Thickness Measurements Using Birefringence (10 points)

Values in black (blue) are typical (acceptable).

Part A. Measurement System Setup (2.3 points)

A.1 (0.3 pt)

$\lambda = 684$ nm

$\theta = 20.0°$

A.2 (0.2 pt)

$\theta = -30.0°,\ 70.0°$

A.3 (0.8 pt)

$\theta = -28.0°$ $\quad (-28.9° \le \theta \le -27.7° \quad \text{or} \quad 67.7° \le \theta \le 68.9°)$

$\lambda_{\text{Peak}} = 458$ nm
$(450\ \text{nm} \le \lambda_{\text{Peak}} \le 460\ \text{nm};\quad \lambda_{\text{Peak}}$ and θ must be consistent with Eq. (7) or (8).)

$\alpha = 40.0°$

A.4 (0.3 pt)

$\varphi_\perp = 90°$ $\quad (85° \le \varphi_\perp \le 95° \quad \text{or} \quad 265° \le \varphi_\perp \le 275°)$

$\varphi_\parallel = 0°$ $\quad (\varphi_\parallel = \varphi_\perp + 90°$ or $\varphi_\perp - 90°)$

A.5 (0.2 pt)

$I_{\text{Offset }\perp} = 0.005\ \text{V}$ $(I_{\text{Offset }\perp} \leq 0.010\ \text{V})$

$I_{\text{Offset }\parallel} = 0.010\ \text{V}$ $(I_{\text{Offset }\parallel} \leq 0.020\ \text{V})$

A.6 (0.5 pt)

$I_{\perp} = 0.001\ \text{V}$ $(I_{\perp} \leq 0.003\ \text{V})$

$I_{\parallel} = 0.160\ \text{V}$ $(I_{\parallel} \geq 0.100\ \text{V})$

Part B. Measurement of transmitted light intensities (4.7 points)

B.1 (2.0 pt)

θ_{Stage}/degree	θ/degree	λ/nm	$I_{\perp}$/mV	$I_{\parallel}$/mV	I_{Total}/mV	I_{Norm}
30.5	-31	430.5	13	26	39	0.333
30	-30.5	435.1	38	31	69	0.551
29.5	-30	439.7	83	27	110	0.755
29	-29.5	444.2	166	17	183	0.907
28.5	-29	448.8	244	21	265	0.921
28	-28.5	453.3	280	80	360	0.778
27.5	-28	457.7	267	159	426	0.627
27	-27.5	462.1	188	216	404	0.465
26.5	-27	466.5	73	223	296	0.247
26	-26.5	470.9	17	197	214	0.079
25.5	-26	475.2	12	162	174	0.069
25	-25.5	479.5	19	121	140	0.136
24.5	-25	483.7	34	71	105	0.324
24	-24.5	487.9	48	43	91	0.527
23.5	-24	492.1	61	22	83	0.735
23	-23.5	496.2	72	10	82	0.878
22.5	-23	500.3	83	4	87	0.954
22	-22.5	504.3	94	8	102	0.922
21.5	-22	508.3	97	19	116	0.836

B.1 (2.0 pt)

(Continued)

θ_{Stage}/degree	θ/degree	λ/nm	$I_{\perp}$/mV	$I_{\parallel}$/mV	I_{Total}/mV	I_{Norm}
21	-21.5	512.3	92	37	129	0.713
20.5	-21	516.3	77	68	145	0.531
20	-20.5	520.1	61	90	151	0.404
19.5	-20	524.0	35	130	165	0.212
19	-19.5	527.8	18	153	171	0.105
18.5	-19	531.6	8	166	174	0.046
18	-18.5	535.3	8	167	175	0.046
17.5	-18	539.0	14	158	172	0.081
17	-17.5	542.7	32	141	173	0.185
16.5	-17	546.3	47	127	174	0.270
16	-16.5	549.9	73	99	172	0.424
15.5	-16	553.4	93	76	169	0.550
15	-15.5	556.9	112	55	167	0.671
14.5	-15	560.3	130	34	164	0.793
14	-14.5	563.7	141	20	161	0.876
13.5	-14	567.1	147	10	157	0.936
13	-13.5	570.4	148	6	154	0.961
12.5	-13	573.7	146	6	152	0.961
12	-12.5	576.9	138	10	148	0.932

B.1 (2.0 pt)

(Continued)

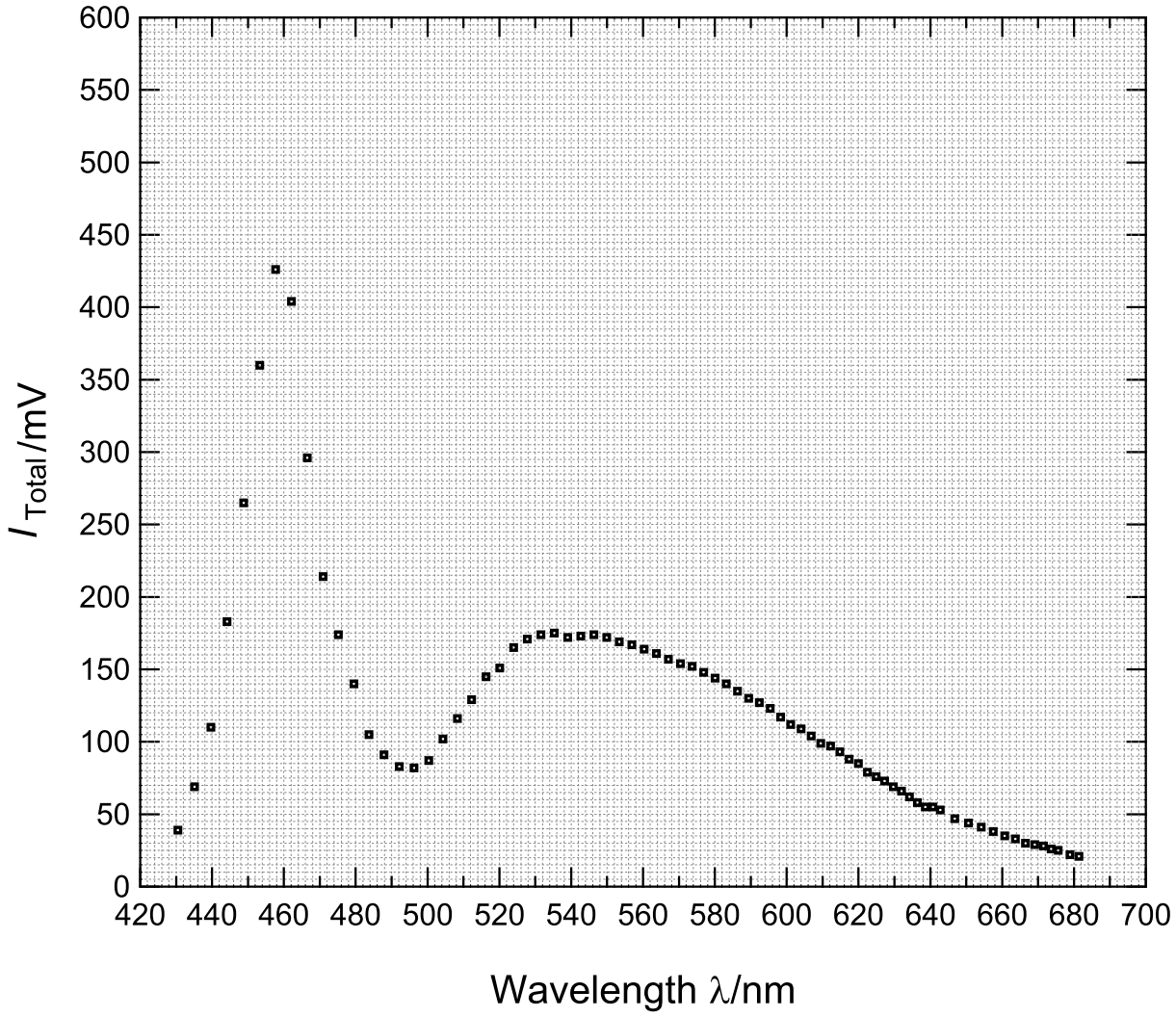
θ_{Stage}/degree	θ/degree	λ/nm	$I_{\perp}$/mV	$I_{\parallel}$/mV	I_{Total}/mV	I_{Norm}
11.5	-12	580.1	127	17	144	0.882
11	-11.5	583.2	114	26	140	0.814
10.5	-11	586.3	97	38	135	0.719
10	-10.5	589.4	80	50	130	0.615
9.5	-10	592.4	67	60	127	0.528
9	-9.5	595.4	54	69	123	0.439
8.5	-9	598.3	41	76	117	0.350
8	-8.5	601.1	31	81	112	0.277
7.5	-8	604.0	22	87	109	0.202
7	-7.5	606.8	15	89	104	0.144
6.5	-7	609.5	8	91	99	0.081
6	-6.5	612.2	6	91	97	0.062
5.5	-6	614.8	4	89	93	0.043
5	-5.5	617.4	3	85	88	0.034
4.5	-5	620.0	4	81	85	0.047
4	-4.5	622.5	5	74	79	0.063
3.5	-4	624.9	7	69	76	0.092
3	-3.5	627.3	10	63	73	0.137
2.5	-3	629.7	12	57	69	0.174

B.1 (2.0 pt)

(Continued)

θ_{Stage}/degree	θ/degree	λ/nm	$I_{\perp}$/mV	$I_{\parallel}$/mV	I_{Total}/mV	I_{Norm}
2	-2.5	632.0	15	51	66	0.227
1.5	-2	634.2	18	44	62	0.290
1	-1.5	636.4	21	37	58	0.362
0.5	-1	638.6	23	32	55	0.418
0	-0.5	640.7	25	30	55	0.455
-0.5	0	642.8	27	26	53	0.509
-1.5	1	646.8	29	18	47	0.617
-2.5	2	650.6	31	13	44	0.705
-3.5	3	654.2	32	9	41	0.780
-4.5	4	657.5	32	6	38	0.842
-5.5	5	660.7	31	4	35	0.886
-6.5	6	663.7	30	3	33	0.909
-7.5	7	666.5	28	2	30	0.933
-8.5	8	669.1	27	2	29	0.931
-9.5	9	671.5	26	2	28	0.929
-10.5	10	673.6	24	2	26	0.923
-11.5	11	675.6	23	2	25	0.920
-13.5	13	678.9	20	2	22	0.909
-15.5	15	681.4	18	3	21	0.857

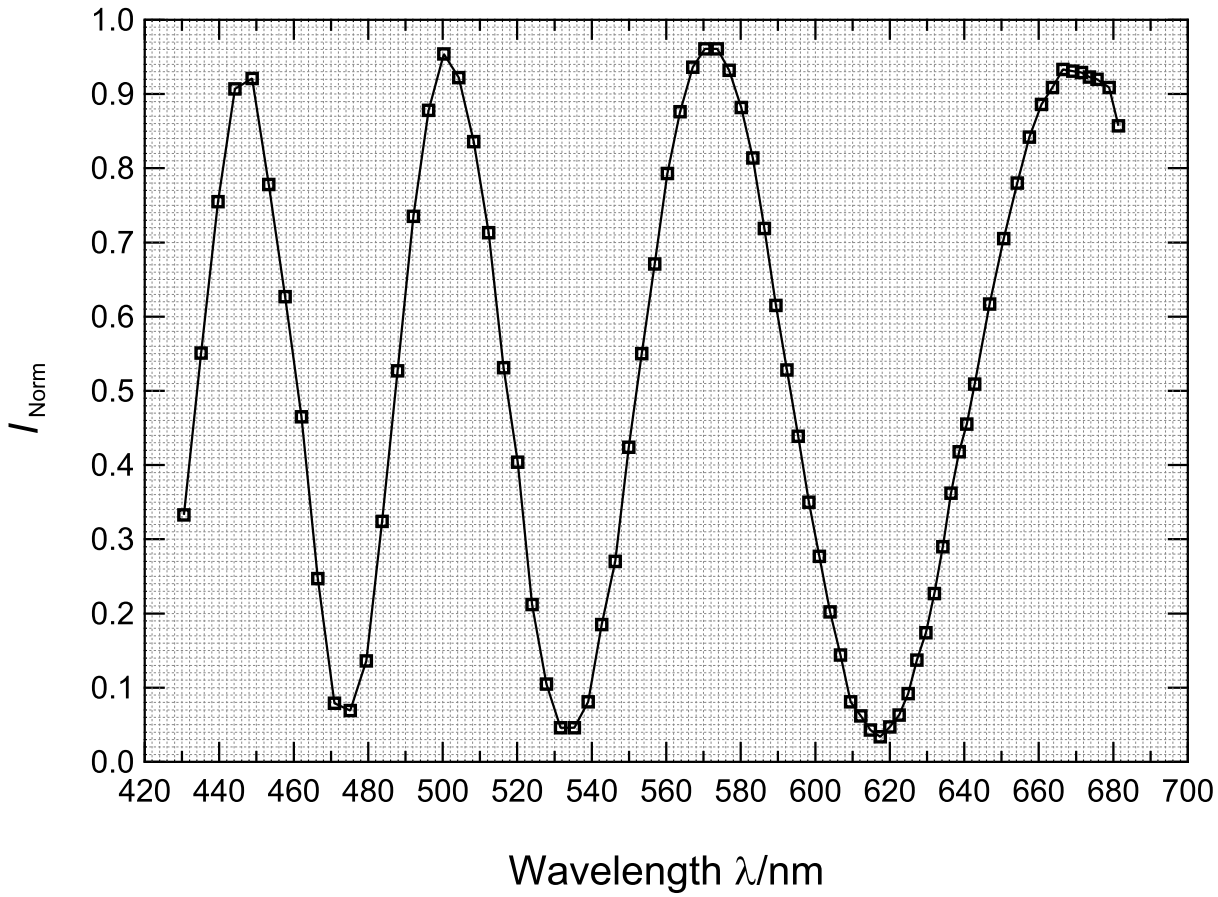
B.2 (1.0 pt)



B.3 (0.2 pt)

$\Delta\lambda_{FWHM} = 25$ nm $\quad (\Delta\lambda_{FWHM} \leq 40$ nm)

B.4 (1.5 pt)


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
I_{Norm}
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
Wavelength λ/nm

Part C. Analyses of Measured Results (3.0 points)

C.1 (1.5 pt)

$\lambda = 473$ nm, 534 nm, 617 nm

(455 nm $< \lambda <$ 479 nm, 513 nm $< \lambda <$ 539 nm, 590 nm $< \lambda <$ 620 nm)

$m = 8, \quad 7, \quad 6$

C.2 (1.5 pt)

$L = 407\ \mu$m (390 μm $< L <$ 410 μm)