

Appendix D

Lithium Niobate Optical Properties

The following table lists the optical properties used for the finite-difference time-domain simulations of lithium niobate color filtering used in Chapter 6. The data was obtained through a combination of spectroscopic ellipsometry (Appendix C) of x-cut lithium niobate single crystal samples [3], and from Reference [11].

The experimental lithium niobate data was fit from 400 - 700 nm as a Cauchy layer given by:

$$n(\lambda) = n_0 + C_0 \frac{n_1}{\lambda^2} + C_1 \frac{n_2}{\lambda^4} \quad (\text{D.1})$$

$$k(\lambda) = k_0 + C_0 \frac{k_1}{\lambda^2} + C_1 \frac{k_2}{\lambda^4} \quad (\text{D.2})$$

where $n_0 = 2.093$, $n_1 = 305.9$, $n_2 = 52.9$, $k_0 = 0.02$, $k_1 = 24.541$, $k_2 = 23.276$, $C_0 = 10^2$, $C_1 = 10^7$, and λ is given in nm.

For lithium niobate with and without an applied electric field, the imaginary part of the index of refraction was kept constant.

λ (nm)	index (V = 0)	index (V = Applied)	k
401.02526	2.295547794937	2.4811	0.042641086753
403.42627	2.292915889071	2.4724	0.042479604977
405.22704	2.290220480056	2.4662	0.041942041808
407.0278	2.286990340738	2.4604	0.042214882671
409.42881	2.286026168866	2.4529	0.041374350774
411.22958	2.285425935878	2.4477	0.041877079415
413.03034	2.282431581504	2.4427	0.041445679342

λ (nm)	index ($V = 0$)	index ($V = \text{Applied}$)	k
415.43136	2.279966319221	2.4364	0.040676174432
417.23212	2.277795129075	2.4319	0.040615512823
419.03288	2.278910830714	2.4277	0.041104888292
421.4339	2.274188880289	2.4224	0.041134279634
423.23466	2.273746292495	2.4187	0.040516113998
425.03542	2.271451574133	2.4152	0.040462235188
427.43644	2.269774672465	2.4108	0.040339049254
429.2372	2.268345389284	2.4077	0.04000318701
431.03796	2.266298826854	2.4048	0.039411300994
433.43898	2.263197744359	2.4011	0.03928415182
435.23974	2.261341755004	2.3986	0.039384665092
437.05143	2.259935128628	2.3961	0.038946835023
439.47428	2.25818164547	2.3931	0.038986820125
441.29143	2.255412782436	2.391	0.038574236313
443.10857	2.256097845995	2.3889	0.038248913181
445.53143	2.255317977897	2.3864	0.038940901467
447.34857	2.254592989005	2.3846	0.038639297794
449.16571	2.252856467425	2.3829	0.038025880732
451.58857	2.249629378184	2.3807	0.03760654238
453.40571	2.250908699316	2.3792	0.038182430589
455.22286	2.246089233332	2.3777	0.037111405325
457.04	2.244748068969	2.3763	0.037353289677
459.46286	2.241808351136	2.3744	0.036764937843
461.28	2.240764124125	2.373	0.036860061753
463.09714	2.2379256399	2.3717	0.036035534084
465.52	2.239242050242	2.3699	0.036465321264

λ (nm)	index ($V = 0$)	index ($V = \text{Applied}$)	k
467.33715	2.237030323115	2.3686	0.036207846931
469.15429	2.237964714116	2.3672	0.035898843425
471.57715	2.234177505899	2.3654	0.035854047051
473.39429	2.2335359336	2.3641	0.035935482701
475.21143	2.231849223515	2.3627	0.035309255449
477.02858	2.230681746645	2.3614	0.035567273397
479.45143	2.230494398356	2.3596	0.035034845206
481.26858	2.229035773325	2.3583	0.034584633557
483.08572	2.226294411702	2.357	0.034935406597
485.50858	2.227499217249	2.3552	0.034634480114
487.32572	2.223739802698	2.3538	0.034870354576
489.14286	2.225152475139	2.3524	0.034839664448
491.56572	2.223450090601	2.3506	0.033643944321
493.38286	2.220418051273	2.3493	0.034480765961
495.20001	2.222105572746	2.3479	0.034054848208
497.01715	2.221531576874	2.3466	0.034379173006
499.44001	2.219402852086	2.345	0.033407835672
501.25715	2.218389248616	2.3438	0.033764955447
503.07429	2.219626095105	2.3427	0.03337352644
505.49715	2.216619003587	2.3414	0.032779262417
507.3143	2.217686599371	2.3404	0.032838448584
509.13144	2.214931089318	2.3395	0.033552394516
511.5543	2.211594081761	2.3384	0.032089013321
513.37144	2.212054998039	2.3375	0.032534282952
515.18858	2.211793191858	2.3367	0.032691289963
517.00573	2.21277231374	2.3358	0.032032312494

λ (nm)	index ($V = 0$)	index ($V = \text{Applied}$)	k
519.42858	2.212475258751	2.3345	0.031602194739
521.24573	2.210164496519	2.3336	0.032351716416
523.06287	2.209180177114	2.3326	0.03197502082
525.48573	2.206979432532	2.3314	0.031814076593
527.30287	2.208212917783	2.3304	0.031299248444
529.12001	2.205797756892	2.3295	0.031143985951
531.54287	2.202749330335	2.3282	0.031820874302
533.36001	2.204151669529	2.3273	0.031504426013
535.17716	2.204431199275	2.3264	0.031405280968
537.60002	2.200727780531	2.3252	0.030920951346
539.41716	2.203431984846	2.3243	0.031677409181
541.2343	2.204941152164	2.3234	0.031016980409
543.05145	2.201577706581	2.3225	0.030548518703
545.4743	2.198392565327	2.3214	0.031171522965
547.29832	2.198461211603	2.3206	0.031031469631
549.12577	2.199752990946	2.3197	0.03076527891
551.56236	2.196946981393	2.3186	0.030139540608
553.38981	2.195113463733	2.3178	0.03083848737
555.21726	2.197399768609	2.317	0.030550105186
557.04471	2.197071876184	2.3162	0.031098167226
559.48131	2.194649490887	2.3152	0.029370110902
561.30876	2.195204118874	2.3144	0.030498374513
563.13621	2.196700909541	2.3137	0.031272109273
565.57281	2.192231120891	2.3127	0.029781594097
567.40025	2.190097861767	2.312	0.029801134882
569.2277	2.189152495703	2.3112	0.02998194035

λ (nm)	index ($V = 0$)	index ($V = \text{Applied}$)	k
571.05515	2.192003324649	2.3105	0.029301143845
573.49175	2.184366555474	2.3096	0.031241157331
575.3192	2.189708472662	2.3089	0.029763429199
577.14665	2.191524128982	2.3082	0.029067192221
579.58325	2.184802435272	2.3073	0.029805898884
581.4107	2.184890243556	2.3067	0.02870992971
583.23815	2.185306692374	2.306	0.030031157319
585.06559	2.186261077891	2.3054	0.028794480564
587.50219	2.192100021931	2.3045	0.029617318151
589.32964	2.185435918315	2.3039	0.02881657328
591.15709	2.186863406349	2.3033	0.029086579226
593.59369	2.186678540584	2.3025	0.029862045055
595.42114	2.185196011682	2.3019	0.02906069493
597.24859	2.181772339395	2.3013	0.029689046827
599.07604	2.18218189584	2.3007	0.029190396102
601.51263	2.183127282914	2.2999	0.027721432644
603.34008	2.179356414814	2.2993	0.028443297323
605.16753	2.189309778319	2.2988	0.028396370583
607.60413	2.186779961645	2.298	0.028218135452
609.43158	2.173323583877	2.2975	0.028267675088
611.25903	2.179423722739	2.2969	0.02889179145
613.08648	2.177644404099	2.2964	0.028278353395
615.52308	2.180137548989	2.2957	0.027272526035
617.35052	2.180620151686	2.2952	0.027738103764
619.17797	2.177027372489	2.2947	0.028119462632
621.00542	2.173156689346	2.2942	0.027404417869

λ (nm)	index ($V = 0$)	index ($V = \text{Applied}$)	k
623.44202	2.173883799245	2.2935	0.027305713974
625.26947	2.17989293822	2.293	0.027635389683
627.09692	2.179475106873	2.2925	0.027465910429
629.53352	2.185592040394	2.2919	0.027035194544
631.36097	2.168215958126	2.2914	0.026026853308
633.18842	2.172650790625	2.2909	0.027569972329
635.01586	2.173202410334	2.2904	0.026268829933
637.45246	2.174181573092	2.2898	0.02674623731
639.27991	2.176229755329	2.2893	0.026294592776
641.10736	2.164889544323	2.2889	0.026340120368
643.54396	2.174844716569	2.2883	0.026445817283
645.37141	2.172663435937	2.2878	0.026278612096
647.19886	2.178957488219	2.2874	0.026587905539
649.02631	2.16868444964	2.287	0.028383915752
651.4629	2.176746486213	2.2864	0.025702919695
653.29035	2.173289219561	2.2859	0.025552505524
655.1178	2.166357544031	2.2855	0.025541591091
657.5544	2.175280175351	2.2849	0.025852691809
659.38185	2.177850136368	2.2845	0.024734731358
661.2093	2.170548560355	2.2841	0.026540626906
663.03675	2.175102831575	2.2837	0.025807555118
665.47335	2.172607303241	2.2831	0.024717102527
667.3008	2.172155089829	2.2827	0.025636857576
669.12824	2.169962799807	2.2823	0.025207845949
671.56484	2.162078648812	2.2818	0.025506919331
673.39229	2.173205603574	2.2814	0.024661790652

λ (nm)	index ($V = 0$)	index ($V = \text{Applied}$)	k
675.21974	2.167413076397	2.281	0.02630575861
677.04719	2.162001422702	2.2806	0.025369020208
679.48379	2.168977307923	2.28	0.024264548093
681.31124	2.163138163318	2.2796	0.024254139542
683.13869	2.16902872799	2.2792	0.024374636952
685.57528	2.169269641001	2.2787	0.025776000858
687.40273	2.154264788399	2.2783	0.026447812887
689.23018	2.161039994855	2.2779	0.026034923451
691.05763	2.159770867746	2.2775	0.025316378965
693.49423	2.164054423597	2.277	0.023498716441
695.32168	2.163088338121	2.2766	0.025752554405
697.16007	2.164523676774	2.2762	0.024176896755
699.02035	2.164164354689	2.2758	0.025124714717
699.64044	2.165886613617	2.2757	0.025104436349