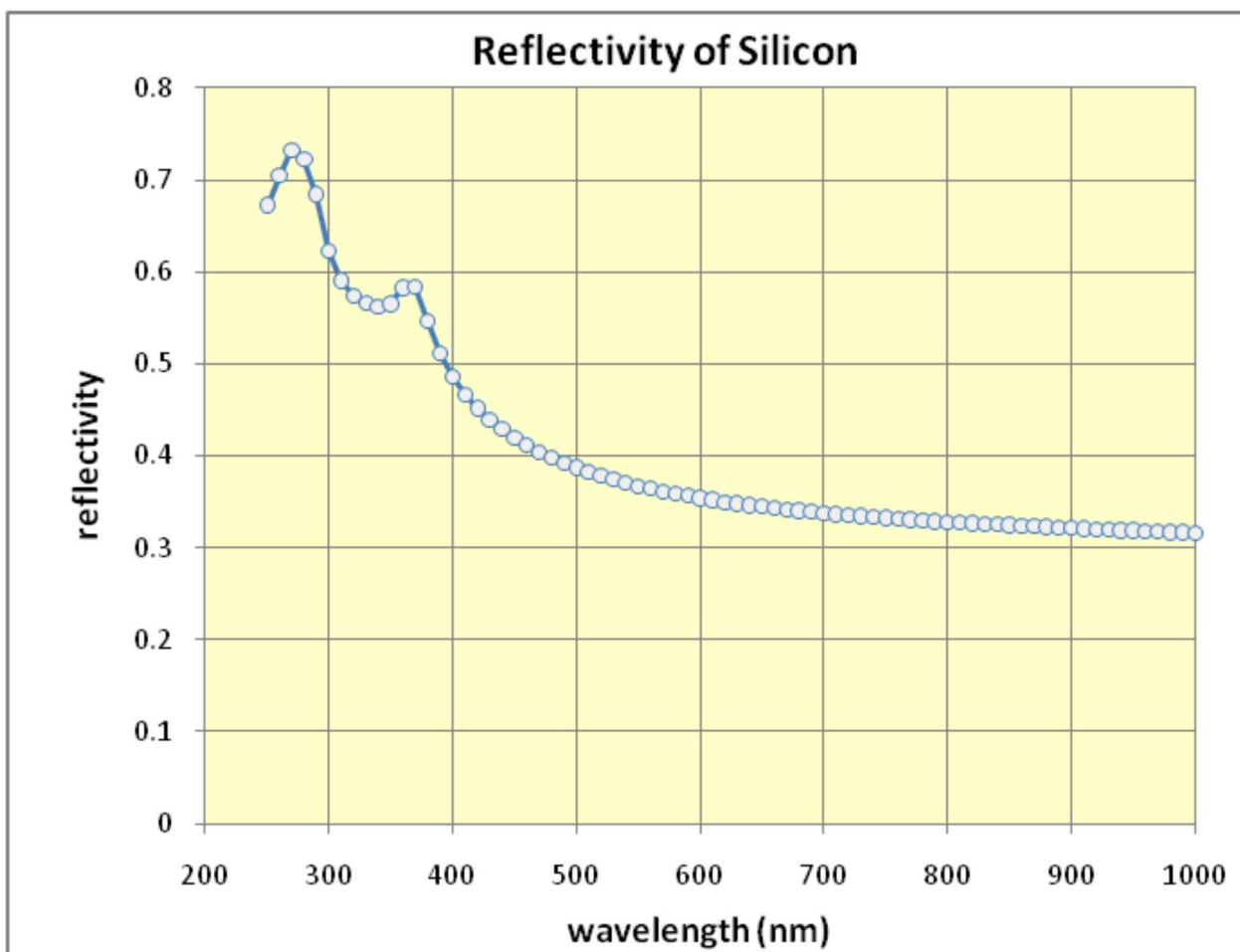
Absorption coefficient of silicon in cm^{-1} as a function of the wavelength. Silicon is an indirect bandgap semiconductor so there is a long tail in absorption out to long wavelengths. The data is graphed on a log scale. The drop in absorption at the band gap (around 1100 nm) is sharper than might first appear. See also [absorption coefficient \(/pvcldrom/pn-junctions/absorption-coefficient\)](#) .



The absorption depth is the inverse of the absorption coefficient. An absorption depth of, for example, 1 μm means that the light intensity has fallen to 36% ($1/e$) of its original value. See also [absorption coefficient \(/pvcdrom/pn-junctions/absorption-coefficient\)](/pvcdrom/pn-junctions/absorption-coefficient).



Real and (negative) imaginary components of the refractive index for silicon at 300 K.



The reflectivity of a polished silicon wafer is determined from the complex refractive index.

The data for the above graph is given below. As noted above, it is also available in a much more convenient Excel spreadsheet (</sites/default/files/PVCDROM/Appendices/OpticalPropertiesOfSilicon.xlsx>). .

W - wavelength

a - absorption coefficient

n - real component of refractive index

k - extinction coefficient

refractive index = $n - ik$

W(nm)	a(μm)	n	k
250	1.84E+06	1.694	3.666
260	1.97E+06	1.800	4.072
270	2.18E+06	2.129	4.690
280	2.36E+06	3.052	5.258
290	2.24E+06	4.426	5.160
300	1.73E+06	5.055	4.128
310	1.44E+06	5.074	3.559
320	1.28E+06	5.102	3.269
330	1.17E+06	5.179	3.085
340	1.09E+06	5.293	2.951
350	1.04E+06	5.483	2.904
360	1.02E+06	6.014	2.912
370	6.97E+05	6.863	2.051
380	2.93E+05	6.548	0.885
390	1.50E+05	5.976	0.465
400	9.52E+04	5.587	0.303
410	6.74E+04	5.305	0.220
420	5.00E+04	5.091	0.167
430	3.92E+04	4.925	0.134
440	3.11E+04	4.793	0.109
450	2.55E+04	4.676	0.091
460	2.10E+04	4.577	0.077
470	1.72E+04	4.491	0.064
480	1.48E+04	4.416	0.057
490	1.27E+04	4.348	0.050
500	1.11E+04	4.293	0.045
510	9.70E+03	4.239	0.039
520	8.80E+03	4.192	0.036
530	7.85E+03	4.150	0.033
540	7.05E+03	4.110	0.030
550	6.39E+03	4.077	0.028
560	5.78E+03	4.044	0.026
570	5.32E+03	4.015	0.024
580	4.88E+03	3.986	0.023
590	4.49E+03	3.962	0.021
600	4.14E+03	3.939	0.020
610	3.81E+03	3.916	0.018
620	3.52E+03	3.895	0.017
630	3.27E+03	3.879	0.016
640	3.04E+03	3.861	0.015
650	2.81E+03	3.844	0.015
660	2.58E+03	3.830	0.014
670	2.38E+03	3.815	0.013
680	2.21E+03	3.800	0.012
690	2.05E+03	3.787	0.011
700	1.90E+03	3.774	0.011
710	1.77E+03	3.762	0.011
720	1.66E+03	3.751	0.010
730	1.54E+03	3.741	0.009
740	1.42E+03	3.732	0.008
750	1.30E+03	3.723	0.008
760	1.19E+03	3.714	0.007
770	1.10E+03	3.705	0.007
780	1.01E+03	3.696	0.006
790	9.28E+02	3.688	0.006
800	8.50E+02	3.681	0.005

810	7.75E+02	3.674	0.005
820	7.07E+02	3.668	0.005
830	6.47E+02	3.662	0.004
840	5.91E+02	3.656	0.004
850	5.35E+02	3.650	0.004
860	4.80E+02	3.644	0.003
870	4.32E+02	3.638	0.003
880	3.83E+02	3.632	0.003
890	3.43E+02	3.626	0.002
900	3.06E+02	3.620	0.002
910	2.72E+02	3.614	0.002
920	2.40E+02	3.608	0.002
930	2.10E+02	3.602	0.002
940	1.83E+02	3.597	0.001
950	1.57E+02	3.592	0.001
960	1.34E+02	3.587	0.001
970	1.14E+02	3.582	0.001
980	9.59E+01	3.578	0.001
990	7.92E+01	3.574	0.001
1000	6.40E+01	3.570	0.001
1010	5.11E+01	3.566	-
1020	3.99E+01	3.563	-
1030	3.02E+01	3.560	-
1040	2.26E+01	3.557	-
1050	1.63E+01	3.554	-
1060	1.11E+01	3.551	-
1070	8.00E+00	3.548	-
1080	6.20E+00	3.546	-
1090	4.70E+00	3.544	-
1100	3.50E+00	3.541	-
1110	2.70E+00	3.539	-
1120	2.00E+00	3.537	-
1130	1.50E+00	3.534	-
1140	1.00E+00	3.532	-
1150	6.80E-01	3.530	-
1160	4.20E-01	3.528	-
1170	2.20E-01	3.526	-
1180	6.50E-02	3.524	-
1190	3.60E-02	3.522	-
1200	2.20E-02	3.520	-
1210	1.30E-02	3.528	-
1220	8.20E-03	3.516	-
1230	4.70E-03	3.515	-
1240	2.40E-03	3.513	-
1250	1.00E-03	3.511	-
1260	3.60E-04	3.510	-
1270	2.00E-04	3.508	-
1280	1.20E-04	3.507	-
1290	7.10E-05	3.506	-
1300	4.50E-05	3.504	-
1310	2.70E-05	3.503	-
1320	1.60E-05	3.501	-
1330	8.00E-06	3.500	-
1340	3.50E-06	3.498	-
1350	1.70E-06	3.497	-
1360	1.00E-06	3.496	-
1370	6.70E-07	3.495	-

1380	4.50E-07	3.493	-
1390	2.50E-07	3.492	-
1400	2.00E-07	3.491	-
1410	1.50E-07	3.490	-
1420	8.50E-08	3.489	-
1430	7.70E-08	3.488	-
1440	4.20E-08	3.487	-
1450	3.20E-08	3.486	-

1. M. A. Green (/biblio?f%5Bauthor%5D=112) and Keevers, M. J. (/biblio?f%5Bauthor%5D=116) , “Optical properties of intrinsic silicon at 300 K” (/node/316) , *Progress in Photovoltaics: Research and Applications*, vol. 3, pp. 189 - 192, 1995.
2. M. A. Green (/biblio?f%5Bauthor%5D=112) , “Self-consistent optical parameters of intrinsic silicon at 300 K including temperature coefficients” (/node/489) , *Solar Energy Materials and Solar Cells*, vol. 92, pp. 1305–1310, 2008.

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and Stuart Bowden

[Instructions \(/pvcdrom/welcome-to-pvcdrom/instructions\)](/pvcdrom/welcome-to-pvcdrom/instructions)

[Welcome \(/pvcdrom/welcome-to-pvcdrom\)](/pvcdrom/welcome-to-pvcdrom)

1. [Introduction \(/pvcdrom/welcome-to-pvcdrom/introduction\)](/pvcdrom/welcome-to-pvcdrom/introduction)
2. [Properties of Sunlight \(/pvcdrom/welcome-to-pvcdrom/properties-of-sunlight\)](/pvcdrom/welcome-to-pvcdrom/properties-of-sunlight)
3. [Semiconductors & Junctions \(/pvcdrom/welcome-to-pvcdrom/pn-junctions\)](/pvcdrom/welcome-to-pvcdrom/pn-junctions)
4. [Solar Cell Operation \(/pvcdrom/welcome-to-pvcdrom/solar-cell-operation\)](/pvcdrom/welcome-to-pvcdrom/solar-cell-operation)
5. [Design of Silicon Cells \(/pvcdrom/welcome-to-pvcdrom/design-of-silicon-cells\)](/pvcdrom/welcome-to-pvcdrom/design-of-silicon-cells)
6. [Manufacturing Si Cells \(/pvcdrom/welcome-to-pvcdrom/manufacturing-si-cells\)](/pvcdrom/welcome-to-pvcdrom/manufacturing-si-cells)
7. [Modules and Arrays \(/pvcdrom/welcome-to-pvcdrom/modules-and-arrays\)](/pvcdrom/welcome-to-pvcdrom/modules-and-arrays)
8. [Characterization \(/pvcdrom/welcome-to-pvcdrom/characterisation\)](/pvcdrom/welcome-to-pvcdrom/characterisation)
9. [Material Properties \(/pvcdrom/welcome-to-pvcdrom/materials\)](/pvcdrom/welcome-to-pvcdrom/materials)

[General Properties of Silicon \(/pvcdrom/materials/general-properties-of-silicon\)](/pvcdrom/materials/general-properties-of-silicon)

[Optical Properties of Silicon \(/pvcdrom/materials/optical-properties-of-silicon\)](/pvcdrom/materials/optical-properties-of-silicon)

[Bi2S3 \(/pvcdrom/materials/bismuth-trisulfide-bi2s3\)](/pvcdrom/materials/bismuth-trisulfide-bi2s3)

[CZTSSe Theory and Fabrication \(/pvcdrom/materials/cztsse\)](/pvcdrom/materials/cztsse)

[CdS \(/pvcdrom/materials/cds\)](/pvcdrom/materials/cds)

[CdSe \(/pvcdrom/materials/cdse-wurtzite\)](/pvcdrom/materials/cdse-wurtzite)

[CuInSe2 \(/pvcdrom/materials/cuinse2\)](/pvcdrom/materials/cuinse2)

[CuO \(/pvcdrom/materials/cuo\)](/pvcdrom/materials/cuo)

[CuS \(/pvcdrom/materials/cus\)](/pvcdrom/materials/cus)

[FeS2 \(/pvcdrom/materials/fes2-pyrite\)](/pvcdrom/materials/fes2-pyrite)

[Mg2Si \(/pvcdrom/materials/mg2si\)](/pvcdrom/materials/mg2si)

[MnS \(/pvcdrom/materials/mns\)](/pvcdrom/materials/mns)

[SnS \(/pvcdrom/materials/sns-herzenbergite\)](/pvcdrom/materials/sns-herzenbergite)

[TiS2 \(/pvcdrom/materials/tis2\)](/pvcdrom/materials/tis2)

10. Batteries (/pvcdrom/welcome-to-pvcdrom/batteries)

11. Appendices (/pvcdrom/appendices)

Korean Version PDF (/pvcdrom/welcome-to-pvcdrom/korean-version-pdf).

Equations (/list-of-equations)

Interactive Graphs (/list-of-graphs)

References (/biblio)

◀ General Properties of Silicon

(/pvcdrom/materials/general-properties-of-silicon)

Bi₂S₃ → (/pvcdrom/materials/bismuth-trisulfide-

bi₂s₃)
