Optical Properties of Silicon

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A Introduction

This article contains a table and graphs on the optical properties of silicon. The table contains information about the dielectric constant, index of refraction, and absorption coefficient of silicon for different photon energies and wavelengths. It also contains information on the reflection, transmission, and absorption percentages at different thickness. The graphs relate wavelength to the absorption coefficient and to the percentages of reflection, transmission, and absorption.

B Optical Properties

This table outlines some basic optical properties of silicon. For all calculations and data values given in this paper it is assumed that the wafers are double side polished and there are no reflective or absorptive phenomena associated with surface roughness, damage, or anomalies. Normal incident radiation is assumed for all reflection and transmission calculations. The following variables, and units are included in the table: $E(eV)$- energy, λ- wavelength (um), E_1- real part of the dielectric constant, E_2- imaginary part of the dielectric constant, κ- imaginary part of index of refraction, n- real part of index of refraction, R_{600}- percent reflected at 600um, $\alpha(cm^{-1})$- absorption coefficient, A_{600}- percent absorbed at 600 um, and T_{600}- percent transmitted at 600 um.

$E(eV)$	λ	E_1	E_2	n	κ	$\alpha(cm^{-1})$	$R_{(600)}$	$T_{(600)}$	$A_{(600)}$
0.000	-	11.69640	0.00000	3.420	0.000	0.00E+00	46.00%	53.44%	
0.020	61.982	11.69298	0.00000	3.419	0.000	0.00E+00	45.98%	53.45%	
0.040	30.991	11.69640	0.00000	3.420	0.000	0.00E+00	46.00%	53.44%	
0.060	20.661	11.69913	0.00171	3.420	0.000	1.52E+00	43.14%	48.11%	8
0.080	15.496	11.70119	0.00109	3.421	0.000	1.30E+00	43.53%	48.83%	7
0.100	12.396	11.70324	0.00116	3.421	0.000	1.72E+00	42.82%	47.44%	9
0.120	10.330	11.70597	0.00068	3.421	0.000	1.22E+00	43.67%	49.10%	7
0.140	8.855	11.70940	0.00048	3.422	0.000	9.94E-01	44.09%	49.85%	6
0.160	7.748	11.71350	0.00016	3.422	0.000	3.73E-01	45.27%	52.04%	2
0.180	6.887	11.71830	0.00015	3.423	0.000	4.01E-01	45.22%	51.93%	2
0.200	6.198	11.72309	0.00001	3.424	0.000	1.50E-02	46.02%	53.33%	0
0.220	5.635	11.72103	0.00000	3.424	0.000	0.00E+00	46.05%	53.38%	
0.240	5.165	11.72691	0.00000	3.424	0.000	0.00E+00	46.05%	53.38%	
0.260	4.768	11.73330	0.00000	3.425	0.000	0.00E+00	46.06%	53.37%	
0.280	4.427	11.74021	0.00000	3.426	0.000	0.00E+00	46.07%	53.36%	
0.300	4.132	11.74765	0.00000	3.427	0.000	0.00E+00	46.09%	53.34%	
0.320	3.874	11.75561	0.00000	3.429	0.000	0.00E+00	46.11%	53.31%	
0.340	3.646	11.76411	0.00000	3.430	0.000	0.00E+00	46.13%	53.30%	

0.360	3.443	11.77313	0.00000	3.431	0.000	0.00E+00	46.14%	53.29%	
0.380	3.262	11.78269	0.00000	3.433	0.000	0.00E+00	46.17%	53.26%	
0.400	3.099	11.79279	0.00000	3.434	0.000	0.00E+00	46.18%	53.25%	
0.420	2.952	11.80343	0.00000	3.436	0.000	0.00E+00	46.20%	53.22%	
0.440	2.817	11.81462	0.00000	3.437	0.000	0.00E+00	46.22%	53.20%	
0.460	2.695	11.82636	0.00000	3.439	0.000	0.00E+00	46.24%	53.18%	
0.480	2.583	11.83865	0.00000	3.441	0.000	0.00E+00	46.27%	53.15%	
0.500	2.479	11.85150	0.00000	3.443	0.000	0.00E+00	46.29%	53.12%	
0.520	2.384	11.86491	0.00000	3.445	0.000	0.00E+00	46.32%	53.09%	
0.540	2.296	11.87889	0.00000	3.447	0.000	0.00E+00	46.35%	53.07%	
0.560	2.214	11.89344	0.00000	3.449	0.000	0.00E+00	46.37%	53.04%	
0.580	2.137	11.90857	0.00000	3.451	0.000	0.00E+00	46.40%	53.01%	
0.600	2.066	11.92429	0.00000	3.453	0.000	0.00E+00	46.42%	52.99%	
0.620	1.999	11.94059	0.00000	3.456	0.000	0.00E+00	46.46%	52.94%	
0.640	1.937	11.95750	0.00000	3.458	0.000	0.00E+00	46.49%	52.92%	
0.660	1.878	11.97500	0.00000	3.460	0.000	0.00E+00	46.51%	52.89%	
0.680	1.823	11.99311	0.00000	3.463	0.000	0.00E+00	46.55%	52.85%	
0.700	1.771	12.01185	0.00000	3.466	0.000	0.00E+00	46.59%	52.81%	
0.720	1.722	12.03120	0.00000	3.469	0.000	0.00E+00	46.63%	52.77%	
0.740	1.675	12.05119	0.00000	3.471	0.000	0.00E+00	46.65%	52.74%	
0.760	1.631	12.07181	0.00000	3.474	0.000	0.00E+00	46.69%	52.70%	
0.780	1.589	12.09308	0.00000	3.478	0.000	0.00E+00	46.74%	52.65%	
0.800	1.550	12.11502	0.00000	3.481	0.000	0.00E+00	46.78%	52.61%	
0.820	1.512	12.13761	0.00000	3.484	0.000	0.00E+00	46.82%	52.57%	
0.840	1.476	12.16089	0.00000	3.487	0.000	0.00E+00	46.86%	52.53%	
0.860	1.441	12.18484	0.00000	3.491	0.000	0.00E+00	46.91%	52.47%	
0.880	1.409	12.20950	0.00000	3.494	0.000	0.00E+00	46.95%	52.43%	
0.900	1.377	12.23486	0.00000	3.498	0.000	0.00E+00	47.00%	52.38%	
0.920	1.347	12.26095	0.00000	3.502	0.000	0.00E+00	47.05%	52.32%	
0.940	1.319	12.28776	0.00000	3.505	0.000	0.00E+00	47.08%	52.28%	
0.960	1.291	12.31533	0.00000	3.509	0.000	0.00E+00	47.13%	52.23%	
0.980	1.265	12.34365	0.00000	3.513	0.000	0.00E+00	47.19%	52.18%	
1.000	1.240	12.37275	0.00000	3.517	0.000	1.23E-07	47.24%	52.12%	
1.020	1.215	12.40265	0.00000	3.522	0.000	2.98E-02	47.23%	51.95%	
1.040	1.192	12.43336	0.00001	3.526	0.000	8.54E-02	47.17%	51.69%	1
1.060	1.169	12.46490	0.00002	3.531	0.000	2.32E-01	46.93%	51.10%	1
1.080	1.148	12.49731	0.00004	3.535	0.000	5.81E-01	46.28%	49.81%	3
1.100	1.127	12.53059	0.00008	3.540	0.000	1.33E+00	44.95%	47.22%	7
1.120	1.107	12.56479	0.00017	3.545	0.000	2.78E+00	42.68%	42.69%	14
1.140	1.087	12.59991	0.00033	3.550	0.000	5.32E+00	39.62%	35.97%	24
1.160	1.069	12.63595	0.00057	3.555	0.000	9.35E+00	36.43%	27.67%	35
1.180	1.051	12.67294	0.00091	3.560	0.000	1.52E+01	33.94%	19.14%	46
1.200	1.033	12.71086	0.00136	3.565	0.000	2.33E+01	32.48%	11.64%	55
1.220	1.016	12.74972	0.00194	3.571	0.000	3.36E+01	31.90%	6.24%	61
1.240	1.000	12.78952	0.00265	3.576	0.000	4.65E+01	31.75%	2.87%	65
1.260	0.984	12.83026	0.00348	3.582	0.000	6.20E+01	31.76%	1.13%	67
1.280	0.968	12.87196	0.00443	3.588	0.001	8.02E+01	31.82%	0.38%	67
1.300	0.954	12.91463	0.00552	3.594	0.001	1.01E+02	31.88%	0.11%	68
1.320	0.939	12.95828	0.00673	3.600	0.001	1.25E+02	31.95%	0.03%	68
1.340	0.925	13.00292	0.00808	3.606	0.001	1.52E+02	32.01%	0.01%	67

1.360	0.912	13.04857	0.00954	3.612	0.001	1.82E+02	32.08%	0.00%	67
1.380	0.898	13.09524	0.01114	3.619	0.002	2.15E+02	32.15%	0.00%	67
1.400	0.885	13.14295	0.01287	3.625	0.002	2.52E+02	32.21%	0.00%	67
1.420	0.873	13.19172	0.01427	3.632	0.002	2.92E+02	32.29%	0.00%	67
1.440	0.861	13.24157	0.01670	3.639	0.002	3.35E+02	32.36%	0.00%	67
1.460	0.849	13.29251	0.01881	3.646	0.003	3.82E+02	32.44%	0.00%	67
1.480	0.838	13.34457	0.02104	3.653	0.003	4.32E+02	32.51%	0.00%	67
1.500	0.826	13.39777	0.02340	3.660	0.003	4.86E+02	32.58%	0.00%	67
1.520	0.816	13.45214	0.02590	3.668	0.004	5.44E+02	32.67%	0.00%	67
1.540	0.805	13.50770	0.02851	3.675	0.004	6.06E+02	32.74%	0.00%	67
1.560	0.795	13.56447	0.03126	3.683	0.004	6.71E+02	32.82%	0.00%	67
1.580	0.785	13.62248	0.03413	3.691	0.005	7.41E+02	32.91%	0.00%	67
1.600	0.775	13.68177	0.03714	3.699	0.005	8.14E+02	32.99%	0.00%	67
1.620	0.765	13.74235	0.04027	3.707	0.005	8.92E+02	33.07%	0.00%	66
1.640	0.756	13.80427	0.04352	3.715	0.006	9.74E+02	33.16%	0.00%	66
1.660	0.747	13.86756	0.04691	3.724	0.006	1.06E+03	33.25%	0.00%	66
1.680	0.738	13.93224	0.05042	3.733	0.007	1.15E+03	33.34%	0.00%	66
1.700	0.729	13.99836	0.05406	3.741	0.007	1.25E+03	33.43%	0.00%	66
1.720	0.721	14.06597	0.05783	3.750	0.008	1.34E+03	33.52%	0.00%	66
1.740	0.712	14.13509	0.06173	3.760	0.008	1.45E+03	33.62%	0.00%	66
1.760	0.704	14.20577	0.06575	3.769	0.009	1.56E+03	33.71%	0.00%	66
1.780	0.696	14.27805	0.06990	3.779	0.009	1.67E+03	33.81%	0.00%	66
1.800	0.689	14.35198	0.07418	3.788	0.010	1.79E+03	33.91%	0.00%	66
1.820	0.681	14.42761	0.07859	3.798	0.010	1.91E+03	34.01%	0.00%	65
1.840	0.674	14.50499	0.08312	3.809	0.011	2.04E+03	34.12%	0.00%	65
1.860	0.666	14.58417	0.08778	3.819	0.011	2.17E+03	34.22%	0.00%	65
1.880	0.659	14.66521	0.09257	3.830	0.012	2.30E+03	34.33%	0.00%	65
1.900	0.652	14.74816	0.09749	3.840	0.013	2.45E+03	34.43%	0.00%	65
1.920	0.646	14.83308	0.10254	3.851	0.013	2.59E+03	34.54%	0.00%	65
1.940	0.639	14.92004	0.10771	3.863	0.014	2.74E+03	34.66%	0.00%	65
1.960	0.632	15.00910	0.11301	3.874	0.015	2.90E+03	34.77%	0.00%	65
1.980	0.626	15.10034	0.11844	3.886	0.015	3.06E+03	34.89%	0.00%	65
2.000	0.620	15.19384	0.12400	3.898	0.016	3.23E+03	35.01%	0.00%	64
2.020	0.614	15.28968	0.12968	3.910	0.017	3.40E+03	35.13%	0.00%	64
2.040	0.608	15.38794	0.13549	3.923	0.017	3.57E+03	35.25%	0.00%	64
2.060	0.602	15.48873	0.14143	3.936	0.018	3.75E+03	35.38%	0.00%	64
2.080	0.596	15.59212	0.14750	3.949	0.019	3.94E+03	35.51%	0.00%	64
2.100	0.590	15.69824	0.15370	3.962	0.019	4.13E+03	35.63%	0.00%	64
2.120	0.585	15.80718	0.16002	3.976	0.020	4.33E+03	35.77%	0.00%	64
2.140	0.579	15.91908	0.16647	3.990	0.021	4.53E+03	35.91%	0.00%	64
2.160	0.574	16.03405	0.17305	4.004	0.022	4.73E+03	36.04%	0.00%	63
2.180	0.569	16.15224	0.17976	4.019	0.022	4.94E+03	36.18%	0.00%	63
2.200	0.563	16.27378	0.18659	4.034	0.023	5.16E+03	36.33%	0.00%	63
2.220	0.558	16.39887	0.19355	4.050	0.024	5.38E+03	36.48%	0.00%	63
2.240	0.553	16.52765	0.20064	4.065	0.025	5.60E+03	36.62%	0.00%	63
2.260	0.549	16.66031	0.20787	4.082	0.025	5.83E+03	36.78%	0.00%	63
2.280	0.544	16.79708	0.21525	4.099	0.026	6.07E+03	36.94%	0.00%	63
2.300	0.539	16.93813	0.22272	4.116	0.027	6.31E+03	37.10%	0.00%	62
2.320	0.534	17.08365	0.23038	4.133	0.028	6.55E+03	37.26%	0.00%	62
2.340	0.530	17.23393	0.23822	4.151	0.029	6.81E+03	37.42%	0.00%	62

2.360	0.525	17.38925	0.24628	4.170	0.030	7.07E+03	37.60%	0.00%	62
2.380	0.521	17.54991	0.25462	4.189	0.030	7.33E+03	37.77%	0.00%	62
2.400	0.517	17.71621	0.26331	4.209	0.031	7.61E+03	37.95%	0.00%	62
2.420	0.512	17.88853	0.27244	4.230	0.032	7.90E+03	38.14%	0.00%	61
2.440	0.508	18.06721	0.28215	4.251	0.033	8.21E+03	38.33%	0.00%	61
2.460	0.504	18.25261	0.29257	4.272	0.034	8.54E+03	38.52%	0.00%	61
2.480	0.500	18.44514	0.30386	4.295	0.035	8.89E+03	38.73%	0.00%	61
2.500	0.496	18.64519	0.31623	4.318	0.037	9.28E+03	38.93%	0.00%	61
2.520	0.492	18.85316	0.32989	4.342	0.038	9.71E+03	39.14%	0.00%	60
2.540	0.488	19.06947	0.34509	4.367	0.040	1.02E+04	39.36%	0.00%	60
2.560	0.484	19.29454	0.36208	4.393	0.041	1.07E+04	39.59%	0.00%	60
2.580	0.480	19.52880	0.38115	4.419	0.043	1.13E+04	39.81%	0.00%	60
2.600	0.477	19.77257	0.40264	4.447	0.045	1.19E+04	40.05%	0.00%	59
2.620	0.473	20.02687	0.42686	4.475	0.048	1.27E+04	40.29%	0.00%	59
2.640	0.470	20.29165	0.45420	4.505	0.050	1.35E+04	40.54%	0.00%	59
2.660	0.466	20.56762	0.48502	4.535	0.053	1.44E+04	40.79%	0.00%	59
2.680	0.463	20.85532	0.51976	4.567	0.057	1.55E+04	41.06%	0.00%	58
2.700	0.459	21.15532	0.55885	4.600	0.061	1.66E+04	41.33%	0.00%	58
2.720	0.456	21.46823	0.60275	4.634	0.065	1.79E+04	41.61%	0.00%	58
2.740	0.452	21.79470	0.65194	4.669	0.070	1.94E+04	41.90%	0.00%	58
2.760	0.449	22.13544	0.70694	4.705	0.075	2.10E+04	42.19%	0.00%	57
2.780	0.446	22.49115	0.76829	4.743	0.081	2.28E+04	42.49%	0.00%	57
2.800	0.443	22.86266	0.83654	4.782	0.087	2.48E+04	42.80%	0.00%	57
2.820	0.440	23.25086	0.91228	4.823	0.095	2.70E+04	43.12%	0.00%	56
2.840	0.436	23.65679	0.99612	4.865	0.102	2.95E+04	43.44%	0.00%	56
2.860	0.433	24.08159	1.08869	4.909	0.111	3.22E+04	43.78%	0.00%	56
2.880	0.430	24.52659	1.19066	4.954	0.120	3.51E+04	44.12%	0.00%	55
2.900	0.427	24.99333	1.30270	5.001	0.130	3.83E+04	44.48%	0.00%	55
2.920	0.425	25.48364	1.42552	5.050	0.141	4.18E+04	44.84%	0.00%	55
2.940	0.422	25.99970	1.55986	5.101	0.153	4.56E+04	45.22%	0.00%	54
2.960	0.419	26.54423	1.70647	5.155	0.166	4.97E+04	45.61%	0.00%	54
2.980	0.416	27.12064	1.86617	5.211	0.179	5.41E+04	46.01%	0.00%	53
3.000	0.413	27.73337	2.03987	5.270	0.194	5.89E+04	46.43%	0.00%	53
3.020	0.410	28.38838	2.22883	5.332	0.209	6.40E+04	46.86%	0.00%	53
3.040	0.408	29.09379	2.43518	5.399	0.226	6.95E+04	47.32%	0.00%	52
3.060	0.405	29.86039	2.66298	5.470	0.243	7.55E+04	47.81%	0.00%	52
3.080	0.402	30.70195	2.91991	5.547	0.263	8.22E+04	48.32%	0.00%	51
3.100	0.400	31.63452	3.21932	5.632	0.286	8.98E+04	48.88%	0.00%	51
3.120	0.397	32.67491	3.58228	5.725	0.313	9.90E+04	49.47%	0.00%	50
3.140	0.395	33.83825	4.03910	5.827	0.347	1.10E+05	50.12%	0.00%	49
3.160	0.392	35.13510	4.63036	5.940	0.390	1.25E+05	50.82%	0.00%	49
3.180	0.390	36.56792	5.40737	6.064	0.446	1.44E+05	51.58%	0.00%	48
3.200	0.387	38.12726	6.43242	6.197	0.519	1.68E+05	52.39%	0.00%	47
3.220	0.385	39.78669	7.77882	6.337	0.614	2.00E+05	53.24%	0.00%	46
3.240	0.383	41.49542	9.53092	6.483	0.735	2.41E+05	54.13%	0.00%	45
3.260	0.380	43.16604	11.78282	6.630	0.889	2.94E+05	55.06%	0.00%	44
3.280	0.378	44.65250	14.63067	6.769	1.081	3.59E+05	55.99%	0.00%	44
3.300	0.376	47.71726	18.14163	6.888	1.317	4.41E+05	56.92%	0.00%	43
3.320	0.373	46.01252	22.27232	6.969	1.598	5.38E+05	57.80%	0.00%	42
3.340	0.371	45.14623	26.74359	6.986	1.914	6.48E+05	58.56%	0.00%	41

3.360	0.369	42.89018	30.97944	6.921	2.238	7.62E+05	59.14%	0.00%	40
3.380	0.367	39.43012	34.27005	6.770	2.531	8.67E+05	59.45%	0.00%	40
3.400	0.365	35.39683	36.13890	6.557	2.756	9.50E+05	59.46%	0.00%	40
3.420	0.362	31.56288	36.61217	6.321	2.896	1.00E+06	59.21%	0.00%	40
3.440	0.360	28.44932	36.13536	6.101	2.962	1.03E+06	58.78%	0.00%	41
3.460	0.358	26.17564	35.24919	5.919	2.977	1.04E+06	58.27%	0.00%	41
3.480	0.356	24.58865	34.33495	5.780	2.970	1.05E+06	57.80%	0.00%	42
3.500	0.354	23.46292	33.56477	5.675	2.957	1.05E+06	57.41%	0.00%	42
3.520	0.352	22.61654	32.97390	5.595	2.947	1.05E+06	57.11%	0.00%	42
3.540	0.350	21.93482	32.54051	5.531	2.942	1.06E+06	56.88%	0.00%	43
3.560	0.348	21.25398	32.23106	5.478	2.942	1.06E+06	56.71%	0.00%	43
3.580	0.346	20.84009	32.01732	5.433	2.946	1.07E+06	56.59%	0.00%	43
3.600	0.344	20.37421	31.87942	5.395	2.955	1.08E+06	56.52%	0.00%	43
3.620	0.342	19.94437	31.80412	5.361	2.966	1.09E+06	56.47%	0.00%	43
3.640	0.341	19.54175	31.78222	5.332	2.981	1.10E+06	56.46%	0.00%	43
3.660	0.339	19.15935	31.80682	5.305	2.998	1.11E+06	56.46%	0.00%	43
3.680	0.337	18.79160	31.87234	5.282	3.107	1.13E+06	56.98%	0.00%	43
3.700	0.335	18.43413	31.97408	5.260	3.039	1.14E+06	56.55%	0.00%	43
3.720	0.333	18.08364	32.10813	5.241	3.063	1.16E+06	56.63%	0.00%	43
3.740	0.331	17.73778	32.27137	5.223	3.098	1.17E+06	56.77%	0.00%	43
3.760	0.330	17.39488	32.46141	5.207	3.117	1.19E+06	56.83%	0.00%	43
3.780	0.328	17.05380	32.67671	5.192	3.147	1.21E+06	56.95%	0.00%	43
3.800	0.326	16.71375	32.91648	5.178	3.178	1.22E+06	57.09%	0.00%	42
3.820	0.325	16.37410	33.18077	5.166	3.211	1.24E+06	57.24%	0.00%	42
3.840	0.323	16.03423	33.47041	5.155	3.246	1.26E+06	57.41%	0.00%	42
3.860	0.321	15.69330	33.78708	5.145	3.283	1.28E+06	57.60%	0.00%	42
3.880	0.319	15.35015	34.13324	5.137	3.322	1.31E+06	57.81%	0.00%	42
3.900	0.318	15.00304	34.51213	5.130	3.364	1.33E+06	58.03%	0.00%	41
3.920	0.316	14.64947	34.92782	5.125	3.408	1.35E+06	58.27%	0.00%	41

Table 1- Optical Properties of Silicon.[1][2][3][4][5][6]

The values for the wavelength were calculated using the following equation (where h represents Plank's constant and c is the speed of light):

$$\lambda = \quad hc \, / \, E(eV) \qquad\qquad (1)$$

and the photon energy is given in Table 1. The values for the percentage of light reflected were calculated using the following equation where R_1 is the light reflected at an air-silicon interface with the air and silicon layers being infinitely thick:

$$R_1 = ((n-1)^2 + \kappa^2) \, / \, ((n+1)^2 + \kappa^2)$$
$$(2)[6]$$

For absorption coefficient values greater than zero, the percentage of total light reflected can be determined using equation (3):

$$R \approx R_1 + (1\text{-} R_1)R_1 e^{-\alpha 2t} - (1\text{-} R_1)R_1^2 e^{-\alpha 2t} + (1\text{-} R_1)R_1^3 e^{-\alpha 4t} - (1\text{-} R_1)R_1^4 e^{-\alpha 4t} + ...$$
$$(3)$$

Each term in the infinite series is associated with the successive reflections as the light bounces between the surfaces of the silicon wafer. Similarly, the percent transmission can be determined using equation (4):

$$T \approx (1\text{-} R_1)e^{-\alpha t} - (1\text{-} R_1)R_1 e^{-\alpha t} + (1\text{-} R_1)R_1^2 e^{-\alpha 3t} - (1\text{-} R_1)R_1^3 e^{-\alpha 3t} + ... \qquad (4)$$

where the percent absorbed light is given by equation (5):

$$A \approx 1\text{-} (R + T). \qquad (5)$$

When the absorption coefficient equals zero, equation (3) can be simplified to the following equation (6):

$$R \approx 2R_1 / (R_1+1) \qquad (6)$$

The geometric series has been factored from equation (3) for this condition.

For the analysis and approximations given above a truncation error of about +0.6% results for the calculated value of the absorption. For example, an artificial absorption of about 0.6% occurs when the absorption coefficient is exactly equal to zero (see Table 1).

C Graphs
Figure 1 is a graph of the absorption coefficient verses photon energy from 0eV-1.5eV. Figure 2 is a graph of the real part of the index of refraction verses photon energy from 0eV-4eV. There are essentially 2 regions of strong optical absorption in Silicon. Figures 3 and 4 show the absorption coefficient verses photon wavelenght for the visible-FIR and IR regions respectively. For photon energies equal-to-or-greater-than the energy gap, normal optical absorption with the generation of free carriers occurs. In the FIR region of about 8um-20um absorption is associated with oxygen and carbon impurtiy complexes.
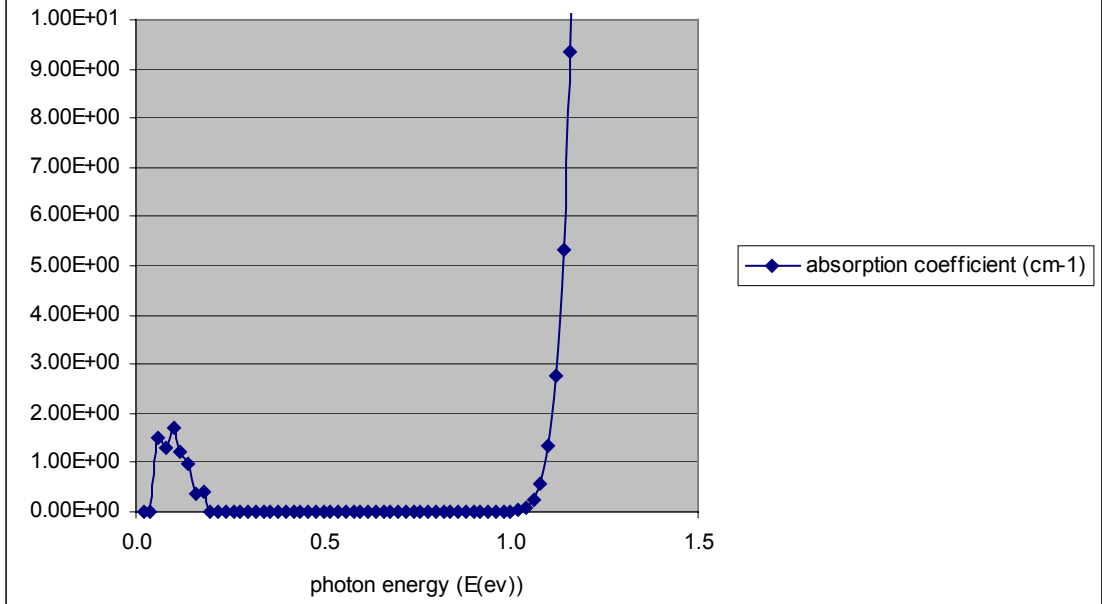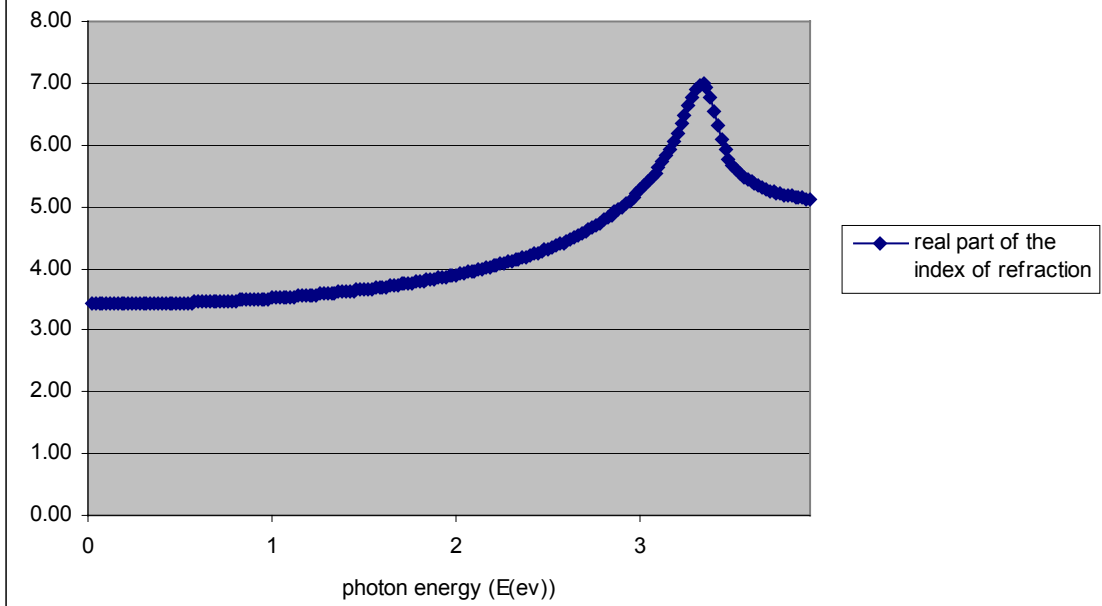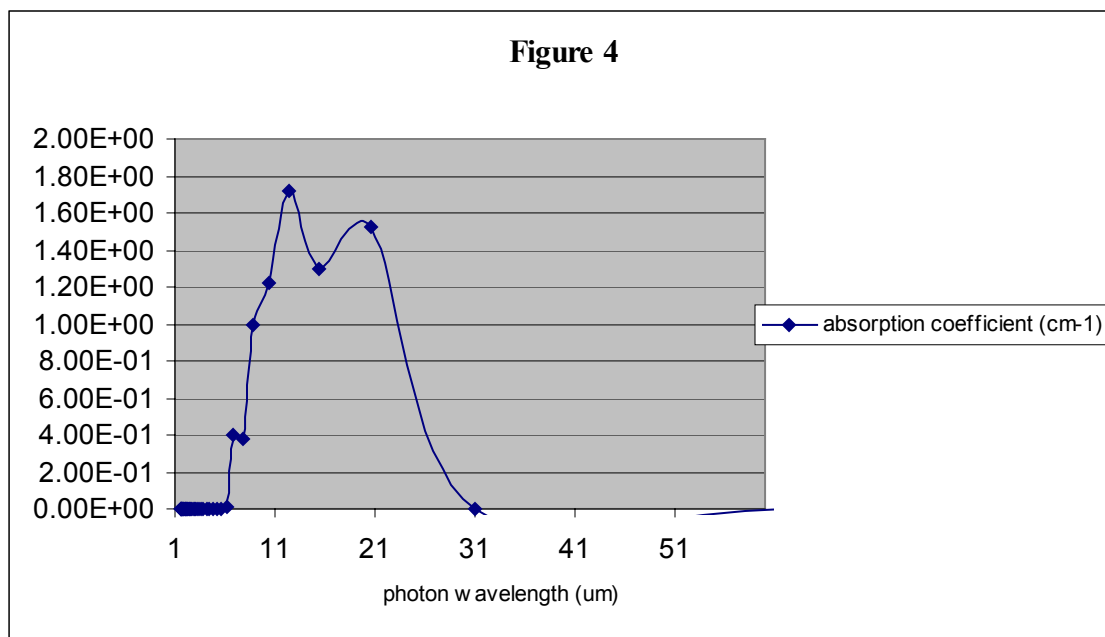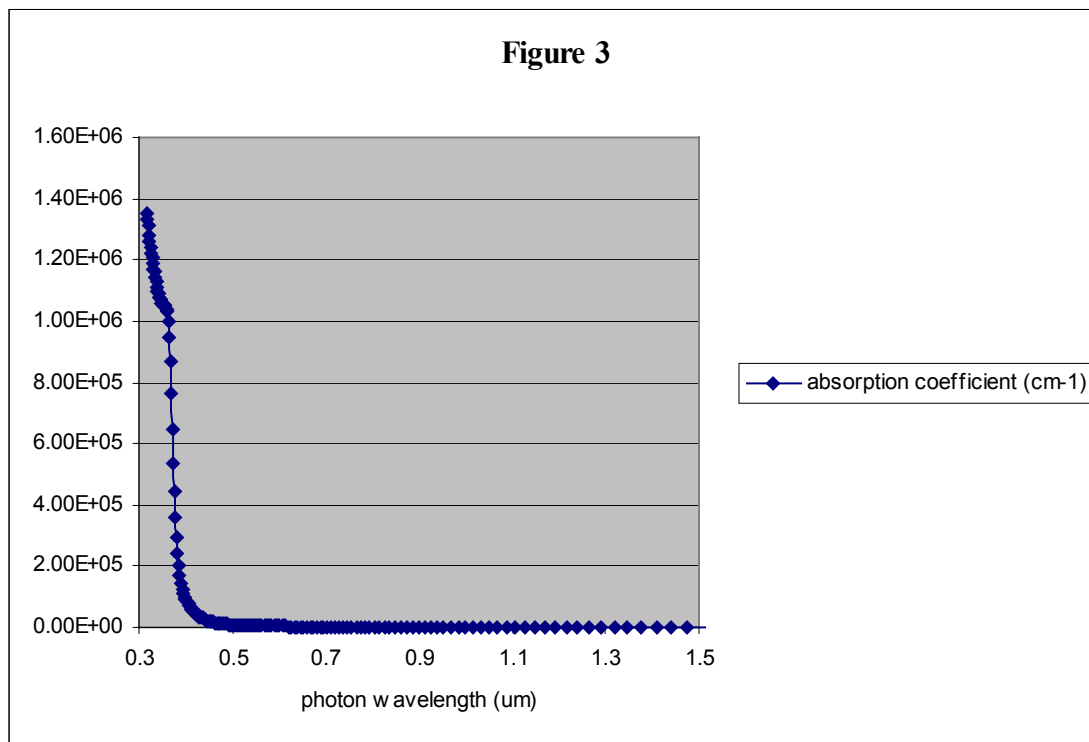
Figure 1
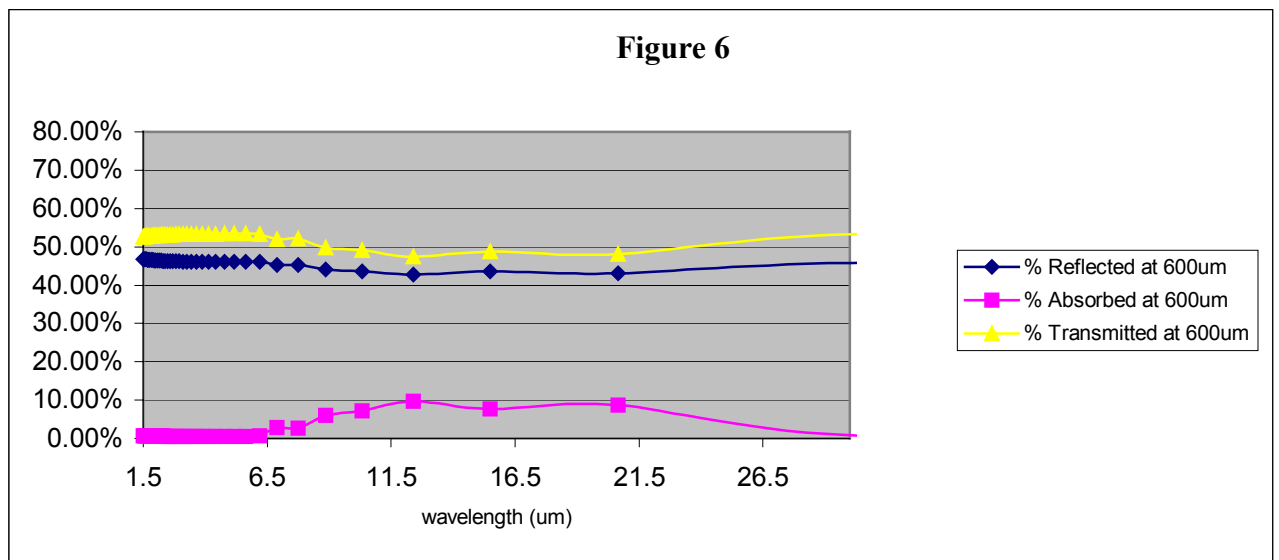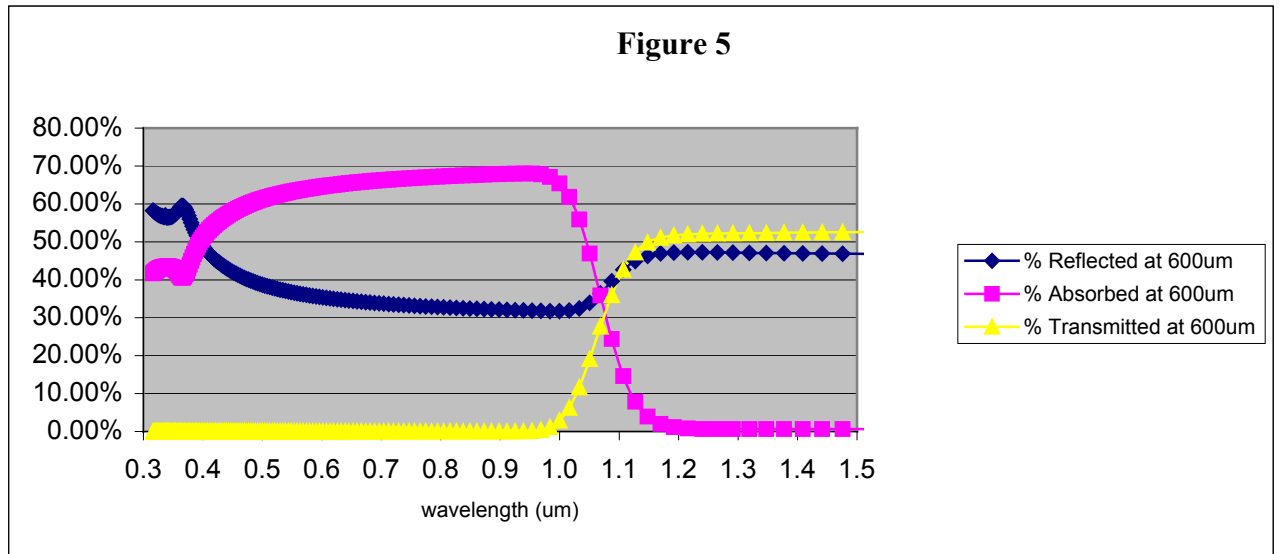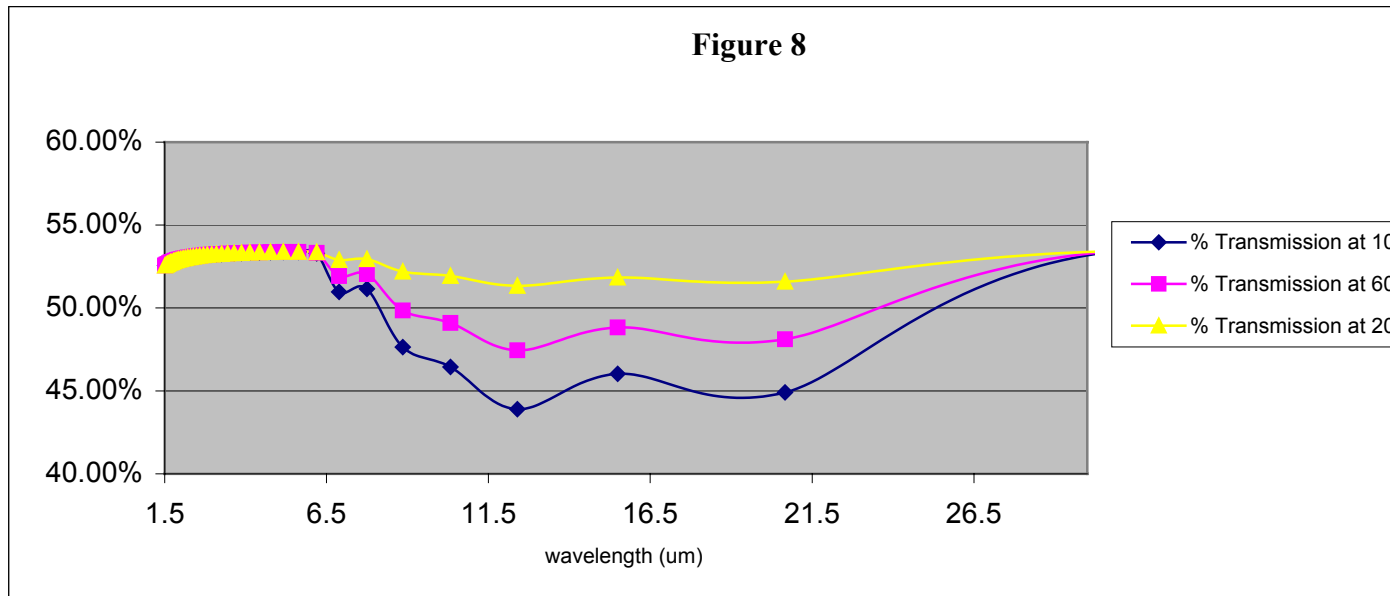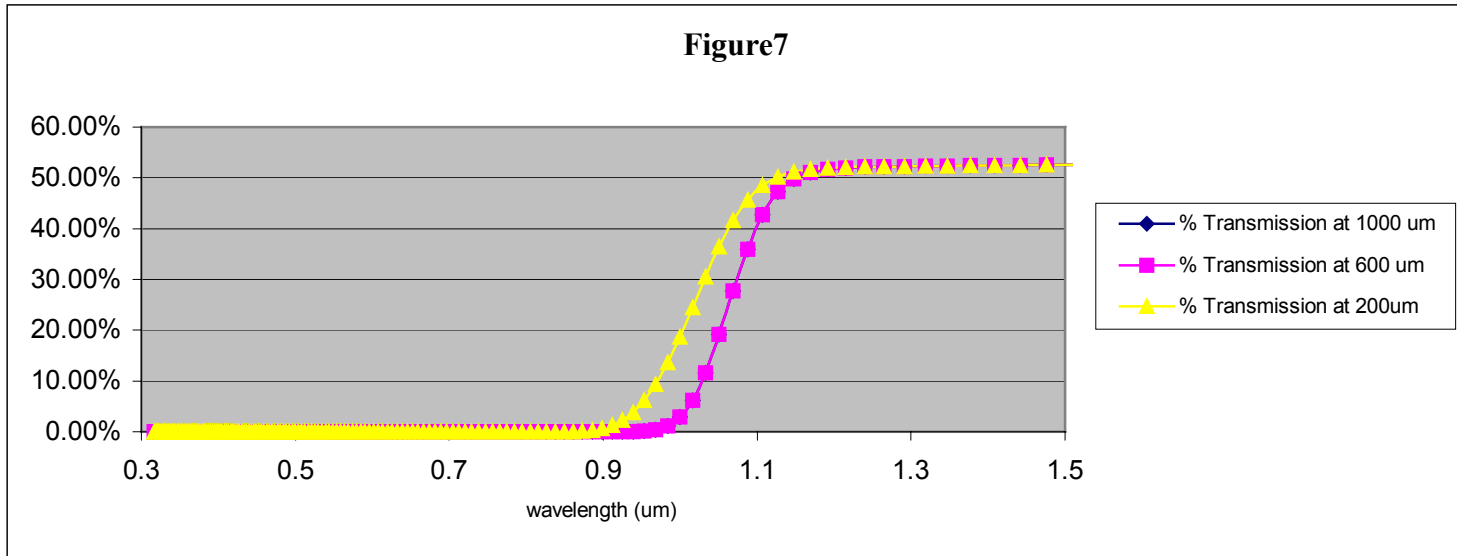

Figure 2

Figure 3

Figure 4

As described above, the % reflectance, % transmission, and % absorption of photons incident on double side polished Si can be calculated for different wavelengths and

thicknesses of Si. Figure 5 shows these properties for 0.3um to 1.5um wavelength radiation and wafer thickness of 600um. Figure 6 shows these properties for 1.5um to 30 um wavelength radiation. Figure 7 plots the % transmission for 0.3 um to 1.5 um radiations and different thickness double side polished wafers. Figure 8 plots this information for 1.5 um to 30 um radiations.

Figure 5

Figure 6

Figure7

Figure 8

D Conclusion

This article contains general information on the optical properties of silicon and displays
this information in several tables and graphs. The information was taken from references
and derived from equations as described.

E References

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