

Supporting information

Spectral simulation and material design of camouflage textiles coloration for multidimensional combat backgrounds in visible and near infrared spectrums

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1. FTIRS spectra of HR materials, 1000-2400 nm; Figure SI. 1-5.
2. FTIRS spectra of LR materials, 1000-2400 nm; Figure SI. 6-9.
3. FTIRS spectra of synthetic dyes, 1000-2400 nm; Figure SI. 10-15.
4. FTIRS spectra of DGTWSIB, 1000-2400 nm; Figure SI. 16-23.
5. Colorflex EZ spectra of HR materials, 400-700 nm; Figure SI. 24-28.
6. Colorflex EZ spectra of LR materials, 400-700 nm; Figure SI. 29-32.
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1. FTIRS spectra of HR materials

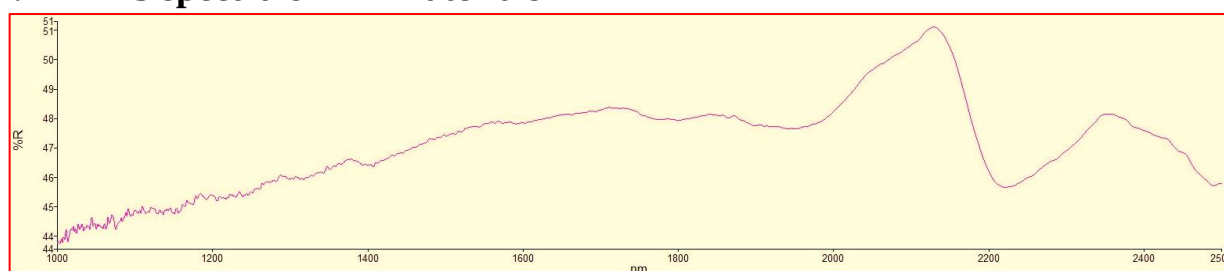


Figure 1. Aluminium powder

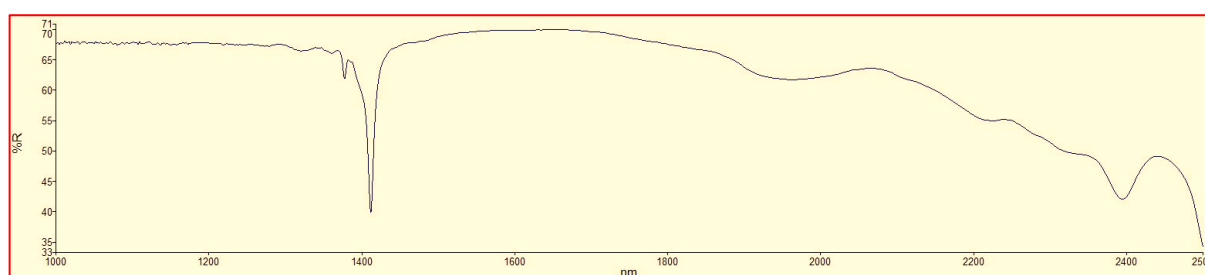


Figure 2. Calcium oxide

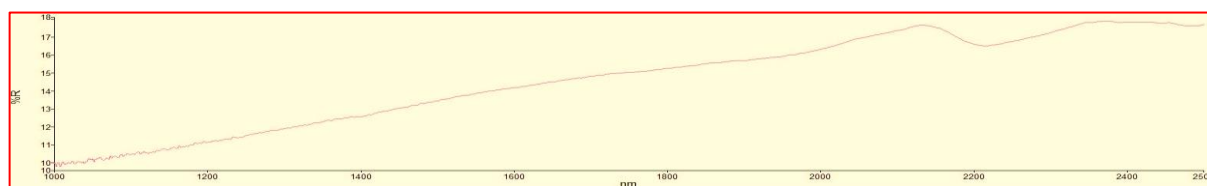


Figure 3. Iron powder



Figure 4. Titanium dioxide

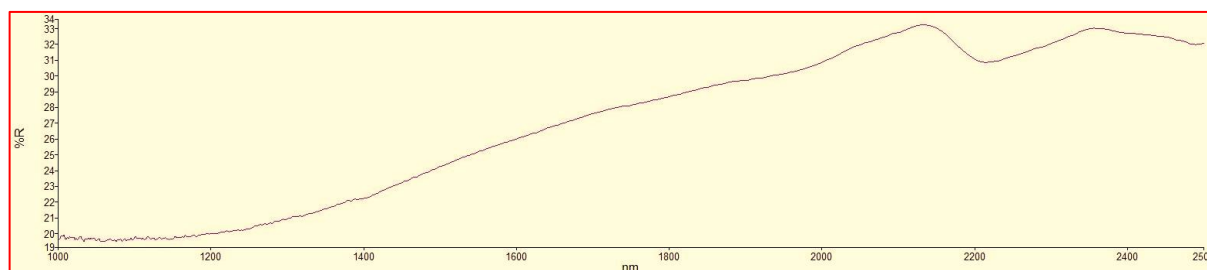


Figure 5. Tin metal

2. FTIRS spectra of LR materials

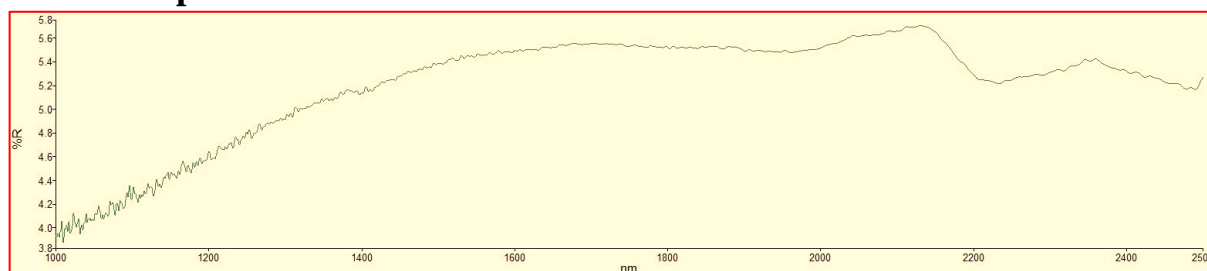


Figure 6. Boron carbide

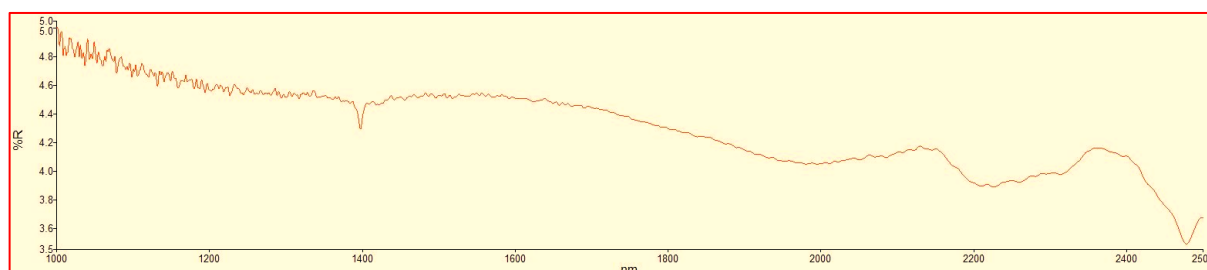


Figure 7. Magnesium powder

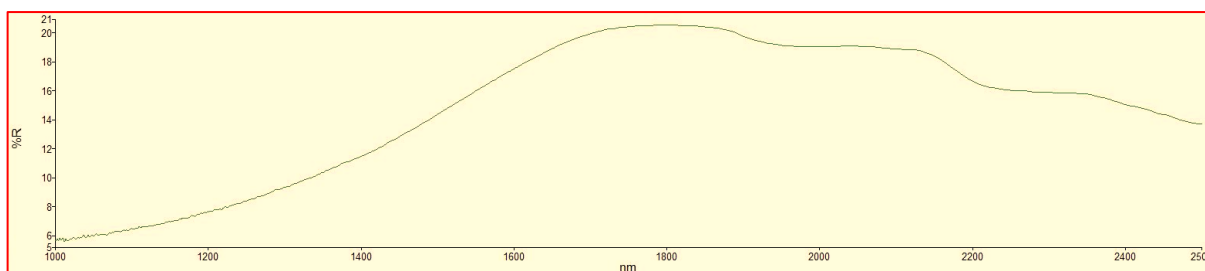


Figure 8. Tin oxide

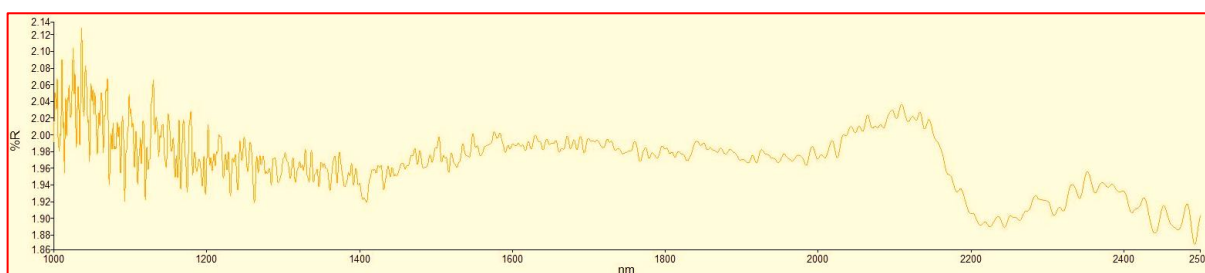


Figure 9. Titanium carbide

3. FTIRS spectra of synthetic textile dyes

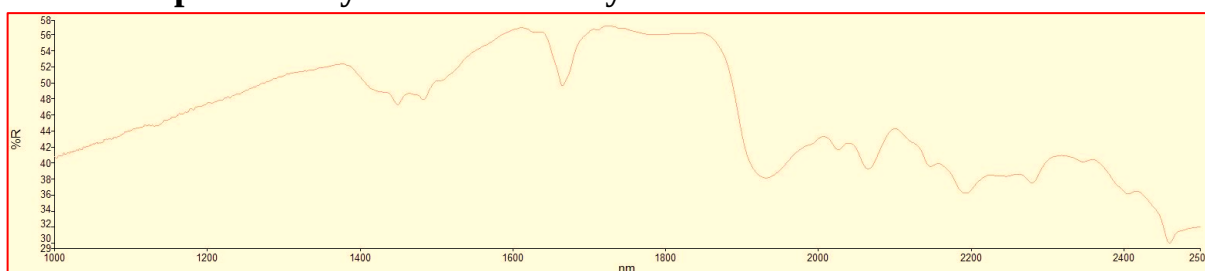


Figure 10. Telon violet 3R

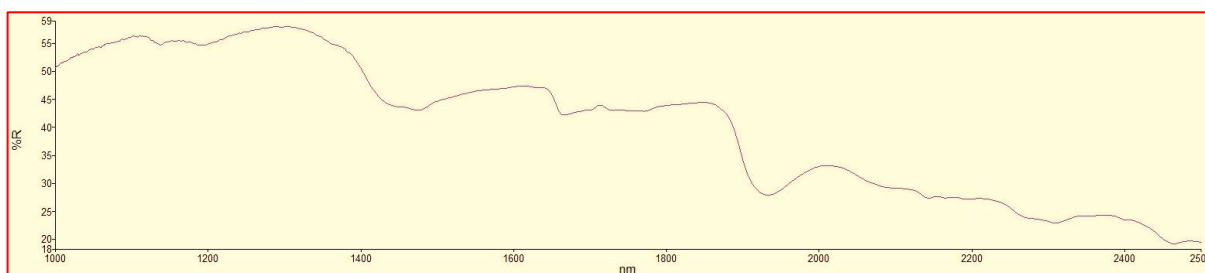


Figure 11. Telon blue A 2R

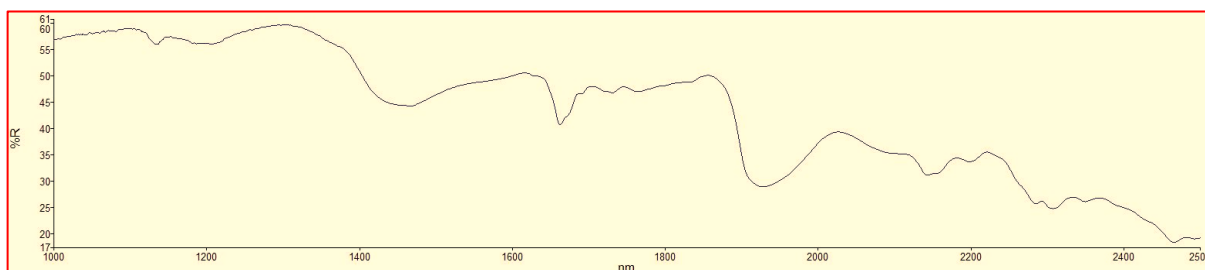


Figure 12. Telon yellow A 2R

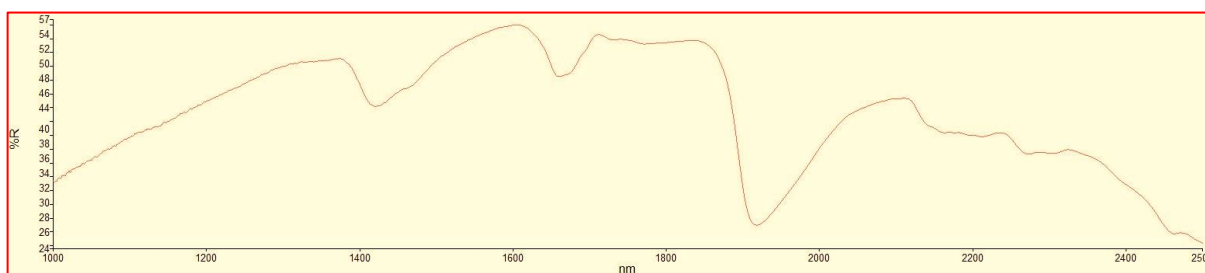


Figure 13. Isolan orange

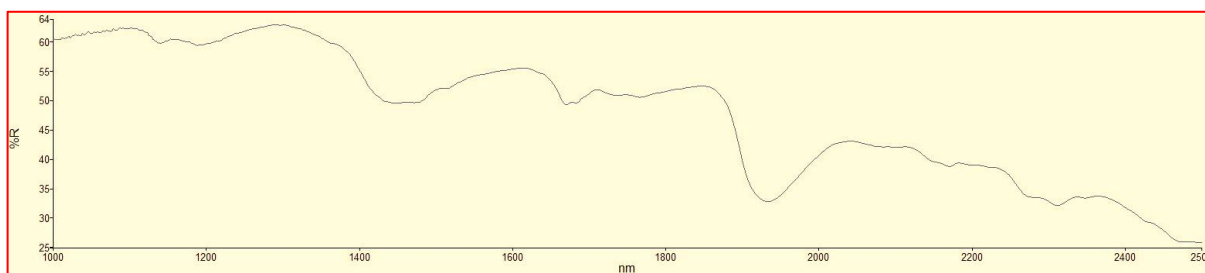


Figure 14. Telon red A 2R



Figure 15. Isolan black 2S LDN

4. FTIRS spectra of DGTWSIB

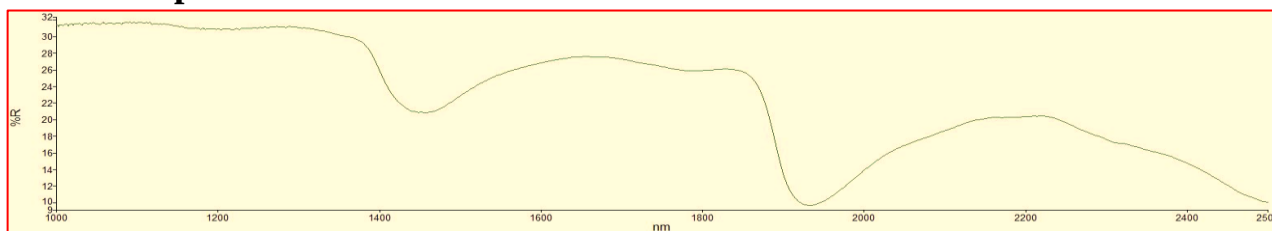


Figure 16. Dry leaves for woodland combat background

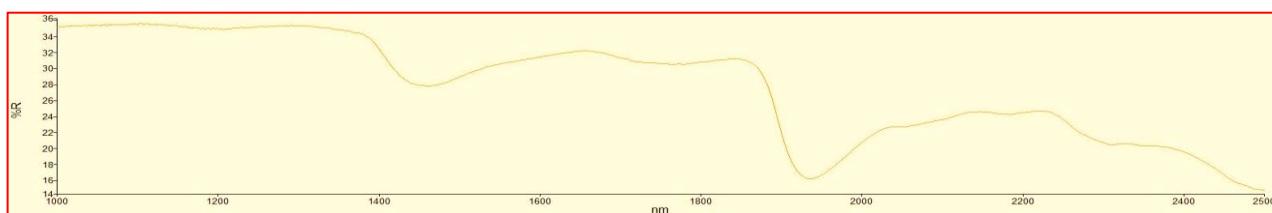


Figure 17. Green leaves for woodland combat background

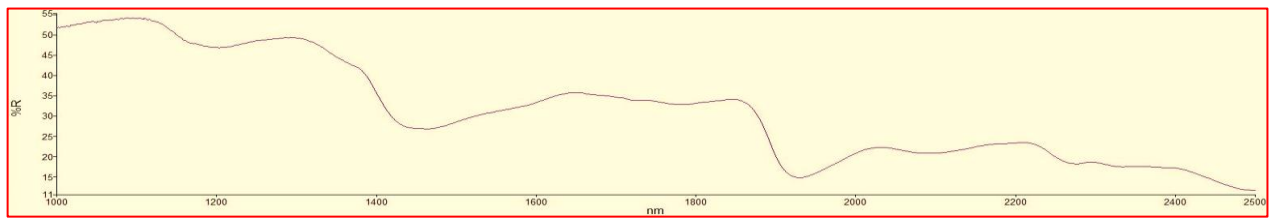


Figure 18. Tree bark for woodland combat background

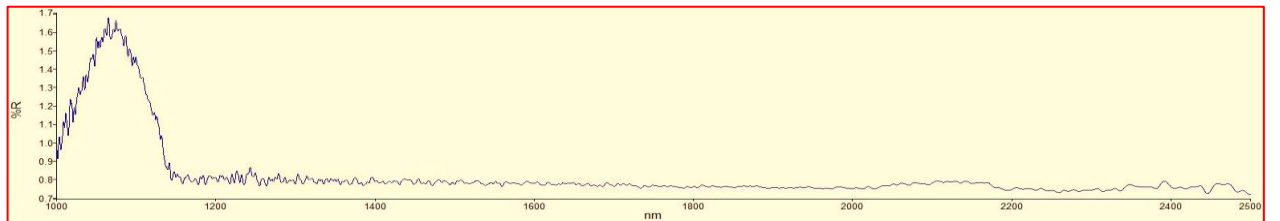


Figure 19. Water for marine combat background

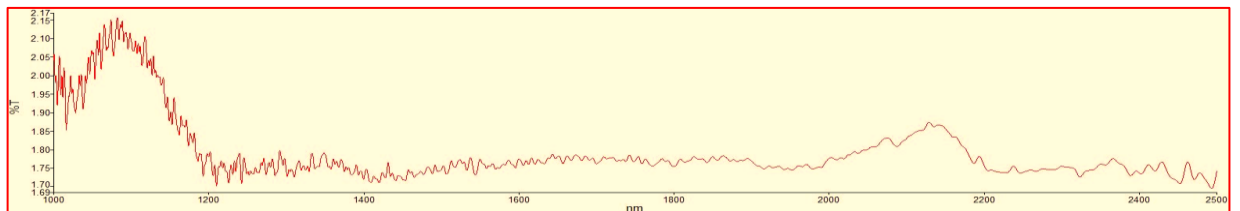


Figure 20. Ice for Iceland combat background

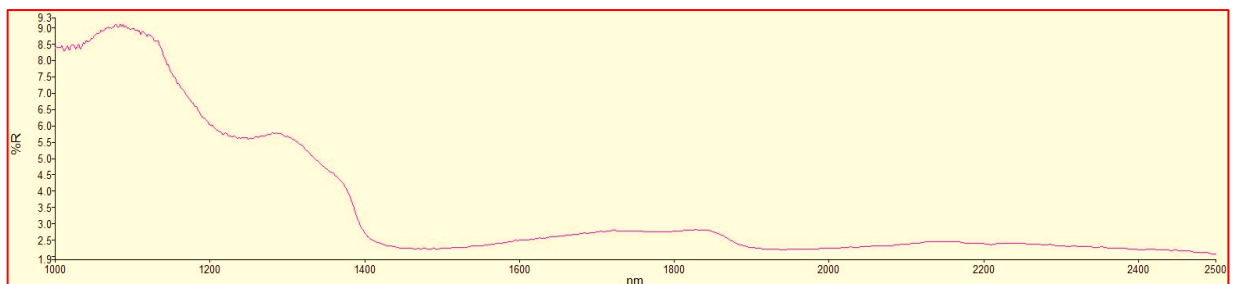


Figure 21. Snow for snowland combat background

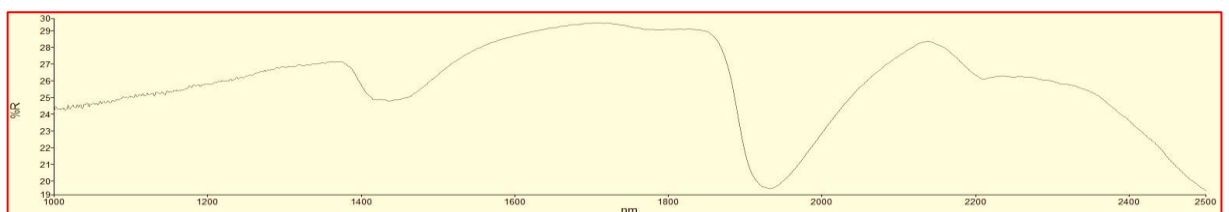
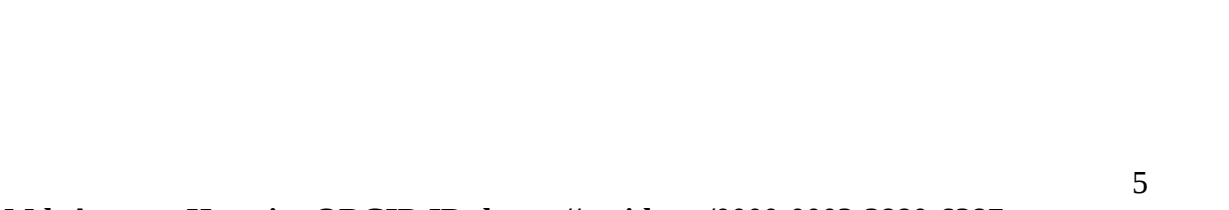


Figure 22. Sand for desertland combat background



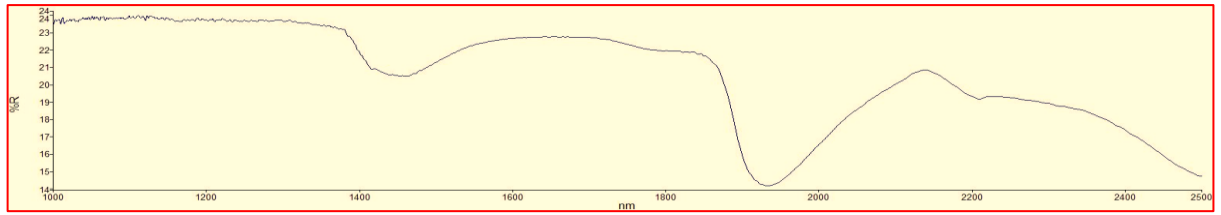


Figure 23. Stone for stoneland combat background

5. ColorflexEZ spectra of HR materials

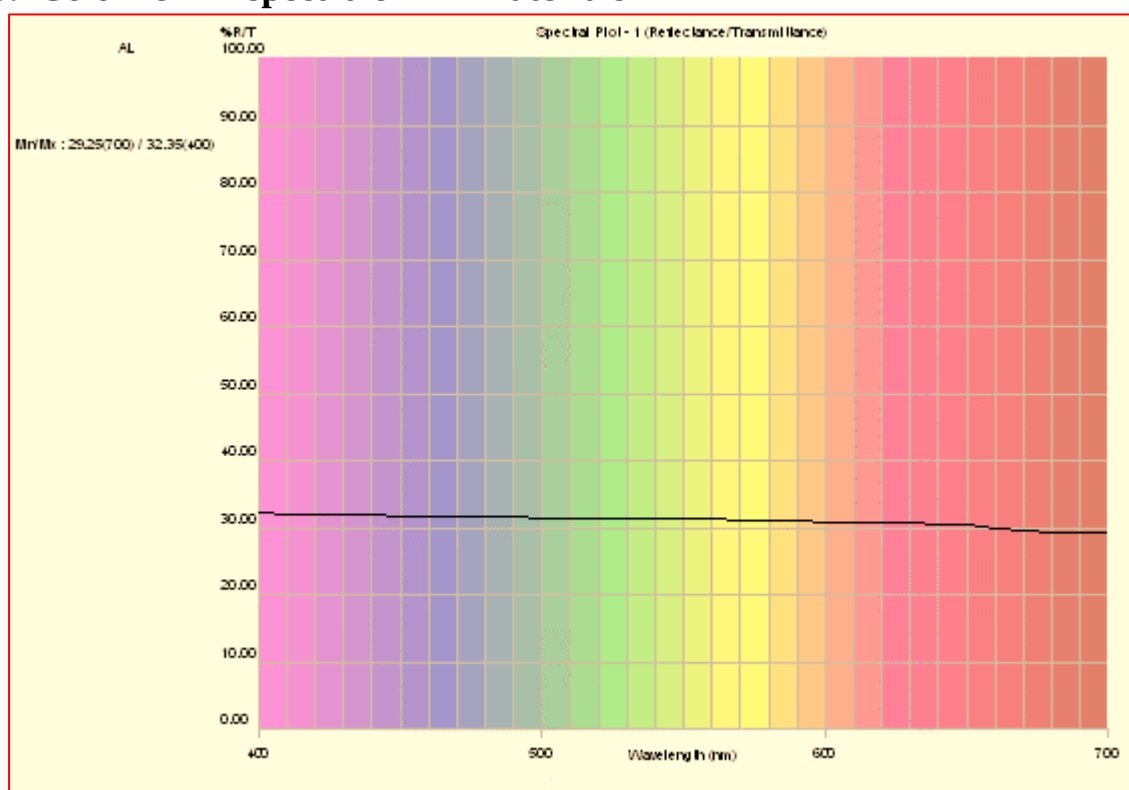


Figure 24. Aluminium powder

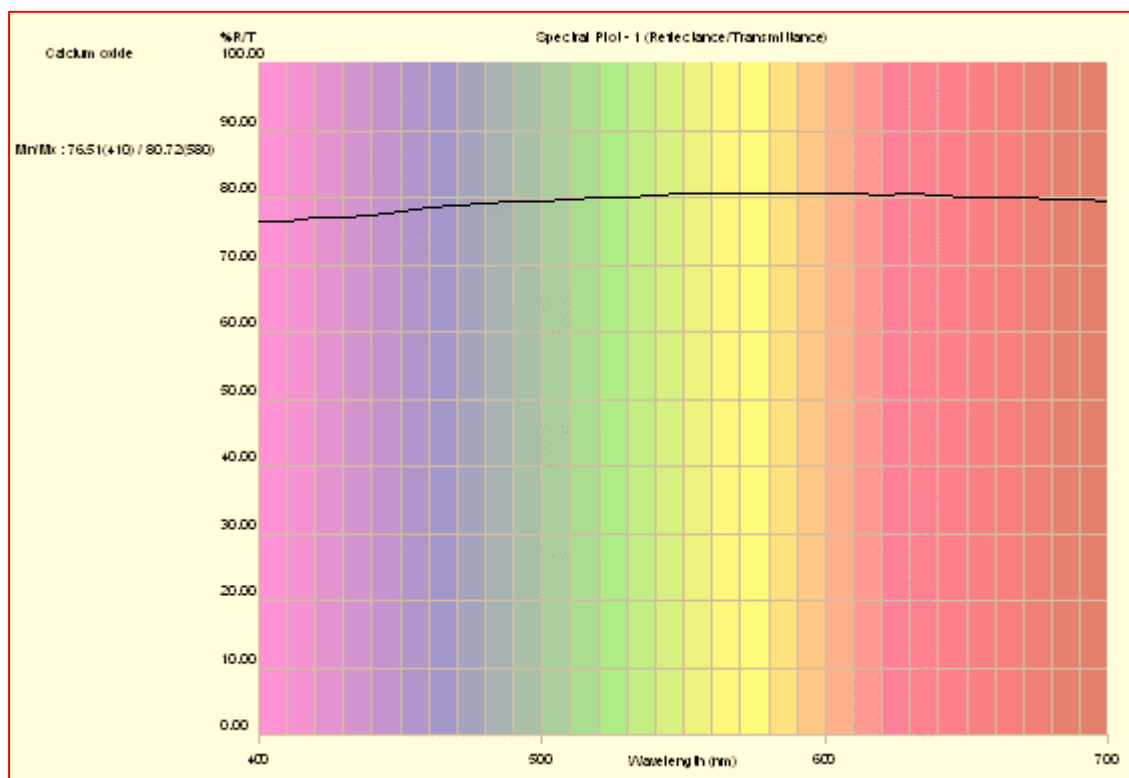


Figure 25. Calcium oxide

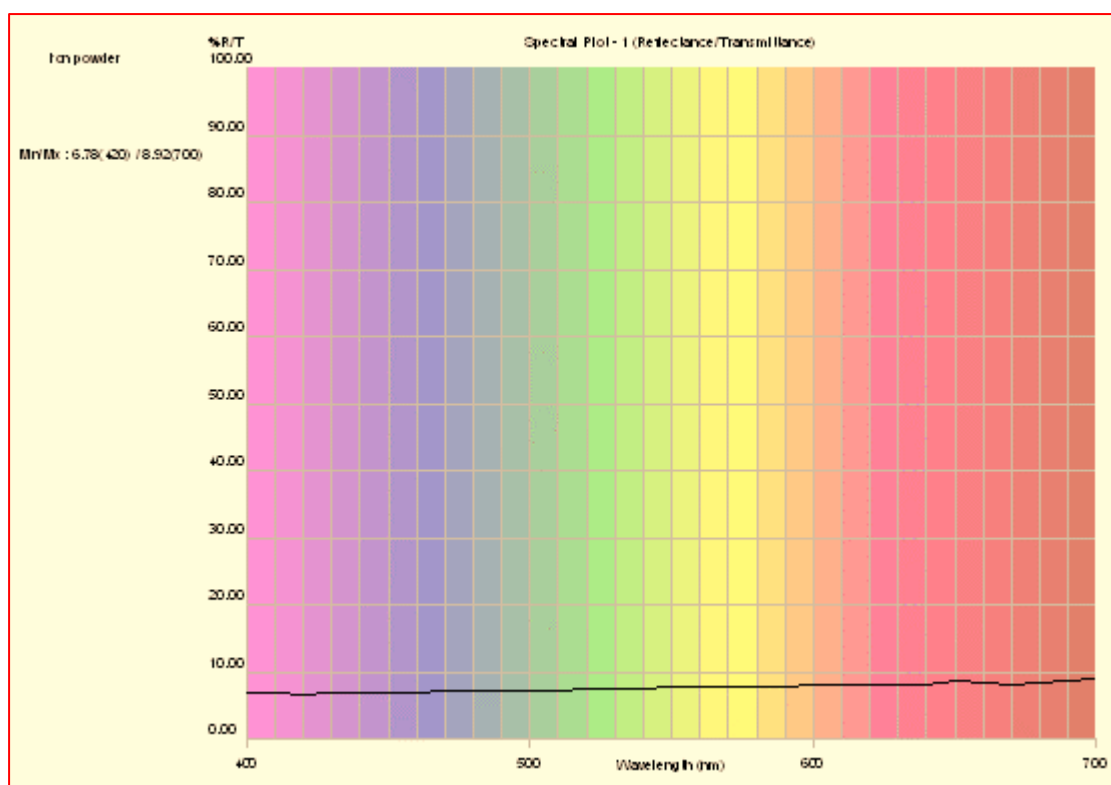


Figure 26. Iron powder

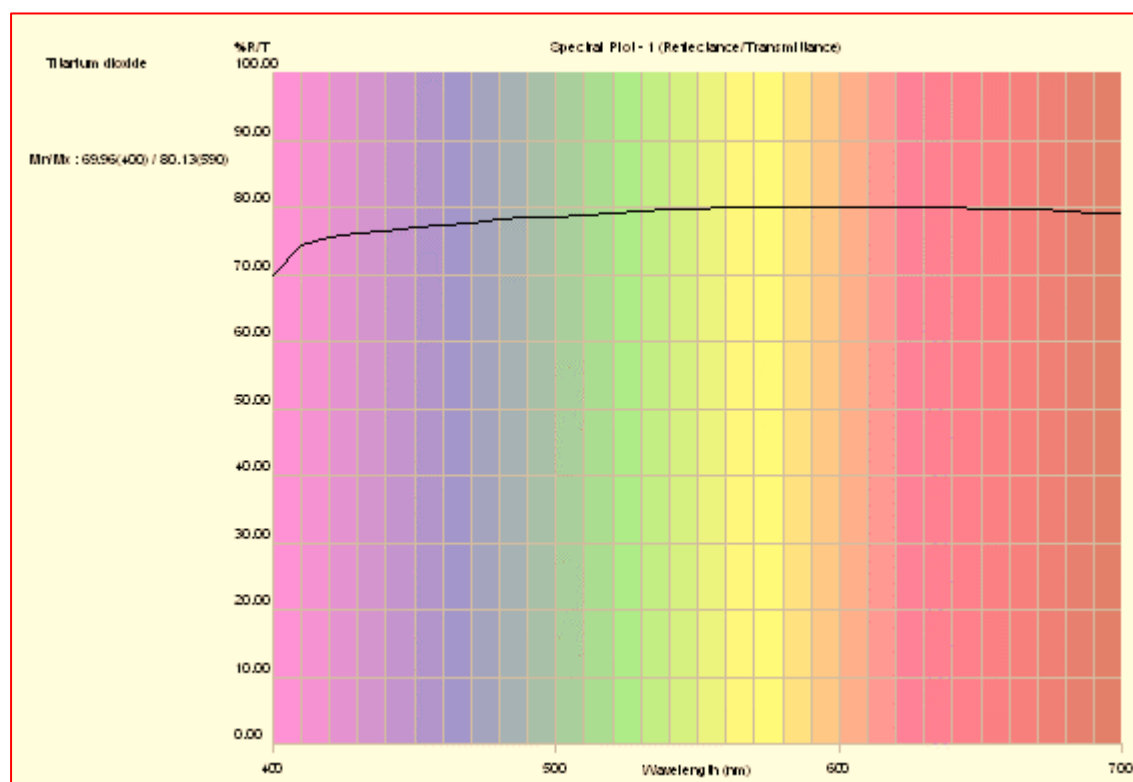


Figure 27. Titanium dioxide

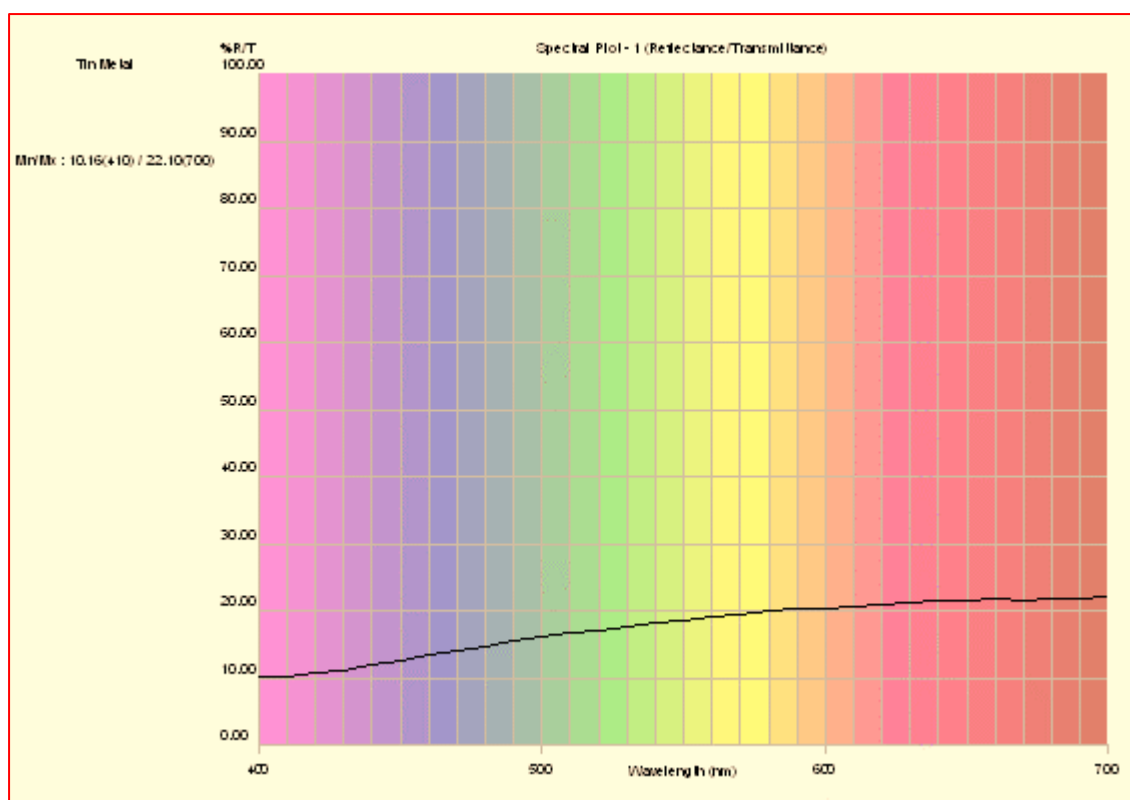


Figure 28. Tin metal

6. ColorflexEZ spectra of LR materials

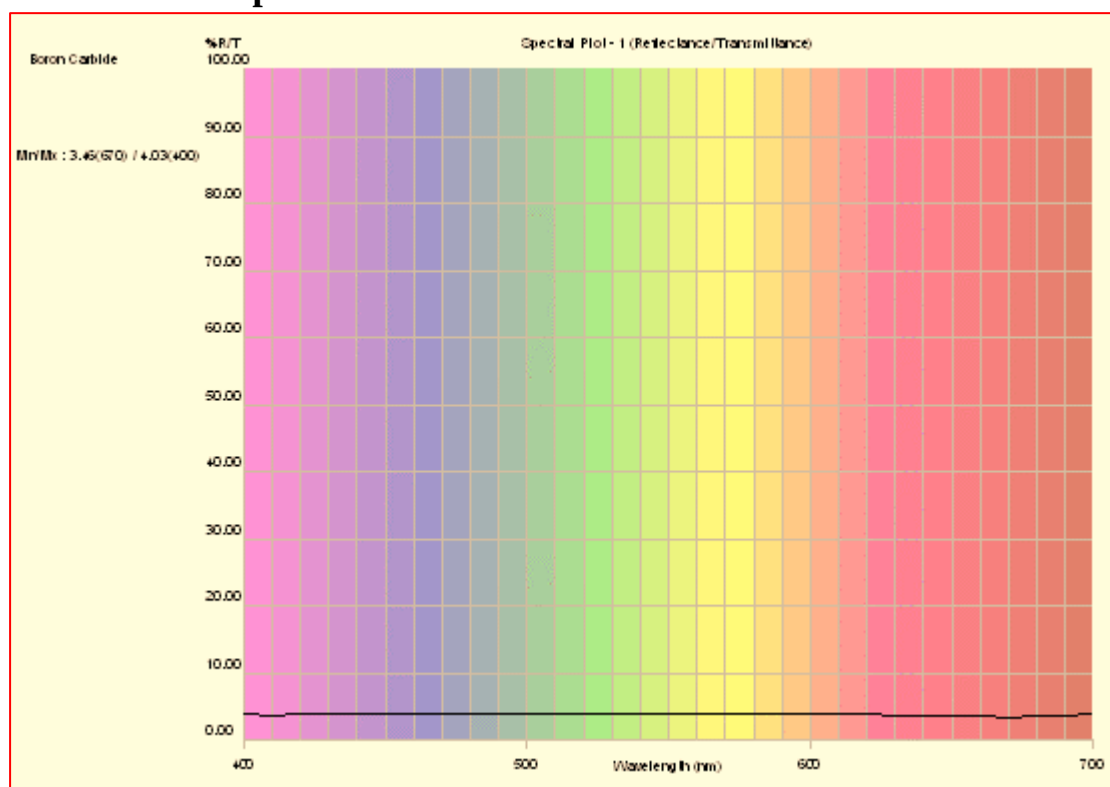


Figure 29. Boron carbide

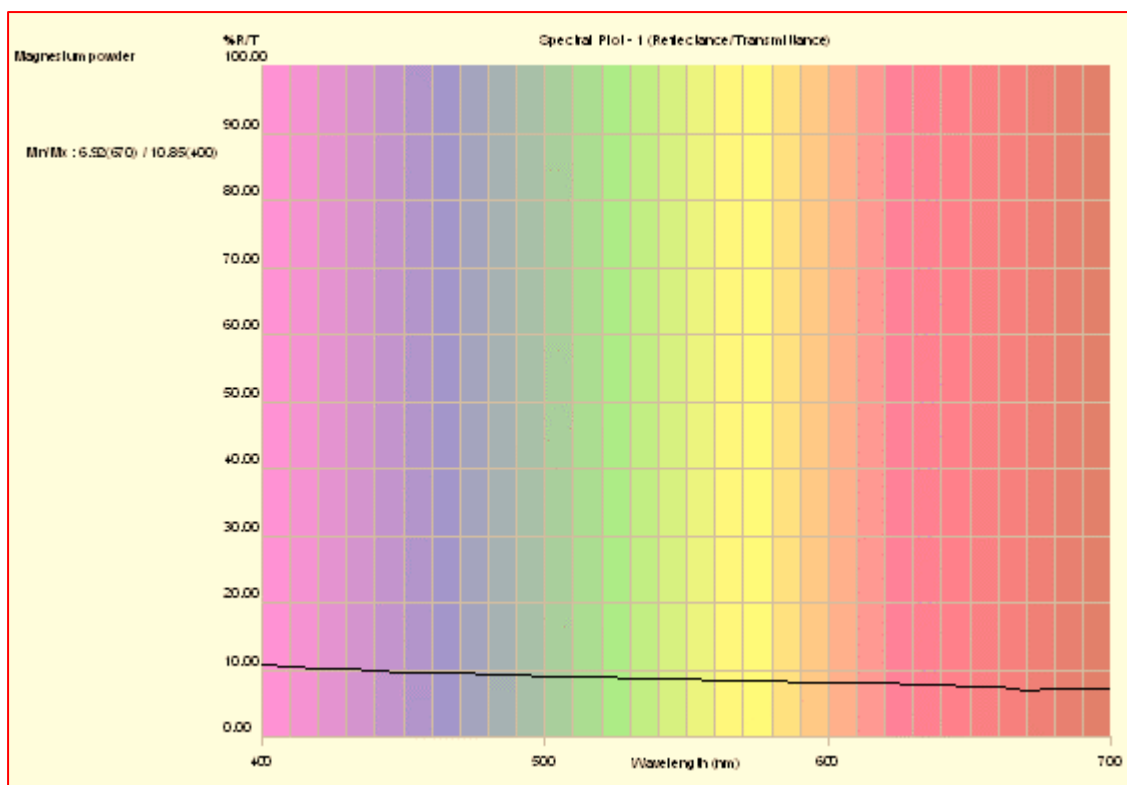


Figure 30. Magnesium powder

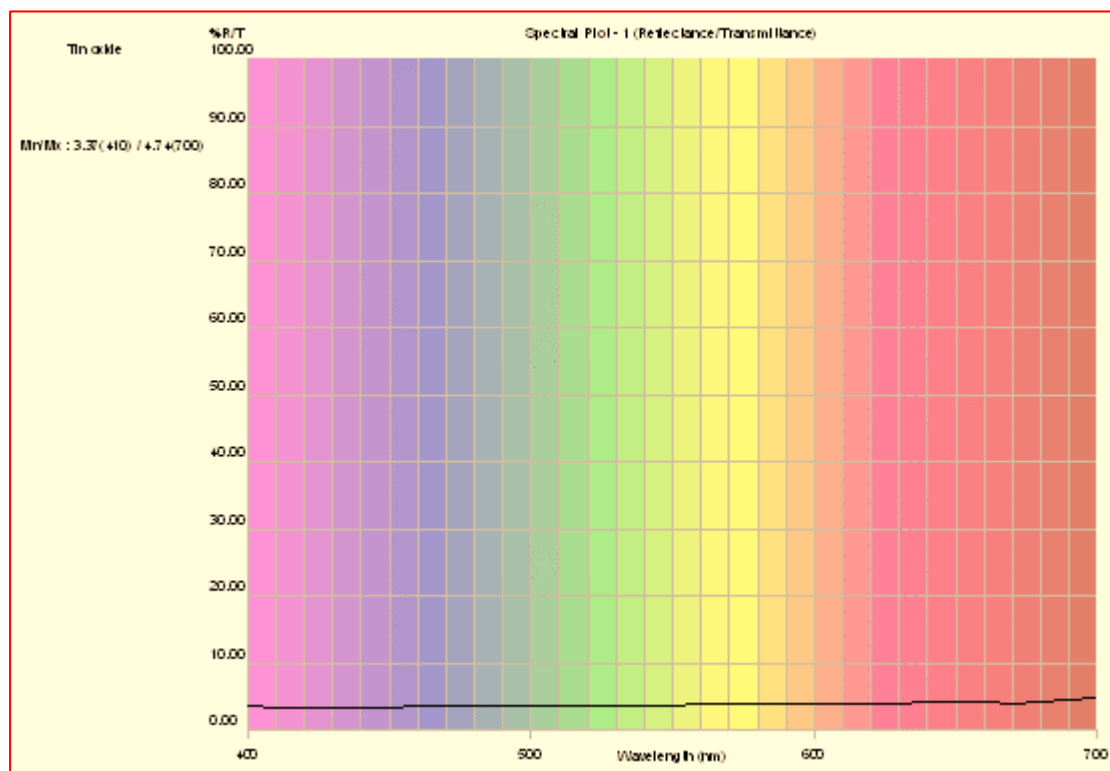


Figure 31. Tin oxide

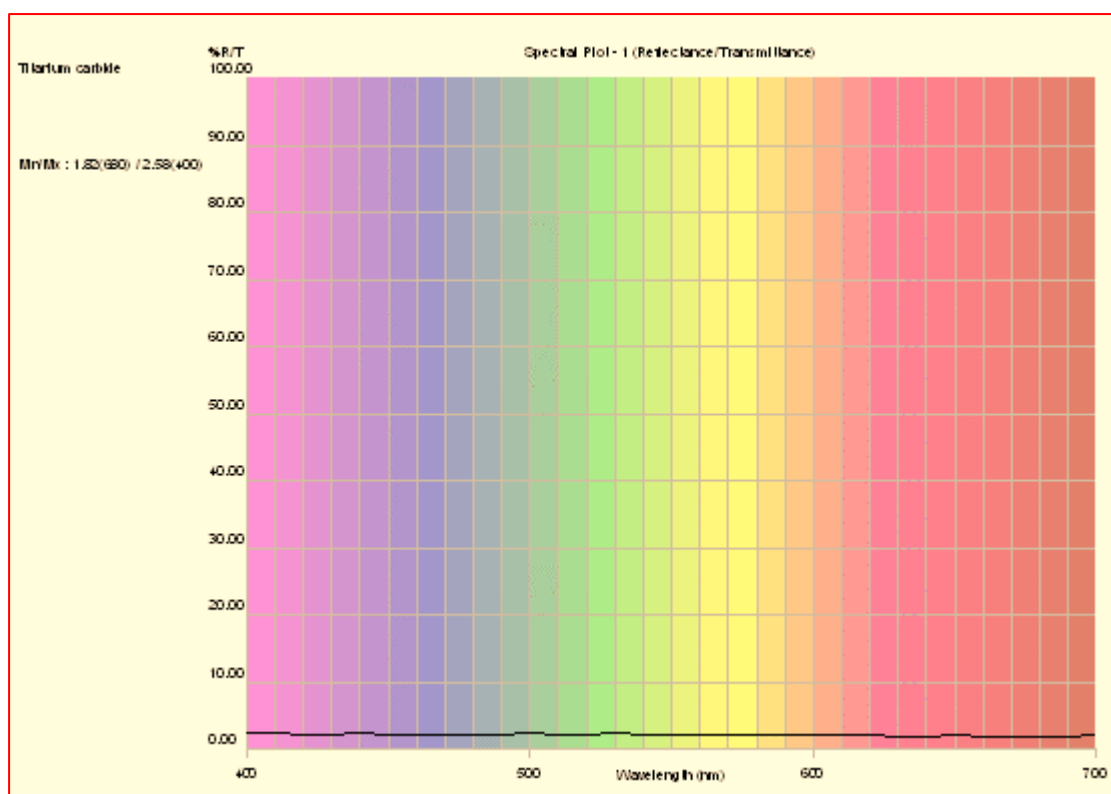


Figure 32. Titanium carbide

7. Colorflex EZ spectra of synthetic dyes

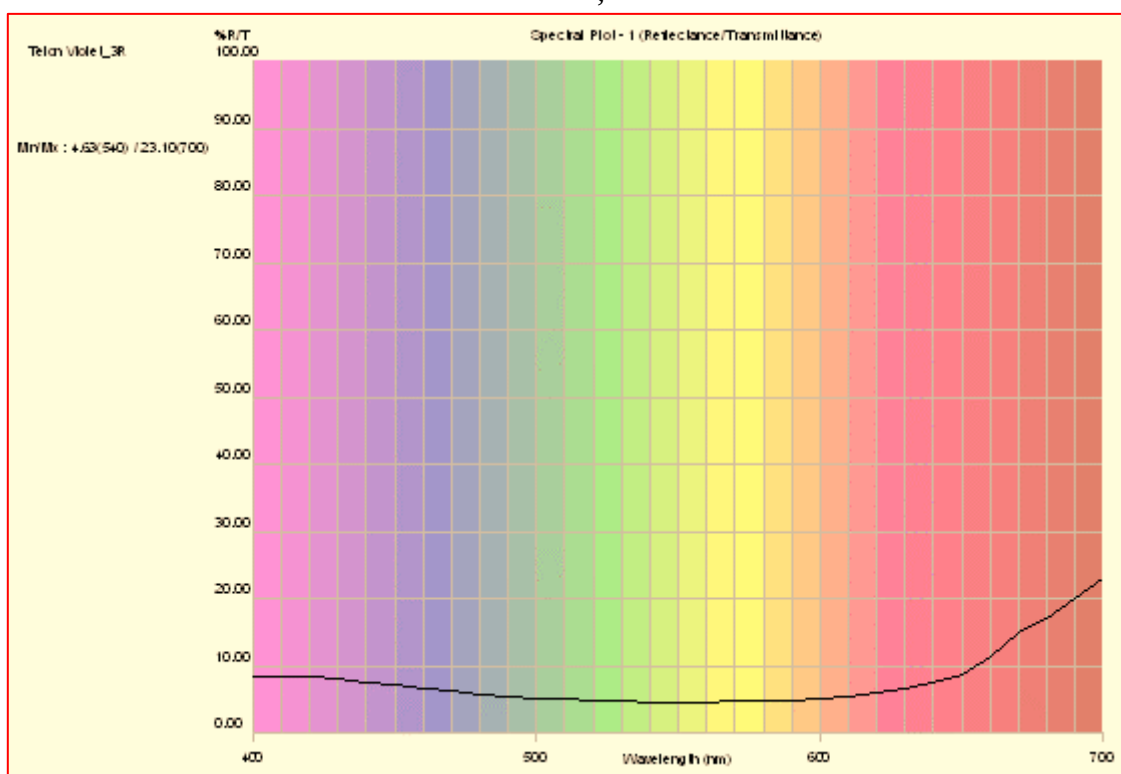


Figure 33. Telon Violet_3R

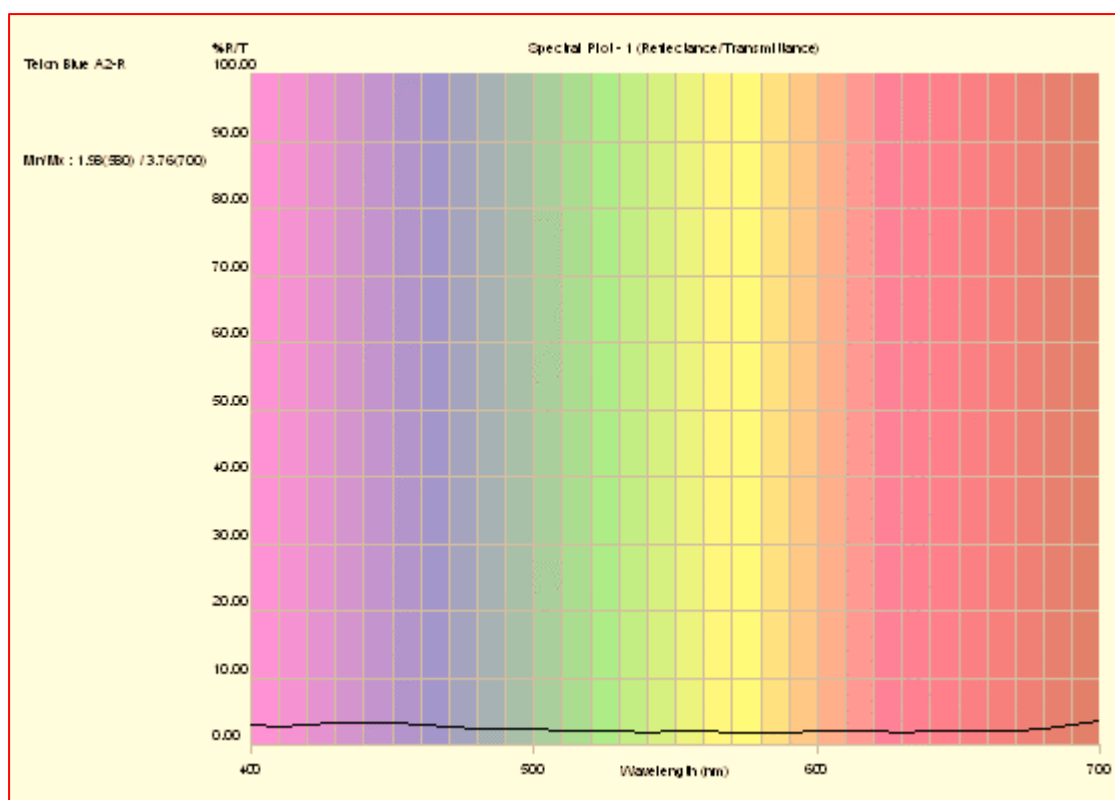


Figure 34. Telon Blue A2R

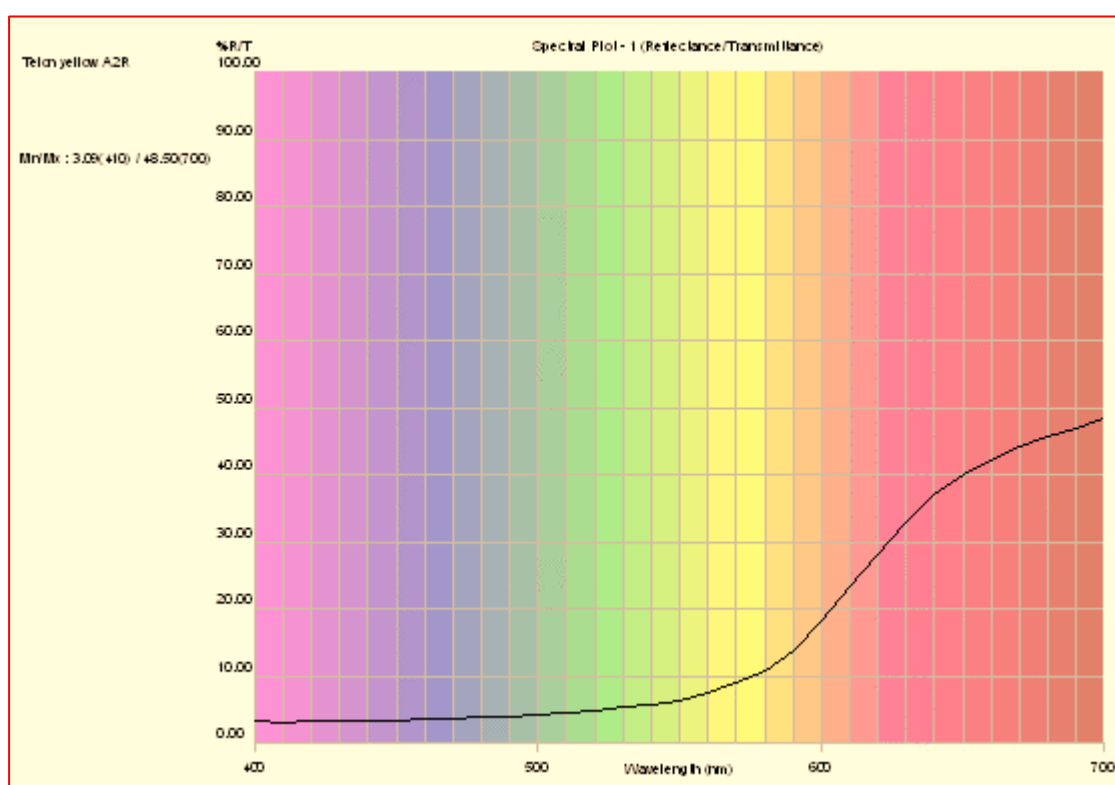


Figure 35. Telon Yellow A2R

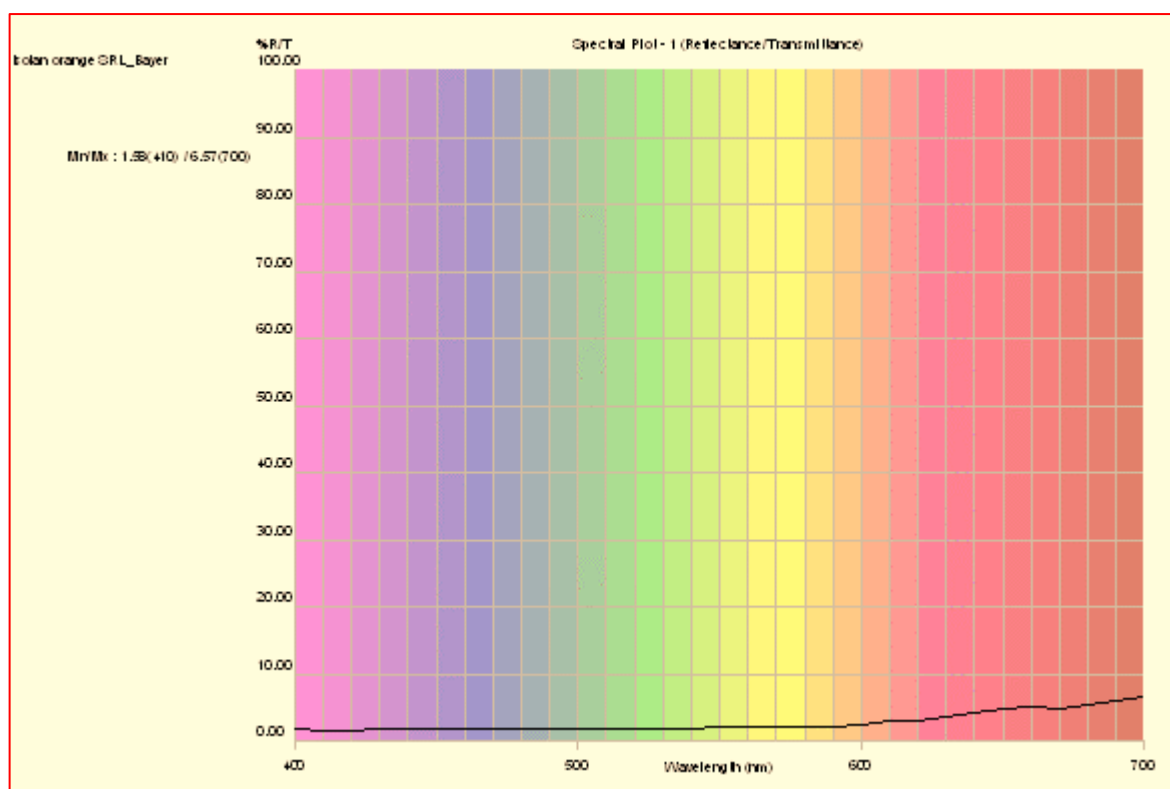


Figure 36. Isolan Orange SRL

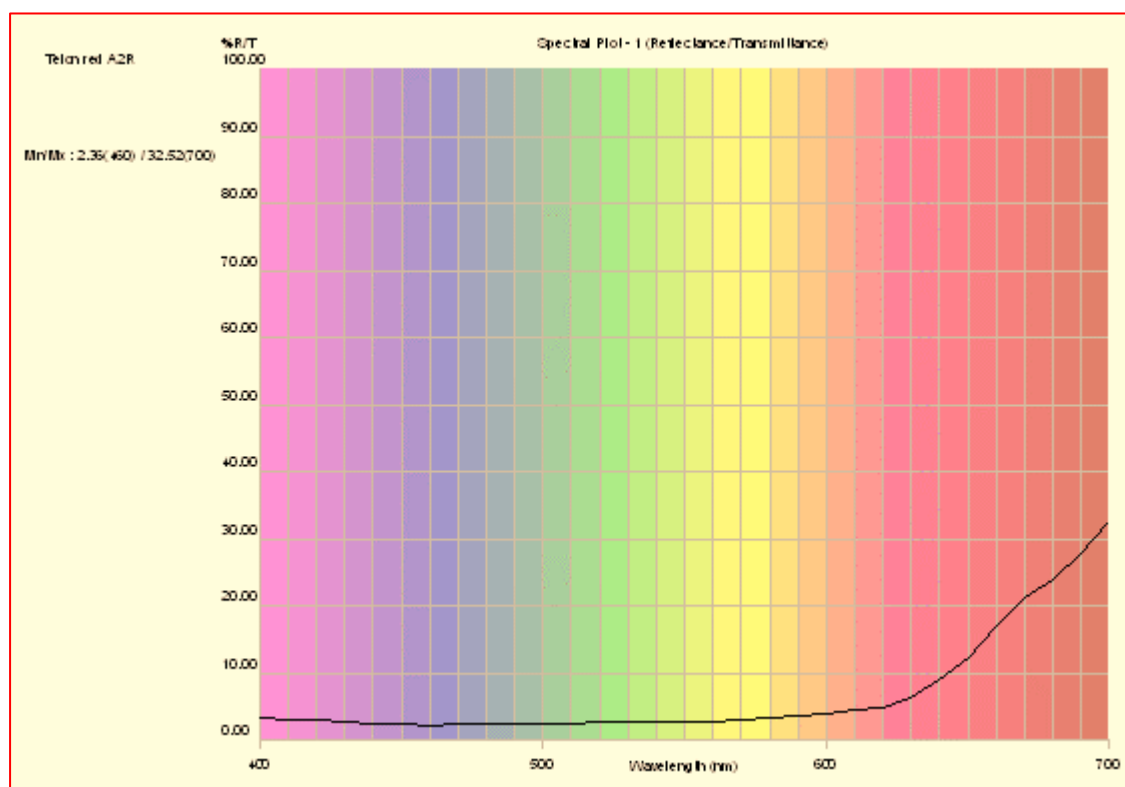


Figure 37, Telon Red A2R

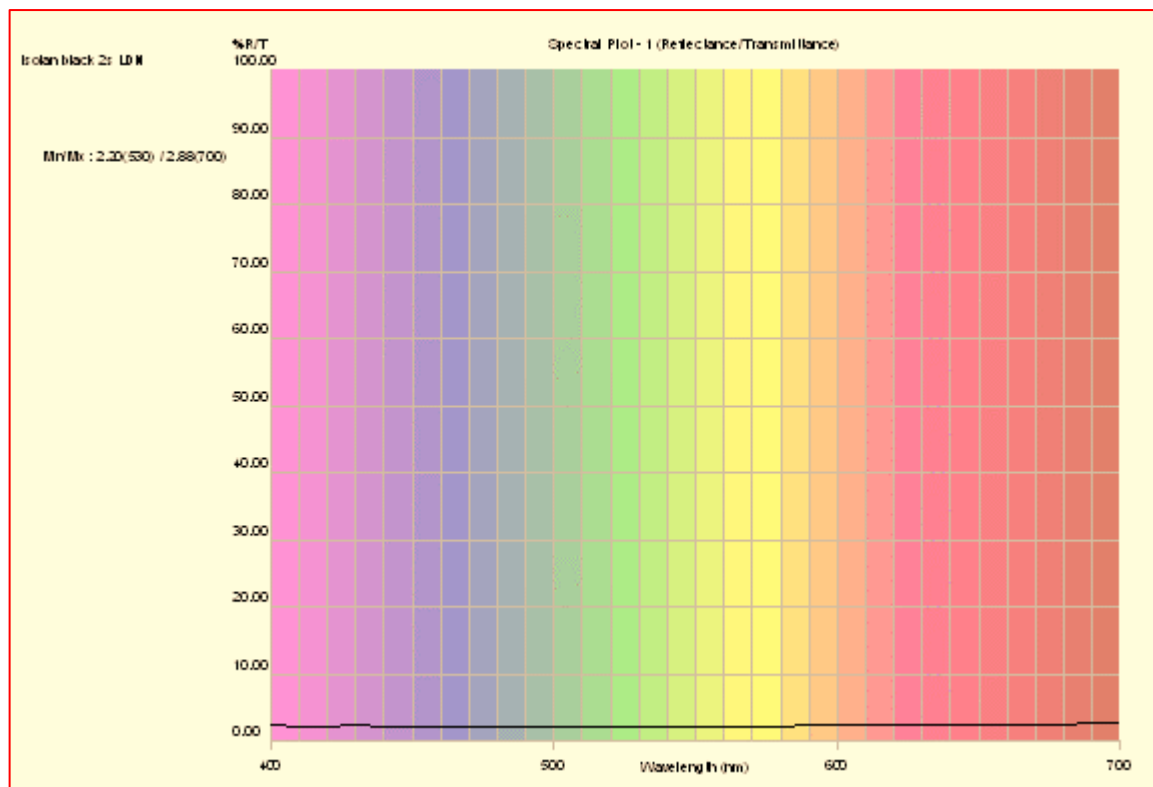


Figure 38. Isolan Black 2S LDN

8. Colorflex EZ spectra of DGTWSIB

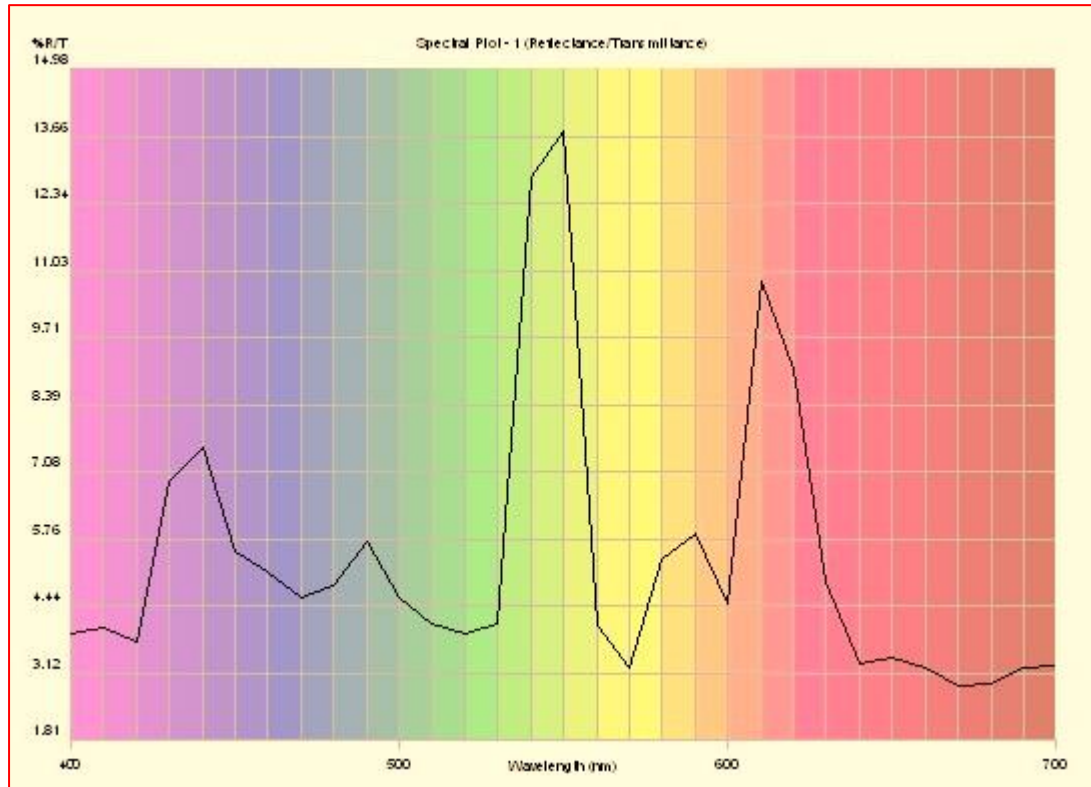


Figure 39. Ice for iceland combat background

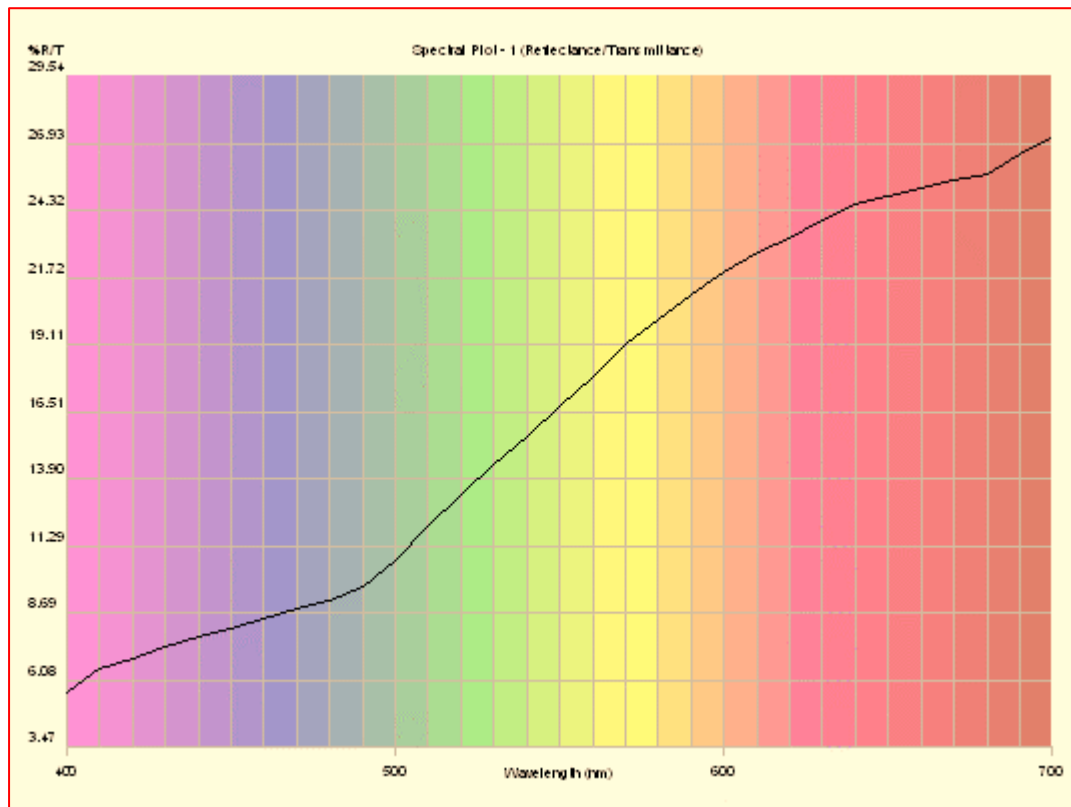


Figure 40. Dry leaves for woodland combat background

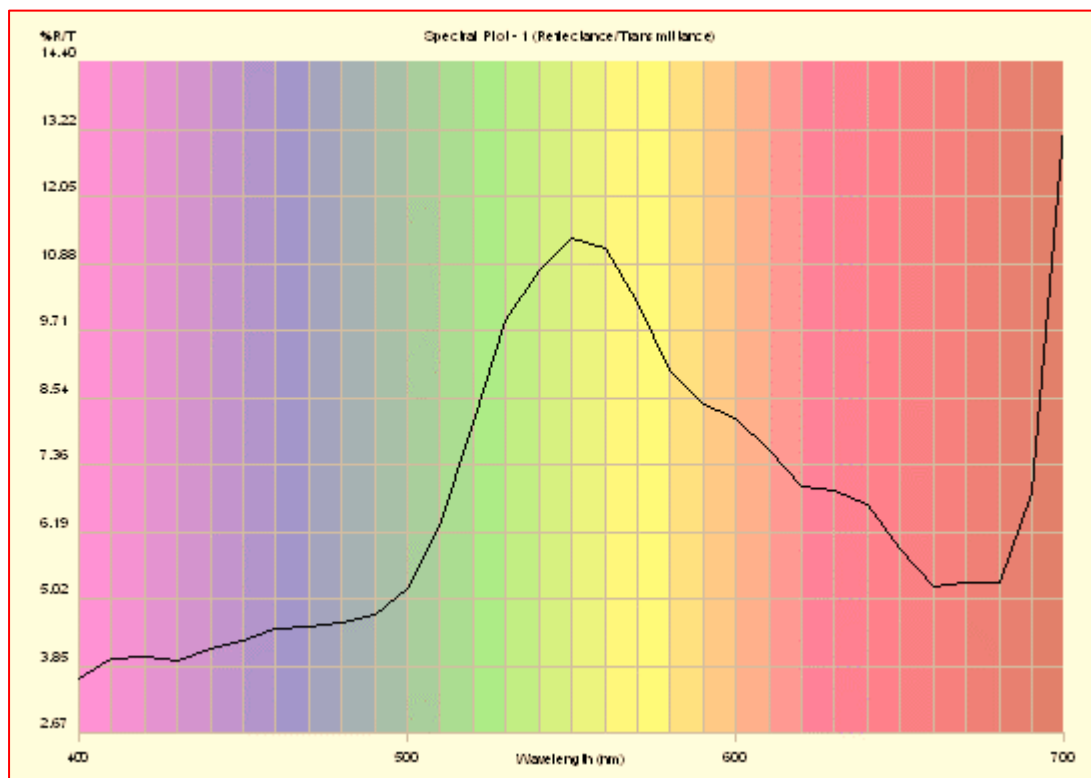


Figure 41. Green leaves for woodland combat background

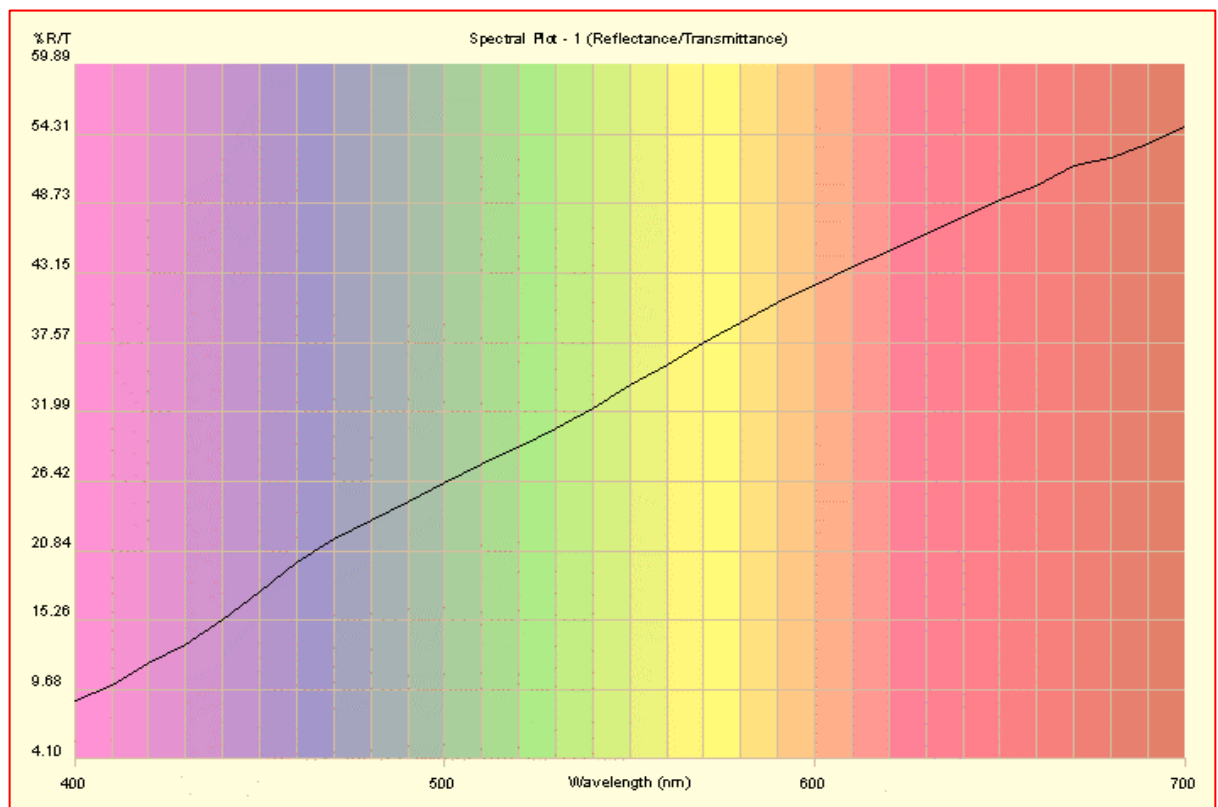


Figure 42. Tree bark for woodland combat background

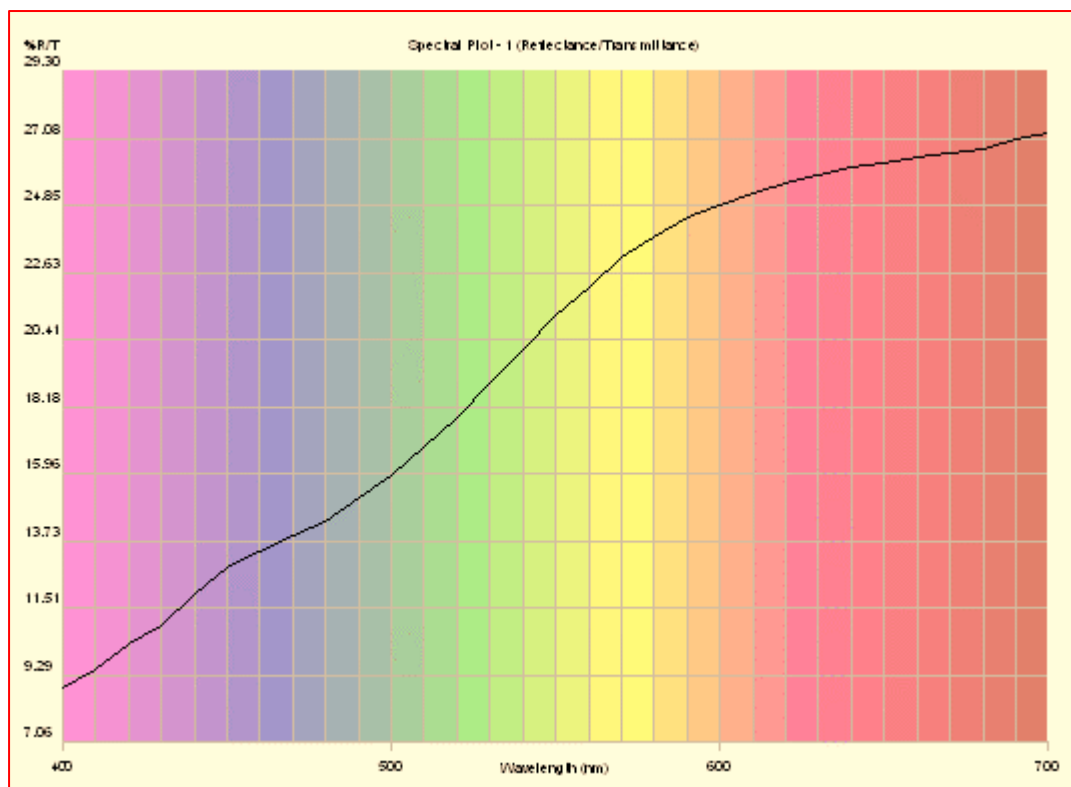


Figure 43. Sand for desertland combat background

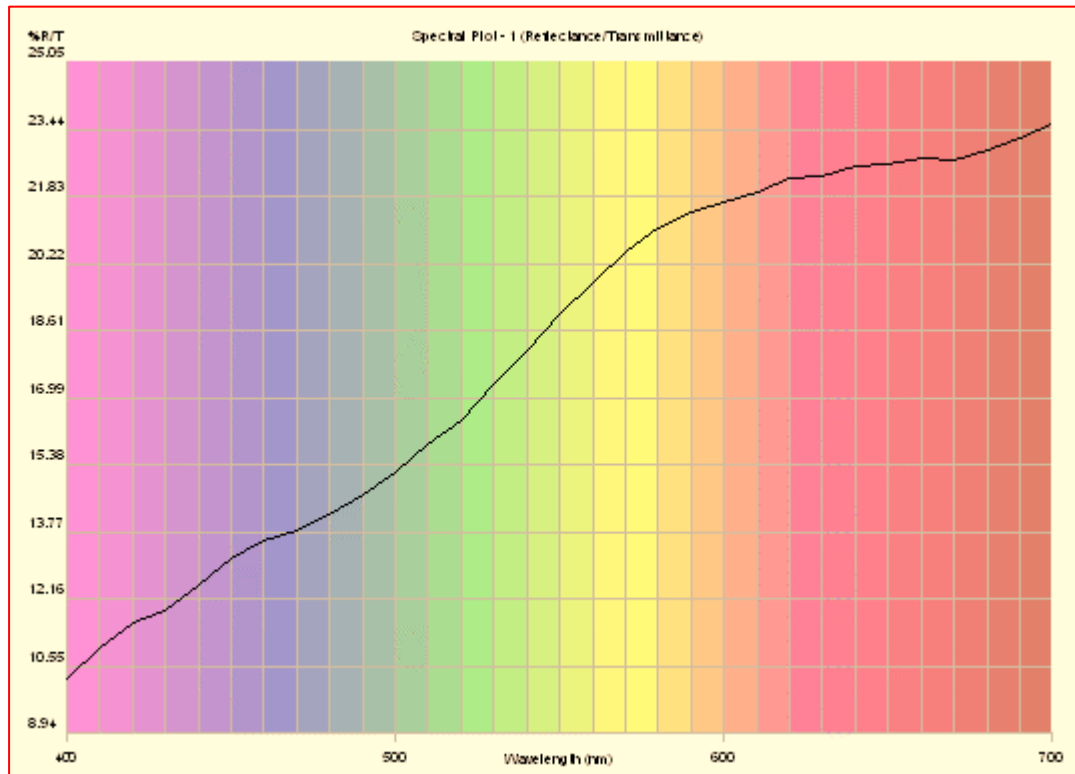


Figure 44. Stone for stoneland combat background

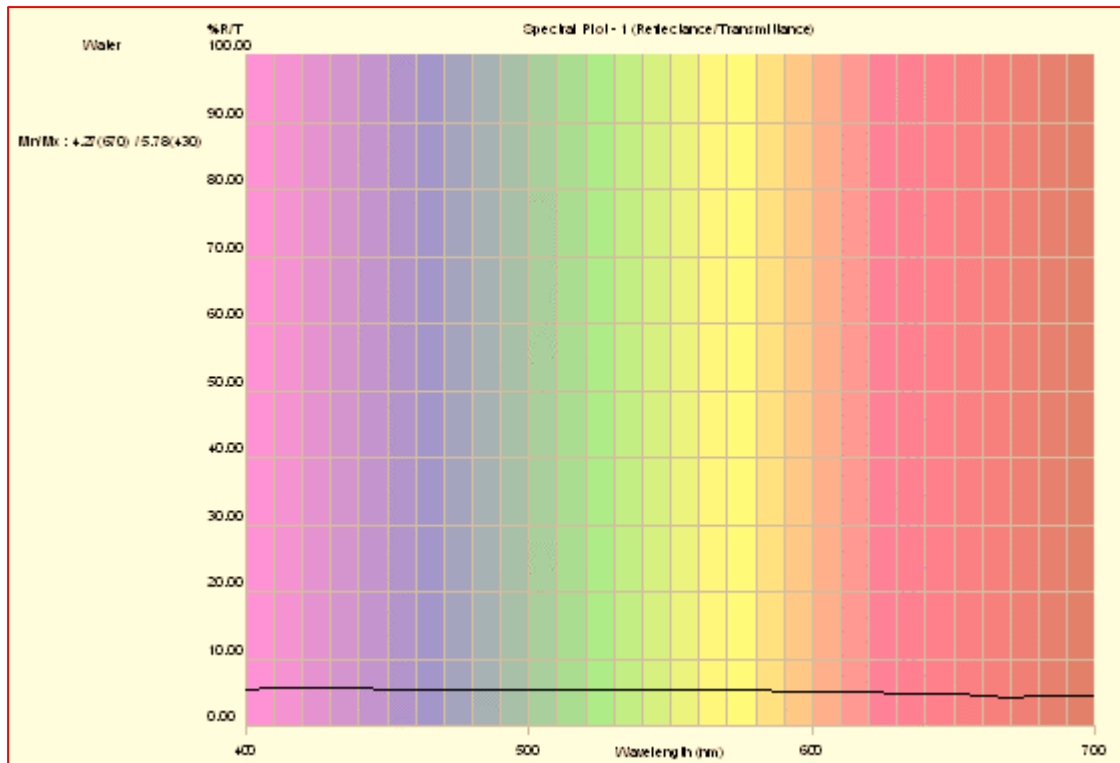


Figure 45. Water for marine combat background.

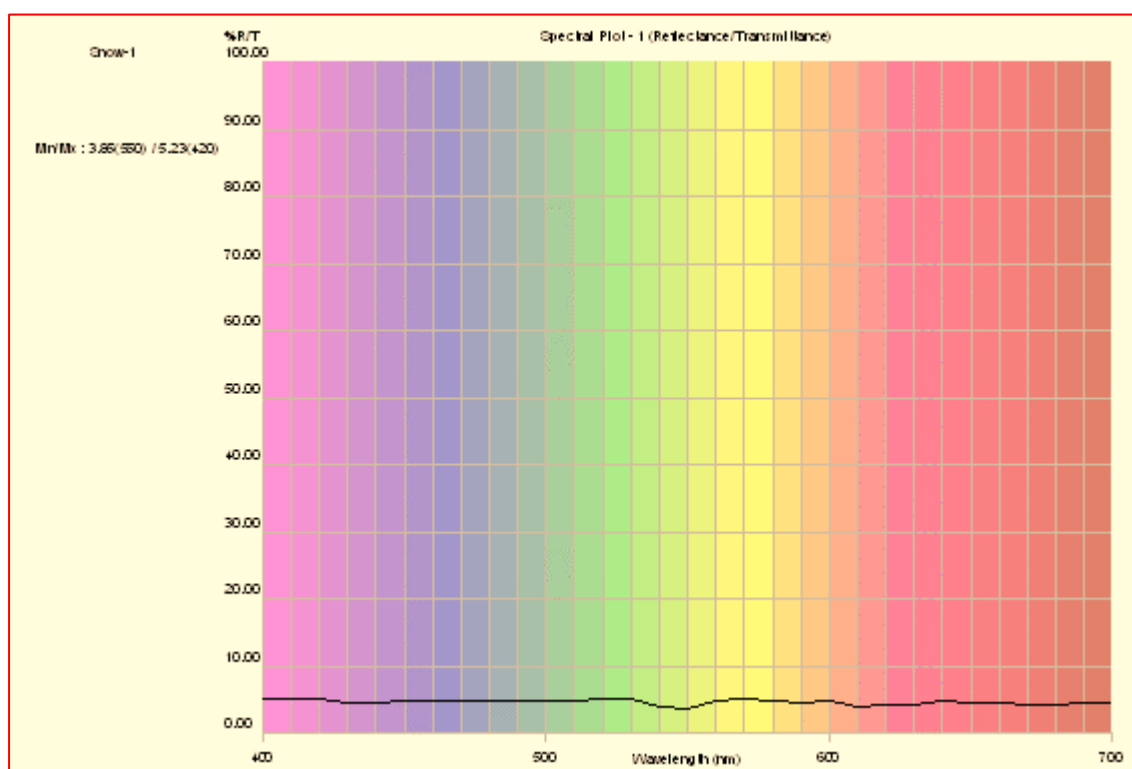


Figure 46. Snow for snowland combat background

Table 1. Chemicals used for materials design of camouflage textiles formulation against multidimensional CB materials.

Chemicals	Suppliers	CB Materials
Titanium dioxide	British Drug Houses Limited, England	Dry leaves, <i>Ulmas minor</i> for woodland CB
Calcium oxide	Unilab	Green leaves, <i>Ulmas minor</i> for woodland CB
Aluminum	Sigma Aldrich	Tree bark, <i>Ulmas minor</i> for woodland CB
Tin metal		Water for marine CB
Tin oxide		Sand for desertland CB
Iron powder		Stone for stoneland CB
Boron carbide		Snow for snowland CB
Magnesium powder		Snow, water and ice for sky CB
Carbon black pigment		Ice for iceland CB
Titanium carbide		
Isolan Black 2S LDN	Bayer, Australia	
Isolan Orange		
Telon Blue A 2R	Dystar	
Telon Red A 2R		
Telon Violet 3R		
Telon Yellow A 2R		

Table 2. Mean reflection of LR-HR-HLR-DGTWSIB materials; reflection (%), R and wavelength, λ (nm).

LR		HR		HLR		DGTWSIB	
R	λ	R	λ	R	λ	R	λ
4.18	400	33.25	400	18.71	400	7.27	400
4.18	500	36.15	500	20.17	500	11.57	500
4.18	600	37.38	600	20.78	600	16.63	600
4.18	700	37.28	700	20.73	700	19.63	700
3.08	1000	35.76	1000	19.42	1000	23.39	1000
3.11	1100	36.15	1100	19.63	1100	22.11	1100
3.18	1200	36.77	1200	19.97	1200	21.66	1200
3.24	1300	37.26	1300	20.25	1300	20.88	1300
3.29	1400	37.78	1400	20.54	1400	16.19	1400
3.34	1500	40.19	1500	21.77	1500	17.44	1500
3.36	1600	41.26	1600	22.31	1600	18.49	1600
3.33	1700	41.52	1700	22.43	1700	18.00	1700
3.28	1800	40.97	1800	22.13	1800	17.02	1800
3.24	1900	39.58	1900	21.41	1900	10.70	1900
3.28	2000	41.02	2000	22.15	2000	13.38	2000
3.27	2100	40.54	2100	21.91	2100	14.48	2100
3.12	2200	37.80	2200	20.43	2200	13.88	2200
3.19	2300	37.30	2300	20.24	2300	12.58	2300
3.07	2400	35.65	2400	19.36	2400	10.51	2400

9. Spectral value (actual) and synthesized value in NIR spectrum

Table 3. FTIRS spectral data and synthesized data for camouflage textiles simulation in NIR spectrums (A).

Categorized high reflectance materials in NIR, mean reflection; HR															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Aluminium (actual value)	44.4	45	45.6	46.3	46.9	47.7	48.1	48.2	48	47.8	49.5	49.6	46.1	47.7	46.2
Titanium dioxide (actual value)	66.4	66.4	67	67.2	66.6	68.7	69.3	68.6	66.3	62	65.6	65.9	61.9	62.1	57.4
Calcium oxide (actual value)	67.8	67.8	67.6	65.8	64	69.6	70	68.7	66.3	62.2	63.1	59.7	54.3	47.8	45.8
Tin metal (actual value)	19.7	19.8	20.4	21.6	23.3	25.2	26.8	28.2	29.3	30.2	31.9	32.6	31.3	32.7	32.4
Tin oxide (actual value)	6.05	7.02	8.46	10.4	12.9	16	18.9	20.4	20.4	19.3	19.1	18.2	16.1	15.7	14.4
Iron powder (actual value)	10.2	10.8	11.5	12.3	13.1	13.9	14.5	15.1	15.5	16	16.9	17.3	16.8	17.7	17.8
Predicted camouflage textiles, HR	35.8	36.15	36.77	37.3	37.78	40.2	41.3	41.53	40.97	39.58	41.02	40.54	37.76	37.30	35.7
Categorized low reflectance materials in NIR, mean reflection; LR															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Boron carbide (actual value)	4.10	4.43	4.79	5.08	5.29	5.45	5.53	5.54	5.52	5.50	5.61	5.59	5.27	5.38	5.25
Magnesium powder (actual value)	4.81	4.65	4.56	4.51	4.51	4.53	4.48	4.37	4.23	4.09	4.09	4.10	3.94	4.09	3.78
Carbon black pigment (actual value)	1.40	1.38	1.39	1.39	1.40	1.41	1.42	1.41	1.40	1.40	1.40	1.40	1.35	1.35	1.33
Titanium carbide (actual value)	2.02	1.98	1.97	1.96	1.96	1.98	1.99	1.98	1.98	1.97	2.00	1.99	1.90	1.93	1.90
Predicted camouflage textiles, LR	3.08	3.11	3.18	3.24	3.29	3.34	3.36	3.33	3.28	3.24	3.28	3.27	3.12	3.19	3.07
Categorized multicolor synthetic dyes, mean reflection of synthetic dyes															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Isolan black 2S LDN	3.48	6.15	21.44	34.16	32.93	40.03	39.82	41.36	37.91	20.20	28.71	28.65	26.89	24.21	17.56
Isolan orange	36.59	42.23	47.56	50.48	46.70	54.00	52.22	53.78	5.43	31.34	43.02	42.08	38.98	36.45	28.06
Telon blue A 2R	53.90	55.45	56.91	55.68	44.85	46.29	45.14	43.35	43.07	30.34	31.40	28.02	25.55	23.94	21.06
Telon red A 2R	61.54	60.64	61.69	60.49	50.77	53.92	52.86	51.21	50.62	35.88	42.48	40.34	36.44	33.14	28.12
Telon violet 3R	42.33	45.63	49.11	51.76	48.85	53.61	54.72	56.56	54.32	40.35	41.98	40.24	38.35	39.85	33.50
Telon yellow A 2R	58.17	57.25	58.26	57.07	45.86	48.62	47.26	47.62	47.81	31.76	37.67	33.58	31.37	26.20	21.17
Mean reflection	42.67	44.56	49.16	51.61	44.99	49.41	48.67	48.98	39.86	31.65	37.54	35.49	32.93	30.63	24.91
Spectral combination of HLR; mean reflection HR and LR															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Mean LR	3.08	3.11	3.18	3.24	3.29	3.34	3.36	3.33	3.28	3.24	3.28	3.27	3.12	3.19	3.07
Mean HR	35.76	36.15	36.77	37.26	37.78	40.19	41.26	41.53	40.97	39.58	41.02	40.54	37.76	37.30	35.65
Predicted camouflage textiles, HLR	19.42	19.63	19.97	20.25	20.54	21.77	22.31	22.43	22.13	21.41	22.15	21.91	20.44	20.24	19.36
Spectral combination of LR and synthetic dyes; mean reflection of synthetic dyes and LR															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Mean synthetic dyes	42.67	44.56	49.16	51.61	44.99	49.41	48.67	48.98	39.86	31.65	37.54	35.49	32.93	30.63	24.91
Mean LR	3.08	3.11	3.18	3.24	3.29	3.34	3.36	3.33	3.28	3.24	3.28	3.27	3.12	3.19	3.07
Mean, synthetic dyes + LR	22.88	23.83	26.17	27.42	24.14	26.38	26.01	26.15	21.57	17.44	20.41	19.38	18.02	16.91	13.99
Spectral combination of HR and dyes; Mean reflection of synthetic dyes and HR															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Mean synthetic dyes	42.67	44.56	49.16	51.61	44.99	49.41	48.67	48.98	39.86	31.65	37.54	35.49	32.93	30.63	24.91
Mean HR	35.76	36.15	36.77	37.26	37.78	40.19	41.26	41.53	40.97	39.58	41.02	40.54	37.76	37.30	35.65
Mean, synthetic dyes + HR	39.21	40.35	42.97	44.43	41.39	44.80	44.97	45.25	40.42	35.61	39.28	38.01	35.35	33.97	30.28
Mean reflection of DGTWSIB in NIR															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Dry leaves background (actual value)	31.60	31.31	31.09	29.93	22.04	25.29	27.44	26.47	23.78	11.23	16.72	19.93	19.46	16.37	12.25
Green leaves background (actual value)	35.45	35.33	35.23	34.73	28.91	30.47	31.93	30.79	29.79	18.12	22.66	24.36	23.24	20.36	16.93
Tree bark background (actual value)	58.64	57.88	56.41	52.47	32.92	34.89	37.95	36.23	34.80	19.19	23.31	23.35	22.93	19.98	16.31
Sand background (actual value)	24.64	25.40	26.31	26.92	25.25	27.78	29.16	29.27	27.80	20.69	25.47	27.73	26.20	25.13	21.49
Stone background (actual value)	23.80	23.82	23.72	23.32	20.86	22.20	22.76	22.35	20.80	15.01	18.49	20.31	19.20	18.35	15.97
Water background (actual value)	1.39	0.95	0.80	0.79	0.79	0.78	0.77	0.77	0.77	0.75	0.77	0.78	0.74	0.75	0.75
Ice background (actual value)	2.32	2.19	1.92	1.85	1.65	1.61	1.60	1.56	1.53	1.46	1.47	1.45	1.32	1.29	1.24
Sky background (predicted value)	14.42	14.08	13.53	13.10	10.93	11.50	11.97	11.68	11.13	7.53	9.17	9.90	9.40	8.63	7.43
Snow background (actual value)	9.17	8.07	6.01	4.81	2.44	2.47	2.76	2.91	2.78	2.35	2.43	2.56	2.50	2.40	2.28
Mean reflection of DGTWSIB, ZR	23.39	22.11	21.66	20.88	16.19	17.44	18.49	18.00	17.02	10.70	13.38	14.48	13.88	12.58	10.51
NIR Simulation of desertland camouflage textiles (actual reflection of sand ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Sand background (actual value)	24.64	25.40	26.31	26.92	25.25	27.78	29.16	29.27	27.80	20.69	25.47	27.73	26.20	25.13	21.49
Predicted camouflage textiles, ZR-1; n=+5%	25.87	26.67	27.62	28.27	26.51	29.17	30.61	30.73	29.20	21.72	26.74	29.11	27.51	26.39	22.56
Predicted camouflage textiles, ZR-2, n=-5%	23.40	24.13	25.00	25.58	23.99	26.40	27.70	27.80	26.41	19.65	24.20	26.34	24.90	23.88	20.41

Table 4. FTIRS spectral data and synthesized data for camouflage textiles simulation in NIR spectrums (B).

NIR Simulation of stoneland camouflage textiles (actual reflection of stone ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Stone background (actual value)	23.80	23.82	23.72	23.32	20.86	22.20	22.76	22.35	20.80	15.01	18.49	20.31	19.20	18.35	15.97
Predicted camouflage textiles, ZR-1; n=+5%	25.00	25.01	24.90	24.49	21.90	23.31	23.90	23.47	21.84	15.77	19.41	21.32	20.16	19.27	16.77
Predicted camouflage textiles, ZR-2, n=-5%	22.61	22.62	22.53	22.15	19.81	21.09	21.62	21.23	19.77	14.25	17.57	19.30	18.24	17.43	15.17
NIR Simulation of marine background camouflage textiles (actual reflection of water ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Water background (actual value)	1.39	0.95	0.80	0.79	0.79	0.78	0.77	0.77	0.77	0.75	0.77	0.78	0.74	0.75	0.75
Predicted camouflage textiles, ZR-1; n=+5%	1.45	1.00	0.84	0.82	0.82	0.81	0.80	0.80	0.80	0.78	0.80	0.81	0.77	0.78	0.78
Predicted camouflage textiles, ZR-2, n=-5%	1.32	0.90	0.76	0.75	0.75	0.74	0.73	0.73	0.73	0.71	0.73	0.74	0.70	0.71	0.71
NIR Simulation of iceland camouflage textiles (actual reflection of ice ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Ice background (actual value)	2.32	2.19	1.92	1.85	1.65	1.61	1.60	1.56	1.53	1.46	1.47	1.45	1.32	1.29	1.24
Predicted camouflage textiles, ZR-1; n=+5%	2.43	2.29	2.01	1.94	1.73	1.70	1.68	1.63	1.60	1.53	1.54	1.52	1.38	1.35	1.30
Predicted camouflage textiles, ZR-2, n=-5%	2.20	2.08	1.82	1.75	1.56	1.52	1.52	1.48	1.45	1.39	1.40	1.37	1.25	1.22	1.17
NIR Simulation of snowland camouflage textiles (actual reflection of snow ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Snow background (actual value)	9.62	8.47	6.31	5.05	2.56	2.59	2.89	3.05	2.91	2.46	2.55	2.68	2.62	2.52	2.39
Predicted camouflage textiles, ZR-1; n=+5%	9.17	8.07	6.01	4.81	2.44	2.47	2.76	2.91	2.78	2.35	2.43	2.56	2.50	2.40	2.28
Predicted camouflage textiles, ZR-2, n=-5%	8.29	7.30	5.44	4.36	2.21	2.24	2.50	2.64	2.51	2.12	2.20	2.30	2.28	2.17	2.07
NIR Simulation of sky background camouflage textiles, mean reflection of simulated natural background (± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Water background (actual value)	1.39	0.95	0.80	0.79	0.79	0.78	0.77	0.77	0.77	0.75	0.77	0.78	0.74	0.75	0.75
Ice background (actual value)	2.32	2.19	1.92	1.85	1.65	1.61	1.60	1.56	1.53	1.46	1.47	1.45	1.32	1.29	1.24
Snow background (actual value)	9.17	8.07	6.01	4.81	2.44	2.47	2.76	2.91	2.78	2.35	2.43	2.56	2.50	2.40	2.28
Stone background (actual value)	23.80	23.82	23.72	23.32	20.86	22.20	22.76	22.35	20.80	15.01	18.49	20.31	19.20	18.35	15.97
Green leaves background (actual value)	35.45	35.33	35.23	34.73	28.91	30.47	31.93	30.79	29.79	18.12	22.66	24.36	23.24	20.36	16.93
Mean reflection	14.42	14.08	13.53	13.10	10.93	11.50	11.97	11.68	11.13	7.53	9.17	9.90	9.40	8.63	7.43
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Sky background (predicted value)	14.42	14.08	13.53	13.10	10.93	11.50	11.97	11.68	11.13	7.53	9.17	9.90	9.40	8.63	7.43
Predicted camouflage textiles, ZR-1; n=+5%	15.14	14.79	14.20	13.75	11.48	12.08	12.57	12.27	11.69	7.90	9.62	10.40	9.88	9.07	7.80
Predicted camouflage textiles, ZR-2, n=-5%	13.67	13.38	12.85	12.44	10.39	10.92	11.38	11.10	10.58	7.15	8.71	9.40	8.93	8.20	7.05
NIR Simulation of woodland camouflage textiles, a (actual reflection of tree bark ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Tree bark background (actual value)	58.64	57.88	56.41	52.47	32.92	34.89	37.95	36.23	34.80	19.19	23.31	23.35	22.93	19.98	16.31
Predicted camouflage textiles, ZR-1; n=+5%	61.58	60.78	59.23	55.09	34.57	36.63	39.84	38.04	36.54	20.14	24.48	24.51	24.07	20.98	17.12
Predicted camouflage textiles, ZR-2, n=-5%	55.70	54.99	53.59	49.84	31.28	33.14	36.05	34.41	33.06	18.23	22.14	22.18	21.79	18.99	15.50
NIR Simulation of woodland camouflage textiles, b (actual reflection of green leaves ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Green leaves background (actual value)	35.45	35.33	35.23	34.73	28.91	30.47	31.93	30.79	29.79	18.12	22.66	24.36	23.24	20.36	16.93
Predicted camouflage textiles, ZR-1; n=+5%	37.22	37.10	37.00	36.47	30.35	32.00	33.52	32.32	31.28	19.02	23.80	25.58	24.40	21.38	17.78
Predicted camouflage textiles, ZR-2, n=-5%	33.68	33.56	33.47	33.00	27.47	28.94	30.33	29.25	28.30	17.21	21.52	23.14	22.07	19.34	16.08
NIR Simulation of woodland camouflage textiles, c (actual reflection of dry leaves ± n%)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Dry leaves background (actual value)	31.60	31.31	31.09	29.93	22.04	25.29	27.44	26.47	23.78	11.23	16.72	19.93	19.46	16.37	12.25
Predicted camouflage textiles, ZR-1; n=+5%	33.18	32.87	32.64	31.42	23.14	26.55	28.81	27.79	24.96	11.79	17.55	20.29	20.33	17.18	12.86
Predicted camouflage textiles, ZR-2, n=-5%	30.02	29.74	29.53	29.84	20.93	24.02	26.07	25.14	22.60	10.67	15.89	18.93	18.48	15.55	11.63
NIR Simulation of marine and woodland camouflage textiles (mean reflection of woodland and water background)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Woodland background (actual value)	41.90	41.50	40.90	39.04	27.95	30.21	32.44	31.16	29.45	16.18	20.90	22.54	21.88	18.90	15.16
Water background (actual value)	1.39	0.95	0.80	0.79	0.79	0.78	0.77	0.77	0.77	0.75	0.77	0.78	0.74	0.75	0.75
Predicted camouflage textiles, ZR	21.64	21.23	20.85	19.92	14.37	15.50	16.61	15.97	15.11	8.47	10.84	11.66	11.31	9.83	7.96
NIR Simulation of simultaneous marine and desertland camouflage textiles (mean reflection of marine and sandland background)															
Wavelength (nm)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Water background (actual value)	1.39	0.95	0.8	0.79	0.79	0.78	0.77	0.77	0.77	0.75	0.77	0.78	0.74	0.75	0.75
Sand background (actual value)	24.6	25.4	26.3	26.9	25.3	27.8	29.2	29.3	27.8	20.7	25.5	27.7	26.2	25.1	21.5
Predicted camouflage textiles, ZR	13.02	13.18	13.56	13.86	13	14.3	14.97	15	14.3	10.7	13.1	14.26	13.5	12.9	11.1

10.Spectral value (actual) and synthesized value in Visible spectrum

Table 5. Colorflex EZ spectral data and synthesized data for camouflage simulation in visible spectrums (A).

Categorized high reflectance materials in Vis. mean reflection: HR																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Aluminum (actual value)	32.35	32.13	32.16	31.96	31.93	31.84	31.77	31.69	31.65	31.74	31.55	31.42	31.44	31.51	31.44	31.39	31.37	31.26	31.13	30.93
Titanium dioxide (actual value)	69.96	74.29	75.66	76.13	76.57	77.06	77.50	77.84	78.27	78.57	78.71	78.96	79.14	79.42	79.61	79.91	80.05	80.06	80.12	80.14
Carbon black pigment (actual value)	76.62	76.51	77.12	77.10	77.53	78.05	78.51	78.81	79.10	79.40	79.51	79.75	79.95	80.13	80.37	80.58	80.70	80.69	80.72	80.71
Tin metal (actual value)	10.16	10.16	10.78	11.28	12.03	12.75	13.53	14.21	14.00	15.64	16.19	16.77	17.27	17.85	18.29	18.78	19.23	19.60	19.97	20.31
Tin oxide (actual value)	3.52	3.37	3.41	3.40	3.49	3.45	3.55	3.52	3.59	3.66	3.68	3.70	3.74	3.78	3.85	3.88	3.91	3.98	3.96	4.03
Iron powder (actual value)	6.86	6.96	6.78	6.85	6.92	6.95	7.02	7.13	7.20	7.34	7.47	7.49	7.64	7.63	7.76	7.83	7.89	7.96	8.01	8.12
Predicted camouflage textiles, HR	33.25	33.90	34.32	34.47	34.75	35.02	35.31	35.54	35.77	36.05	36.17	36.33	36.50	36.72	36.87	37.05	37.18	37.24	37.34	37.38
Categorized low reflectance materials in Vis. mean reflection: LR																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Boron carbide (actual value)	4.03	3.84	4.00	3.91	3.96	3.92	3.96	3.93	3.91	3.99	4.00	3.96	3.97	3.98	3.96	3.97	3.97	3.94	3.94	3.93
Argentine powder (actual value)	10.85	10.52	10.21	10.16	10.03	9.90	9.69	9.54	9.40	9.30	9.15	9.01	8.85	8.73	8.60	8.50	8.35	8.31	8.21	8.03
Carbon black pigment (actual value)	1.18	1.09	0.98	1.30	1.08	1.12	1.09	1.10	1.08	1.13	1.13	1.10	1.01	1.00	1.07	0.98	1.04	1.00	0.99	0.97
Titanium carbide (actual value)	2.58	2.37	2.35	2.28	2.38	2.32	2.35	2.33	2.33	2.33	2.37	2.30	2.33	2.27	2.29	2.28	2.22	2.21	2.23	2.17
Predicted camouflage textiles, LR	4.66	4.46	4.39	4.41	4.36	4.29	4.27	4.23	4.18	4.16	4.10	4.09	4.05	4.01	3.96	3.95	3.88	3.86	3.83	3.80
Categorized multicolor synthetic dyes, mean reflection of synthetic dyes																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Isolan black 2S LDN (actual value)	2.38	2.32	2.27	2.38	2.22	2.24	2.21	2.20	2.25	2.26	2.32	2.23	2.25	2.22	2.24	2.32	2.42	2.49	2.55	2.48
Isolan orange (actual value)	1.79	1.58	1.72	1.84	1.73	1.73	1.75	1.78	1.83	1.86	1.97	1.95	2.06	1.99	2.08	2.13	2.18	2.13	2.27	2.48
Telon blue A 2R (actual value)	2.96	2.89	3.11	3.38	3.38	3.31	3.04	2.77	2.60	2.47	2.39	2.29	2.21	2.12	2.07	2.10	2.08	2.05	1.98	2.01
Telon red A 2R (actual value)	3.38	3.19	3.05	2.89	2.62	2.51	2.56	2.45	2.40	2.68	2.47	2.60	2.48	2.74	2.83	2.90	3.11	3.24	3.59	4.01
Telon violet 3R (actual value)	8.49	8.59	8.48	8.24	7.67	7.13	6.66	6.26	5.94	5.58	5.30	4.95	4.77	4.63	4.66	4.70	4.82	4.86	4.91	5.10
Telon yellow A 2R (actual value)	3.25	3.09	3.30	3.35	3.42	3.47	3.57	3.77	3.95	4.15	4.35	4.59	4.96	5.33	5.78	6.49	7.52	8.94	10.94	13.96
Mean reflection	3.71	3.61	3.66	3.68	3.51	3.40	3.27	3.21	3.17	3.13	3.16	3.12	3.10	3.18	3.40	3.59	3.91	4.25	4.86	5.75
Spectral combination of HLR, mean reflection of HLR and LR																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Mean HR	33.25	33.90	34.32	34.47	34.75	35.02	35.31	35.54	35.77	36.05	36.17	36.33	36.50	36.72	36.87	37.05	37.18	37.24	37.34	37.38
Mean LR	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18
Predicted camouflage textiles, HLR	18.7	19.04	19.25	19.32	19.46	19.60	19.74	19.86	19.97	20.11	20.17	20.25	20.34	20.45	20.51	20.61	20.68	20.71	20.76	20.78
Spectral combination of LR and dyes; mean reflection of synthetic dyes and LR																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Synthetic dyes	3.71	3.61	3.66	3.68	3.51	3.40	3.27	3.21	3.17	3.13	3.16	3.12	3.10	3.18	3.40	3.59	3.91	4.25	4.86	5.75
Low reflection	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18
Mean, synthetic dyes + LR	3.94	3.89	3.92	3.93	3.84	3.79	3.72	3.69	3.67	3.65	3.68	3.71	3.79	3.88	4.04	4.21	4.52	4.96	5.50	6.00
Spectral combination of HR, mean reflection of synthetic dyes and HR																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Synthetic dyes	3.71	3.61	3.66	3.68	3.51	3.40	3.27	3.21	3.17	3.13	3.16	3.12	3.10	3.18	3.40	3.59	3.91	4.25	4.86	5.75
High reflectance	33.25	33.90	34.32	34.47	34.75	35.02	35.31	35.54	35.77	36.05	36.17	36.33	36.50	36.72	36.87	37.05	37.18	37.24	37.34	37.38
Mean, synthetic dyes + HR	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48	18.48
Mean reflection of DCWVSB in Vis																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Ice background (actual value)	3.90	4.04	3.74	6.87	7.57	5.51	5.11	4.60	4.86	5.73	4.62	4.09	3.91	4.10	12.87	13.78	4.05	3.22	5.37	5.87
Dry leaves background (actual value)	6.53	6.54	6.95	7.43	7.81	8.06	8.46	8.91	9.16	9.71	10.74	12.03	13.32	14.46	15.55	16.72	17.92	19.09	20.08	20.03
Green leaves background (actual value)	3.64	4.00	4.01	3.94	4.16	4.30	4.51	4.56	4.63	4.75	5.20	6.28	8.10	9.88	10.78	11.33	11.14	10.20	9.03	8.42
Tree bark background (actual value)	8.71	9.99	11.71	13.19	15.18	17.50	19.84	21.76	23.21	24.76	26.26	27.76	29.10	30.69	32.32	34.08	35.81	37.50	39.09	40.71
Sand background (actual value)	8.90	9.46	10.32	10.96	12.03	12.85	13.41	13.92	14.43	15.93	16.83	17.87	18.96	20.07	21.19	22.18	23.14	23.84	24.44	24.90
Sky background (predicted)	7.04	7.38	7.44	8.11	8.42	8.13	8.18	8.12	8.26	8.58	8.54	8.76	9.22	9.76	10.90	12.39	10.49	10.25	10.56	10.60
Stone background (actual value)	10.27	10.96	11.58	11.91	12.53	13.16	13.57	13.81	14.19	14.67	15.23	15.86	16.48	17.34	18.12	19.01	19.78	20.51	21.04	21.46
Water background (actual value)	5.49	5.73	5.70	5.78	5.72	5.64	5.63	5.62	5.61	5.66	5.63	5.60	5.55	5.58	5.56	5.51	5.50	5.34	5.25	5.16
Snow background (actual value)	11.89	12.19	12.17	12.07	12.14	12.03	12.08	12.01	12.02	12.08	12.02	11.95	11.96	11.91	12.19	12.34	11.97	11.91	12.03	12.00
Predicted camouflage textiles, ZR	7.27	7.81	8.18	8.92	9.51	9.69	10.09	10.37	10.71	11.23	11.57	12.13	12.85	13.63	15.48	16.26	15.43	15.69	16.26	16.73
Vis simulation of red and background camouflage textiles (actual reflection of ice = 0%)																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Ice background	3.90	4.04	3.74	6.87	7.57	5.51	5.11	4.60	4.86	5.73	4.62	4.09	3.91	4.10	12.87	13.78	4.05	3.22	5.37	5.87
Predicted camouflage textiles, ZR-1; n=5%	4.04	4.24	3.93	7.21	7.95	5.79	5.37	4.85	5.10	6.02	4.85	4.29	4.11	4.10	12.87	13.78	4.05	3.22	5.37	5.87
Predicted camouflage textiles, ZR-2; n=5%	3.71	3.84	3.55	6.53	7.19	5.23	4.85	4.37	4.62	5.44	4.39	3.89	3.71	3.90	12.19	13.09	3.85	3.06	5.10	5.58
Vis simulation of dry leaves background camouflage textiles (actual reflection of dry leaves = 0%)																				
Wavelength (nm)	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
Dry leaves background	5.63	6.54	6.95	7.43	7.81	8.06	8.46	8.91	9.16	9.71	10.74	12.03	13.32	14.46	15.55	16.72	17.92	19.09	20.08	21.07
Predicted camouflage textiles, ZR-1; n=5%	5.91	6.87	7.30	7.80	8.20	8.46	8.88	9.36	9.62	10.20	11.28	12.63	13.99	15.18	16.33	17.50	18.82	20.04	21.08	22.12
Predicted camouflage textiles, ZR-2; n=5%	5.35	6.21	6.60	7.06	7.42	7.66	8.04	8.46	8.70	9.22	10.20	11.43	12.65	13.74	14.77	15.88	17.02	18.14	19.08	20.02

Table 6. Colorflex EZ spectral data and synthesized data for camouflage simulation in visible spectrums (B).

Vis simulation of green leaves background camouflage textiles (actual reflection of green leaves ± n%)																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Green leaves background		3.64	4.00	4.01	3.94	4.16	4.30	4.51	4.56	4.63	4.75	5.20	6.28	8.10	9.88	10.78	11.33	11.14	10.20	9.03	8.42	8.17	7.62	7.00	6.93	6.68	5.91	5.24	5.30	5.33	6.90	13.33
Predicted camouflage textiles, ZR-1; n=5%		3.82	4.20	4.21	4.14	4.37	4.52	4.74	4.79	4.86	4.99	5.46	6.59	8.51	10.37	11.32	11.90	11.70	10.71	9.48	8.84	8.58	8.00	7.35	7.28	7.01	6.21	5.50	5.57	5.60	7.25	14.00
Predicted camouflage textiles, ZR-2; n=5%		3.46	3.80	3.81	3.74	3.95	4.09	4.28	4.33	4.40	4.51	4.94	5.97	7.70	9.39	10.24	10.76	10.58	9.69	8.58	8.00	7.76	7.24	6.65	6.58	6.35	5.61	4.98	5.04	5.06	6.56	12.66
Vis simulation of free bark background camouflage textiles (actual reflection of free bark ± n%)																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Tree bark background		8.71	9.09	11.7	13.2	15.2	17.6	19.8	21.8	23.2	24.8	26.3	27.8	29.1	30.7	32.3	34.1	35.8	37.5	39.1	40.7	42.1	43.6	44.8	46.3	47.6	48.9	50.2	51.8	52.4	53.5	54.8
Predicted camouflage textiles, ZR-1; n=5%		9.15	10.49	12.30	13.85	15.94	18.44	20.83	22.85	24.37	26.00	27.57	29.15	30.56	32.22	33.94	35.78	37.60	39.38	41.04	42.75	44.17	45.80	47.60	48.62	49.96	51.39	52.67	54.37	55.00	56.22	57.56
Predicted camouflage textiles, ZR-2; n=5%		8.27	9.49	11.12	12.53	14.42	16.68	18.85	20.67	22.32	23.52	24.95	26.37	27.65	29.16	30.70	32.38	34.02	35.73	37.14	38.67	39.97	41.44	42.58	43.99	45.20	46.49	47.65	49.19	49.76	50.86	52.08
Vis simulation of desertland background camouflage textiles (actual reflection of sand ± n%)																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Sand background		8.90	9.46	10.32	10.96	12.03	12.85	13.41	13.92	14.43	15.15	15.93	16.83	17.87	18.96	20.07	21.19	22.18	23.14	23.84	24.44	24.90	25.29	25.58	25.88	26.12	26.23	26.49	26.62	26.76	27.09	27.28
Predicted camouflage textiles, ZR-1; n=5%		9.35	9.93	10.84	11.51	12.63	13.49	14.08	14.62	15.15	15.93	16.73	17.67	18.76	19.91	21.07	22.25	23.29	24.30	25.03	25.66	26.15	26.55	26.86	27.17	27.43	27.54	27.81	27.95	28.10	28.44	28.64
Predicted camouflage textiles, ZR-2; n=5%		8.46	8.99	9.80	10.41	11.43	12.21	12.74	13.22	13.71	14.39	15.13	15.99	16.98	18.01	19.07	20.13	21.07	21.98	22.65	23.22	23.66	24.03	24.30	24.59	24.81	24.92	25.17	25.29	25.42	25.74	25.92
Vis simulation of storeland background camouflage textiles (actual reflection of stone ± n%)																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Stone background		10.27	10.96	11.58	11.91	12.53	13.16	13.57	13.81	14.19	14.67	15.23	15.86	16.48	17.34	18.12	19.01	19.78	20.51	21.04	21.46	21.68	21.96	22.29	22.31	22.57	22.59	22.76	22.71	22.96	23.26	23.58
Predicted camouflage textiles, ZR-1; n=5%		10.78	11.51	12.16	12.51	13.16	13.82	14.25	14.50	14.90	15.40	15.99	16.65	17.30	18.21	19.03	19.96	20.77	21.54	22.09	22.53	22.76	23.06	23.40	23.43	23.70	23.72	23.90	23.85	24.11	24.42	24.76
Predicted camouflage textiles, ZR-2; n=5%		9.76	10.41	11.00	11.31	11.90	12.50	12.89	13.12	13.48	13.94	14.47	15.07	15.66	16.47	17.21	18.06	18.79	19.48	19.99	20.30	20.60	20.86	21.18	21.19	21.44	21.46	21.63	21.57	21.81	22.10	22.40
Vis simulation of marine background camouflage textiles (actual reflection of water ± n%)																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Water background		5.49	5.73	5.70	5.78	5.72	5.64	5.63	5.62	5.61	5.66	5.63	5.60	5.65	5.58	5.56	5.51	5.50	5.39	5.34	5.25	5.16	5.20	5.07	4.96	4.88	4.89	4.65	4.27	4.46	4.52	4.48
Predicted camouflage textiles, ZR-1; n=5%		5.76	6.02	5.99	6.07	6.01	5.92	5.91	5.90	5.89	5.94	5.91	5.88	5.93	5.86	5.84	5.79	5.78	5.66	5.61	5.51	5.42	5.46	5.32	5.21	5.12	5.13	4.88	4.48	4.68	4.75	4.70
Predicted camouflage textiles, ZR-2; n=5%		5.22	5.44	5.42	5.49	5.43	5.36	5.35	5.34	5.33	5.38	5.35	5.32	5.37	5.30	5.28	5.23	5.23	5.12	5.07	4.90	4.90	4.94	4.82	4.71	4.64	4.65	4.42	4.06	4.24	4.29	4.26
Vis simulation of snowland background camouflage textiles (actual reflection of snow ± n%)																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Snow background		11.89	12.19	12.17	12.07	12.14	12.03	12.08	12.01	12.02	12.08	12.02	11.95	11.96	11.91	12.19	12.34	11.97	11.91	12.03	12.00	11.91	12.15	12.13	11.80	11.69	11.71	11.55	11.07	11.33	11.36	11.46
Predicted camouflage textiles, ZR-1; n=5%		12.48	12.80	12.78	12.67	12.75	12.63	12.68	12.61	12.62	12.68	12.62	12.56	12.51	12.80	12.96	12.57	12.51	12.63	12.60	12.51	11.74	12.39	12.27	12.12	12.10	11.62	11.90	11.93	12.02	12.10	12.19
Predicted camouflage textiles, ZR-2; n=5%		11.30	11.58	11.56	11.47	11.53	11.43	11.48	11.41	11.42	11.48	11.41	11.32	11.31	11.58	11.72	11.31	11.43	11.31	11.31	11.52	11.11	11.11	11.11	11.11	11.11	10.52	10.97	10.52	10.96	10.79	10.89
Vis simulation of simultaneous marine and desertland camouflage textiles (mean reflection of water and sand)																																
Wavelength (nm)		400	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	
Water background		5.49	5.73	5.70	5.78	5.72	5.64	5.63	5.62	5.61	5.66	5.63	5.60	5.65	5.58	5.56	5.51	5.50	5.39	5.34	5.25	5.16	5.20	5.07	4.96	4.88	4.89	4.65	4.27	4.46	4.52	4.48
Sand background		8.90	9.46	10.32	10.96	12.03	12.85	13.41	13.92	14.43	15.15	15.93	16.83	17.87	18.96	20.07	21.19	22.18	23.14	23.84	24.44	24.90	25.29	25.58	25.88	26.12	26.23	26.49	26.62	26.76	27.09	27.28
Predicted camouflage textiles, ZR		7.20	7.60	8.01	8.37	8.88	9.25	9.52	9.77	10.02	10.41	10.78	11.22	11.76	12.27	12.82	13.35	13.84	14.27	14.59	14.85	15.03	15.25	15.33	15.42	15.50	15.56	15.57	15.45	15.61	15.81	15.88
Vis simulation of marine and woodland camouflage textiles, mean reflection of dry leaves, green leaves and tree bark (woodland) and water background																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Dry leaves		5.63	6.54	6.95	7.43	7.81	8.06	8.46	8.91	9.16	9.71	10.74	12.03	13.32	14.46	15.55	16.72	17.92	19.09	20.08	21.07	21.92	22.74	23.30	23.95	24.55	24.92	25.19	25.52	25.72	26.53	27.17
Green Leaves		3.64	4.00	4.01	3.94	4.16	4.30	4.51	4.56	4.63	4.75	5.20	6.28	8.10	9.88	10.78	11.33	11.14	10.20	9.03	8.42	8.17	7.62	7.00	6.93	6.68	5.91	5.24	5.30	5.33	6.90	13.33
Tree bark		8.71	9.09	11.71	13.19	15.18	17.56	19.84	21.76	23.21	24.76	26.26	27.76	29.10	30.69	32.32	34.08	35.81	37.50	39.09	40.71	42.07	43.62	44.82	46.30	47.58	48.94	50.16	51.78	52.38	53.54	54.82
Mean reflection		5.99	6.84	7.56	8.19	9.05	9.97	10.94	11.74	12.33	13.07	14.07	15.36	16.84	18.34	19.55	20.71	21.62	22.26	22.73	23.40	24.05	24.66	25.04	25.73	26.27	26.59	26.86	27.53	27.81	28.99	31.77
Vis simulation of sky background camouflage textiles, mean reflection of simulated natural background																																
Wavelength (nm)		400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700
Water background		5.49	5.73	5.70	5.78	5.72	5.64	5.63	5.62	5.61	5.66	5.63	5.60	5.65	5.58	5.56	5.51	5.50	5.39	5.34	5.25	5.16	5.20	5.07	4.96	4.88	4.89	4.65	4.27	4.46	4.52	4.48
Ice background		3.90	4.04	3.74	6.87	5.71	5.51	1.40	4.86	5.73	4.62	4.09	3.91	4.01	12.87	13.78	4.05	3.32	5.37													