

Appendix I

Classification of the specimens chosen for the work

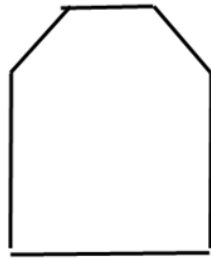
Sample	Scientific Name	Kingdom	Phylum	Class	Order	Family	Genus
Dragonfly	Gynacantha Dravida	Animalia	Euarthropoda	Insecta	Odanata	Aeshnoidea	
Damselfly	Pseudagrion Microcephalum	Animalia	Euarthropoda	Insecta	Odanata	Coenagrionoidea	
White Admiral butterfly	Limenitis Camilla	Animalia	Arthropoda	Insecta	Lepidoptera	Nymphalidae	Limenitis
Large White butterfly	Pieris Brassicae	Animalia	Arthropoda	Insecta	Lepidoptera	Pieridae	Pieris
Dark Blue Tiger butterfly	Tirumala Septentrionis	Animalia	Euarthropoda	Insecta	Lepidoptera	Nymphalidae	Tirumala

Classification of the specimens from plant kingdom chosen for the work

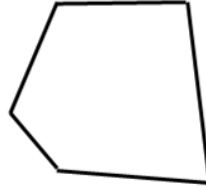
Sample	Scientific name	Family
White rose	Rosa chinensis var spontanea	Rosacea
Light Pink rose	Rosa chinensis var minima	
Dark Pink rose	Rosa chinensis var minima	
Red hibiscus	Hibiscus rosa sinensis	Malvaceae
Pink hibiscus		
Yellow hibiscus		

Appendix II

(a)



Distorted
hexagon



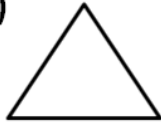
Distorted
pentagon



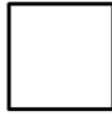
Distorted
rectangle

Structures found in dragonfly wing

(b)



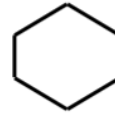
Perfect
Triangle



Perfect
Square



Perfect
Rectangle

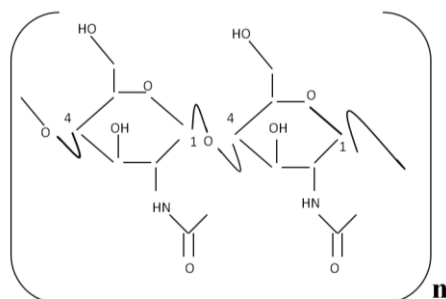


Perfect
hexagon

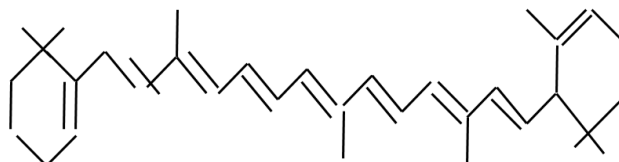
Structures not found in dragonfly wing

Appendix III

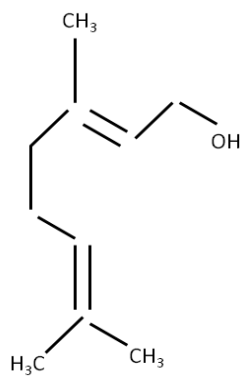
(a) Chitin ($C_8H_{13}O_5N$)_n



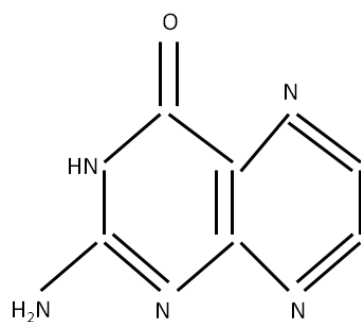
(b) Carotenoid ($C_{40}H_x$)



(c) Geraniol ($C_{10}H_{18}O$)



(d) Pterin ($C_6H_5N_5O$)



Appendix IV

Physical properties of the liquids used for specimen treatment

Solvent	Refractive Index	Appearance	Molar Mass (mol/L)	Density (g/cm ³)	Boiling point (°C)	Melting point (°C)
Ethanol	1.36	Colourless	46.06	0.789	78.5	114.5
Methanol	1.33	Colourless	32.04	0.792	64.7	97.6
Propanol	1.38	Colourless	60.09	0.803	97	126
Glycerine	1.47	Colourless	92.09	1.261	290	17.8

Appendix V

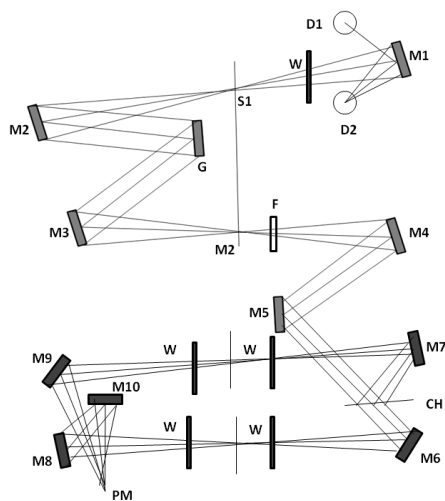


Figure: Schematic representation of the UV-Vis-NIR set up (UV-2550 Shimadzu)

Here, light emitted from the light source (deuterium lamp D2/halogen lamp is reflected by the mirrors and is incident upon the monochromator. The switching wavelength for D2 and W1 lamp are 190 and 900 nm respectively. In this spectrophotometer, the light sources are adjusted automatically ensuring that maximum light intensity is obtained. The slit width can be changed from 0.1 to 5 nm, for normal measurements, the slit width is maintained at 2nm.

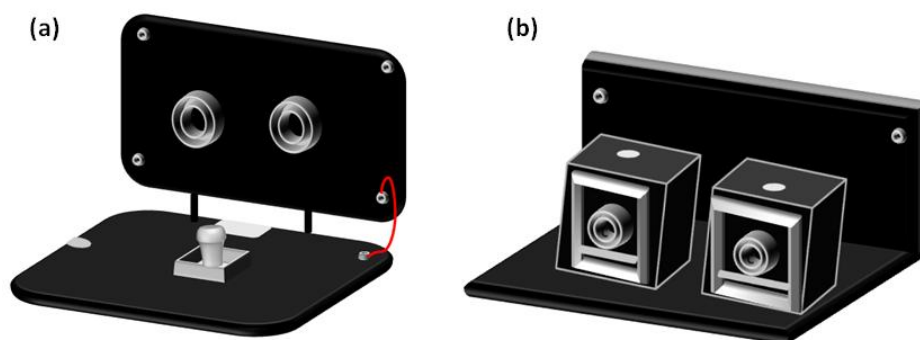


Figure: (a) Detector module of the 50 mm Integrating sphere (PerkinElmer) (b) 50 mm reflection/ transmission sphere

Specification of 50 mm reflectance sphere

Physical characteristic	Specification
Spectral range	190-1100 nm
Dimensions	170 mm x 120 mm x 110 mm
Sphere diameter	60 mm
Weight	1.22 kg
Sample port aperture	12.5 mm
Sphere coating	Barium sulphate

Appendix VI

Chromaticity coordinates of the specimens are listed below

(1) WA white untreated

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
361.35	16.80	0.175	0.005	0.20	0.06
390.30	18.68	0.173	0.004	0.3317	0.3317
427.69	23.79	0.169	0.006	0.311	0.269
450.67	26.41	0.155	0.018	0.20	0.10
488.05	29.38	0.054	0.255	0.2442	0.3080
520.64	30.69	0.079	0.833	0.2297	0.5335
558.02	31.68	0.358	0.638	0.325	0.40
583.34	32.50	0.534	0.464	0.3925	0.3672
611.12	33.17	0.669	0.330	0.44	0.32
641.36	34.48	0.720	0.279	0.4259	0.3208
667.84	35.97	0.731	0.268	0.4618	0.3116
686.02	37.77	0.734	0.265	0.46	0.30
712.50	41.06	0.734	0.265	0.5204	0.3063
761.96	46.00	0.734	0.265	0.485	0.295

(2) WA white treated

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
362.52	22.47	0.173	0.005	0.20	0.07
386.67	25.10	0.173	0.004	0.298	0.269
418.08	31.19	0.171	0.004	0.287	0.241
432.49	34.48	0.167	0.007	0.22	0.125
449.37	37.93	0.017	0.258	0.258	0.210
473.51	41.06	0.114	0.076	0.20	0.17
497.66	42.87	0.014	0.479	0.219	0.38
527.90	44.51	0.137	0.815	0.246	0.545
568.93	45.84	0.436	0.562	0.36	0.405
601.51	46.99	0.633	0.365	0.474	0.352
641.36	48.79	0.720	0.279	0.48	0.30
667.84	50.28	0.731	0.268	0.520	0.306
722.24	55.38	0.734	0.265	0.53	0.29

(3) LW untreated

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
360.06	9.34	0.175	0.005	0.18	0.02
384.20	10.21	0.174	0.004	0.312	0.295
401.08	15.92	0.173	0.004	0.298	0.269
415.62	25.97	0.172	0.004	0.17	0.06
420.42	33.92	0.171	0.005	0.289	0.241
427.69	42.25	0.169	0.006	0.274	0.215
432.49	50.15	0.167	0.007	0.250	0.180
442.23	56.73	0.163	0.012	0.243	0.167
455.47	61.33	0.150	0.023	0.221	0.149
467.54	63.98	0.130	0.047	0.24	0.20
486.88	65.98	0.059	0.233	0.155	0.282
547.12	67.92	0.280	0.710	0.295	0.52
599.04	68.13	0.622	0.376	0.509	0.356
667.84	70.32	0.731	0.268	0.60	0.28
759.62	76.90	0.734	0.265	0.64	0.275

(4) LW treated

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
363.69	10.66	0.175	0.005	0.18	0.006
384.20	10.21	0.174	0.004	0.312	0.295
401.08	15.92	0.173	0.004	0.298	0.269
415.62	25.97	0.172	0.004	0.17	0.06
420.42	33.92	0.171	0.005	0.289	0.241
427.69	42.25	0.169	0.006	0.274	0.215
432.49	50.15	0.167	0.007	0.250	0.180
442.23	56.73	0.163	0.012	0.243	0.167
455.47	61.33	0.150	0.023	0.221	0.149
467.54	63.98	0.130	0.047	0.24	0.20
486.88	65.98	0.059	0.233	0.155	0.282
547.12	67.92	0.280	0.710	0.295	0.52
599.04	68.13	0.622	0.376	0.509	0.356
667.84	70.32	0.731	0.268	0.60	0.28
759.62	76.90	0.734	0.265	0.64	0.275

(5) DBT untreated

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
388.70	20.94	0.173	0.004	0.305	0.282
394.11	21.04	0.173	0.004	0.312	0.295
399.41	21.25	0.173	0.004	0.303	0.284
406.88	21.96	0.172	0.004	0.308	0.280
422.89	25.63	0.170	0.005	0.301	0.286
425.05	28.17	0.170	0.005	0.302	0.285
430.35	30.61	0.168	0.006	0.291	0.256
445.28	34.38	0.160	0.013	0.281	0.247
458.15	36.10	0.146	0.026	0.269	0.240
488.01	37.43	0.054	0.254	0.255	0.311
544.59	38.34	0.262	0.726	0.300	0.468
613.93	39.16	0.677	0.322	0.447	0.325
652.33	41.10	0.727	0.272	0.493	0.306
680.13	42.21	0.733	0.266	0.509	0.303
720.70	45.47	0.734	0.265	0.513	0.305

(6) DBT treated

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
387.73	19.62	0.173	0.004	0.288	0.242
395.19	19.52	0.173	0.004	0.287	0.242
428.19	20.12	0.169	0.006	0.292	0.257
444.20	20.73	0.161	0.013	0.289	0.260
489.09	20.33	0.049	0.275	0.278	0.318
542.42	19.31	0.247	0.740	0.313	0.431
558.43	20.23	0.361	0.635	0.343	0.403
584.07	20.33	0.538	0.460	0.376	0.358
602.25	20.23	0.636	0.362	0.404	0.343
613.93	20.54	0.677	0.322	0.413	0.336
637.40	20.63	0.716	0.283	0.414	0.320
649.19	20.94	0.725	0.274	0.430	0.317
672.67	21.25	0.732	0.267	0.430	0.317
700.36	22.26	0.734	0.265	0.446	0.314
750.56	25.11	0.734	0.265	0.462	0.312

(7) White rose (untreated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
385.50	8.67	0.173	0.004	0.32	0.30
418.08	19.64	0.171	0.005	0.30	0.27
450.67	37.45	0.156	0.183	0.27	0.12
475.98	43.76	0.106	0.094	0.23	0.22
510.90	47.33	0.017	0.764	0.29	0.50
541.15	47.86	0.237	0.747	0.32	0.49
550.75	48.68	0.307	0.307	0.44	0.43
578.53	54.73	0.502	0.502	0.53	0.31
629.29	63.78	0.707	0.707	0.52	0.30
699.26	70.92	0.734	0.730	0.63	0.28

(8) White rose (ethanol- treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
373.43	10.85	0.174	0.005	0.32	0.30
461.44	42.93	0.141	0.032	0.25	0.20
485.59	47.33	0.065	0.210	0.22	0.28
518.17	50.89	0.060	0.829	0.24	0.50
529.07	51.72	0.147	0.810	0.26	0.52
573.73	54.46	0.470	0.528	0.41	0.44
607.48	57.47	0.657	0.342	0.50	0.33
634.09	59.65	0.713	0.286	0.50	0.31
710.16	67.62	0.734	0.265	0.54	0.30

(9) White rose (propanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
381.24	9.14	0.174	0.004	0.321	0.307
399.41	11.96	0.173	0.004	0.314	0.294
426.13	17.08	0.170	0.006	0.306	0.282
444.30	19.18	0.161	0.013	0.299	0.269
460.32	21.72	0.143	0.030	0.296	0.296
490.17	24.53	0.044	0.298	0.264	0.272
561.68	27.55	0.385	0.612	0.351	0.325
596.84	27.79	0.612	0.387	0.404	0.395
650.28	30.33	0.724	0.275	0.429	0.342
647.03	30.33	0.726	0.273	0.429	0.317
695.06	32.67	0.734	0.265	0.495	0.317

(10) White rose (glycerine-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
381.24	8.02	0.174	0.004	0.33	0.46
399.41	9.64	0.173	0.004	0.32	0.29
426.13	17.55	0.170	0.006	0.29	0.26
444.30	21.51	0.161	0.013	0.30	0.29
460.32	23.35	0.143	0.030	0.29	0.27
490.17	25.45	0.044	0.298	0.26	0.33
561.68	25.45	0.385	0.612	0.35	0.38
596.84	26.39	0.612	0.387	0.38	0.35
650.28	28.47	0.726	0.273	0.42	0.33
647.03	27.55	0.724	0.275	0.41	0.33
695.06	29.89	0.734	0.265	0.43	0.32

(11) LP rose (untreated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
379.40	8.10	0.174	0.004	0.31	0.29
418.08	17.16	0.173	0.004	0.30	0.25
492.86	18.81	0.036	0.339	0.27	0.33
518.17	14.51	0.061	0.829	0.39	0.30
535.04	13.59	0.193	0.781	0.32	0.35
583.34	25.65	0.534	0.579	0.40	0.37
601.51	41.28	0.634	0.464	0.43	0.34
622.02	57.47	0.695	0.366	0.51	0.32
696.79	76.93	0.734	0.304	0.59	0.29
714.97	78.85	0.734	0.265	0.64	0.28

(12) LP rose (ethanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
379.40	9.20	0.174	0.004	0.32	0.30
418.08	18.81	0.171	0.004	0.31	0.28
457.81	30.61	0.147	0.026	0.29	0.20
477.15	32.79	0.102	0.104	0.26	0.26
513.37	30.31	0.029	0.796	0.27	0.43
539.98	28.95	0.229	0.754	0.31	0.40
583.34	38.01	0.534	0.464	0.40	0.37
624.36	54.46	0.699	0.300	0.53	0.31
645.00	61.04	0.723	0.276	0.58	0.30
710.16	74.19	0.734	0.265	0.63	0.28

(13) LP rose (propanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
381.35	7.66	0.174	0.004	0.321	0.307
399.41	9.14	0.173	0.004	0.319	0.307
426.13	12.62	0.170	0.006	0.311	0.296
444.30	14.95	0.161	0.013	0.302	0.285
460.32	16.10	0.143	0.030	0.298	0.291
490.17	17.57	0.044	0.298	0.277	0.317
561.68	19.31	0.385	0.612	0.334	0.385
596.84	20.17	0.612	0.387	0.386	0.333
647.03	21.35	0.724	0.275	0.397	0.323
650.28	22.25	0.726	0.273	0.397	0.323
695.06	24.53	0.734	0.265	0.427	0.32
728.16	26.01	0.734	0.265	0.442	0.318

(14) LP rose (glycerine-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
381.24	9.41	0.174	0.004	0.321	0.307
399.41	11.96	0.173	0.004	0.314	0.294
426.13	17.08	0.170	0.006	0.305	0.282
444.30	19.18	0.161	0.013	0.299	0.269
460.32	21.72	0.143	0.030	0.296	0.272
490.17	24.53	0.044	0.298	0.263	0.325
561.68	27.55	0.385	0.612	0.351	0.395
596.84	27.79	0.612	0.387	0.404	0.343
647.03	30.33	0.724	0.275	0.429	0.317
650.28	30.33	0.726	0.273	0.429	0.317
695.06	32.67	0.734	0.265	0.496	0.314
727.08	33.83	0.734	0.265	0.458	0.315

(15) DP rose (untreated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
376.93	6.45	0.174	0.005	0.31	0.295
492.86	5.92	0.184	0.787	0.33	0.35
533.88	5.92	0.333	0.662	0.33	0.34
554.39	5.63	0.534	0.464	0.36	0.33
583.34	5.92	0.633	0.365	0.41	0.33
601.51	9.20	0.695	0.304	0.44	0.32
622.02	20.13	0.716	0.283	0.51	0.31
637.73	33.61	0.727	0.272	0.55	0.30
652.14	47.06	0.732	0.267	0.60	0.29

(16) Red hibiscus (untreated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
361.01	15.54	0.175	0.005	0.313	0.295
462.37	11.08	0.140	0.033	0.300	0.288
557.35	10.05	0.354	0.642	0.329	0.376
617.67	31.64	0.677	0.322	0.429	0.317
743.09	51.79	0.734	0.265	0.526	0.300

(17) Red hibiscus (ethanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
361.01	15.54	0.175	0.005	0.313	0.295
462.37	11.08	0.140	0.033	0.300	0.288
557.35	10.05	0.354	0.642	0.329	0.376
617.67	31.64	0.677	0.322	0.429	0.317
743.09	51.79	0.734	0.265	0.526	0.300

(18) Red hibiscus (methanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
364.14	26.75	0.175	0.005	0.289	0.228
488.01	33.87	0.064	0.214	0.255	0.311
591.54	33.46	0.584	0.415	0.420	0.367
661.96	35.50	0.731	0.268	0.446	0.314
747.31	38.97	0.734	0.265	0.462	0.312

(19) Red hibiscus (propanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
366.31	4.14	0.175	0.005	0.321	0.370
481.52	8.21	0.064	0.264	0.294	0.380
574.44	14.32	0.496	0.502	0.345	0.348
684.35	19.83	0.733	0.266	0.414	0.319
734.55	21.05	0.734	0.265	0.414	0.319

(20) Red hibiscus (glycerine treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
395.08	15.75	0.173	0.004	0.298	0.269
496.55	12.90	0.017	0.451	0.283	0.354
559.51	12.69	0.361	0.635	0.334	0.385
677.97	43.24	0.732	0.267	0.493	0.306
748.39	53.83	0.734	0.265	0.542	0.298

(21) Pink hibiscus (untreated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
394.11	12.05	0.173	0.004	0.318	0.308
481.63	14.50	0.084	0.152	0.293	0.307
596.94	24.79	0.612	0.386	0.398	0.348
625.72	42.24	0.701	0.298	0.494	0.315
722.86	52.01	0.734	0.265	0.526	0.307

(22) Pink hibiscus (ethanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
394.11	23.57	0.173	0.004	0.302	0.267
479.46	42.75	0.093	0.126	0.249	0.253
591.54	41.71	0.584	0.415	0.430	0.369
662.07	53.23	0.730	0.265	0.542	0.298
722.86	59.17	0.734	0.265	0.567	0.298

(23) Pink hibiscus (methanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
394.11	27.41	0.173	0.004	0.295	0.234
497.64	35.78	0.014	0.479	0.245	0.370
572.39	34.03	0.460	0.538	0.368	0.404
647.67	35.96	0.724	0.275	0.493	0.306
690.84	37.87	0.734	0.265	0.505	0.303

(24) Pink hibiscus (propanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
397.25	4.74	0.173	0.004	0.314	0.293
485.85	5.98	0.064	0.214	0.299	0.323
578.66	5.78	0.503	0.495	0.350	0.343
679.05	6.17	0.733	0.266	0.381	0.325
735.63	6.79	0.734	0.265	0.365	0.327

(25) Yellow hibiscus (Untreated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
388.70	12.45	0.174	0.004	0.318	0.308
425.05	15.94	0.168	0.006	0.303	0.284
485.85	16.11	0.064	0.214	0.293	0.367
588.29	38.97	0.538	0.460	0.409	0.378
641.62	48.23	0.718	0.281	0.503	0.319

(26) Yellow hibiscus (ethanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x _n	y _n
382.32	19.95	0.174	0.004	0.300	0.288
478.38	34.09	0.097	0.115	0.267	0.271
580.83	36.71	0.496	0.502	0.385	0.400
666.18	38.27	0.731	0.268	0.461	0.312

(27) Yellow hibiscus (methanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x_n	y_n
391.95	26.24	0.173	0.004	0.296	0.272
481.52	35.14	0.097	0.115	0.258	0.263
590.45	35.67	0.636	0.362	0.425	0.333
689.65	38.80	0.732	0.266	0.462	0.311
716.37	40.73	0.734	0.265	0.510	0.303

(28) Yellow hibiscus (propanol-treated)

Wavelength (nm)	Reflectance (%)	x	y	x_n	y_n
379.07	7.04	0.174	0.004	0.320	0.307
488.01	12.27	0.064	0.214	0.291	0.312
571.20	18.20	0.451	0.547	0.350	0.358
643.79	19.09	0.721	0.278	0.413	0.301
674.72	19.09	0.732	0.267	0.398	0.322

(29) Yellow hibiscus (glycerine-treated)

Wavelength (nm)	Reflectance (%)	x	y	x_n	y_n
364.14	14.54	0.175	0.005	0.317	0.309
428.19	22.40	0.169	0.006	0.298	0.269
495.47	25.70	0.058	0.828	0.282	0.40
592.62	23.09	0.636	0.362	0.415	0.344
647.03	42.46	0.724	0.275	0.493	0.306

Appendix VII

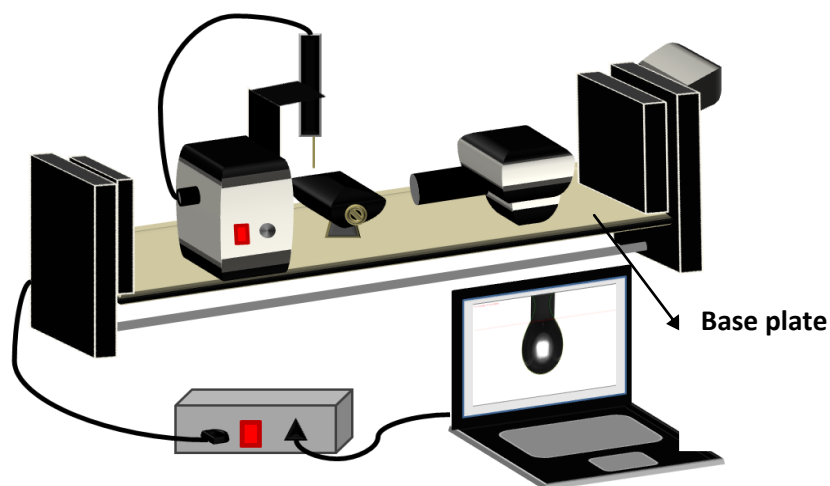


Figure: Sophisticated CA set up (Kyowa interface science Co. Ltd) for contact angle measurement

Using tilting plate methodology, we have assessed the advancing and receding angle as well as the sliding angle.

Mode of tilting	Continuation tilt
Tilting range	0-90 degree
Step size	1 degree
Tilt speed range	0.1~5 (degree/s)