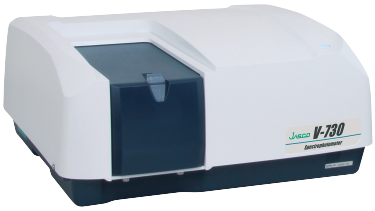
Application Note
UV-0044

Reflectance Measurement Reproducibility of the Color Diagnosis System

Introduction

Color is a visually perceived property that is derived from the reflected or transmitted spectrum of light interacting with the eye. It is important for the development and production of color-based products to evaluate and obtain measurable factors describing the color. JASCO has developed various applications that use the V-700 Series of UV/Vis spectrophotometers for color analysis using both reflectance and/or transmittance spectra of samples. The V-700 spectrophotometers use a double-beam optical system, which offers high measurement accuracy and stability and therefore the results for color calculations can be determined with high reproducibility.



V-730
UV-Visible Spectrophotometer

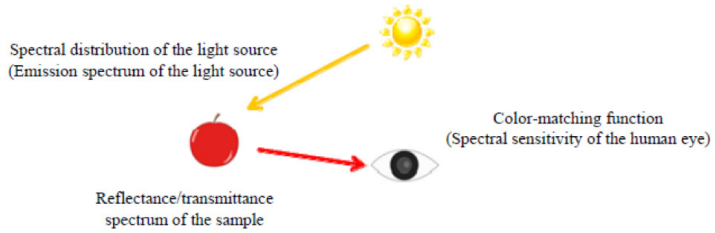


Figure 1. Mechanism of color recognition by the human eye.

This application note illustrates the reproducibility of color calculations made using JASCO's color diagnosis system.

Keywords

V-700, UV-Visible/NIR, Chromaticity, Color Analysis, Material, ISV-922 Integrating Sphere, Color Diagnosis program

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Experimental

Measurements were obtained for a blue, red, and yellow pellet. A baseline measurement was performed using a standard white reference plate, then the sample was measured. Both reference and sample measurements were made with the specular reflection component included. To confirm the measurement reproducibility 10 spectra were collected with the sample removed and replaced in between scans to assess the effects of changing the measurement position.

Measurement Conditions			
Bandwidth	5 nm	Response time	0.96 seconds
Data interval	1 nm	Scan speed	400 nm/min

Results

The reflectance spectra for each sample are shown in Figure 2. The figure on the right shows zoomed-in spectra in the wavelength range 740 - 780 nm. As shown in each spectrum, the difference between maxima and minima of the photometric value is less than 0.15%R, indicating high reproducibility measurements.

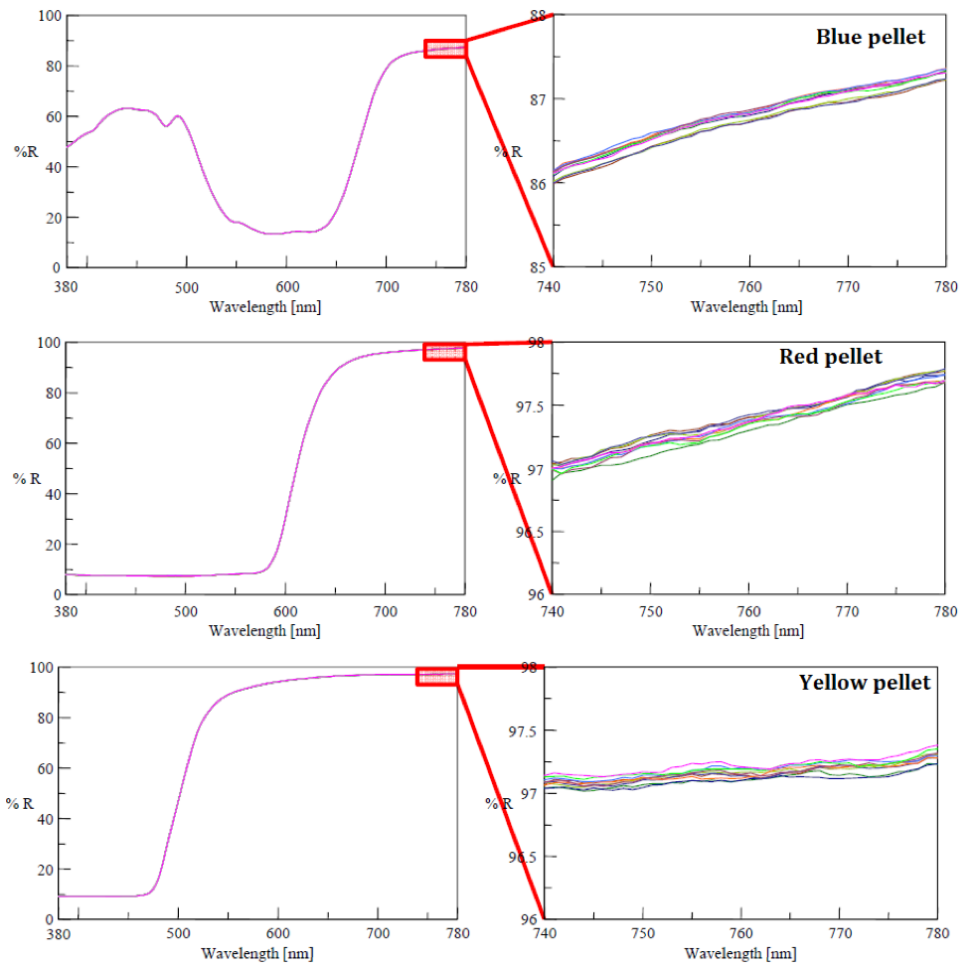

Figure 2. Reflectance spectra of the three colored pellets. The figures on the right are the zoomed in spectra from 740 to 780 nm.

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The Color Diagnosis Program was used to calculate color coordinates from the measured reflectance spectra. Figure 3 shows the results plotted on XYZ, L*a*b*, Lab, and L*u*v* chromaticity diagrams. The calculated values are shown in Tables 1, 2 and 3 for the blue, red, and yellow pellet, respectively. For the color coordinates that represent chroma and hue (xy, a*b*, ab, u*v*), the difference between maxima and the minima are; x and y, less than 0.0012, a* and b*, less than 0.31, a and b, less than 0.18, u* and v*, less than 0.50. For the color coordinates that represent brightness (Y, L, L*), the difference between the maxima and minima is less than 0.1. All results indicate highly reproducible chromaticity values using the Color Diagnosis system.

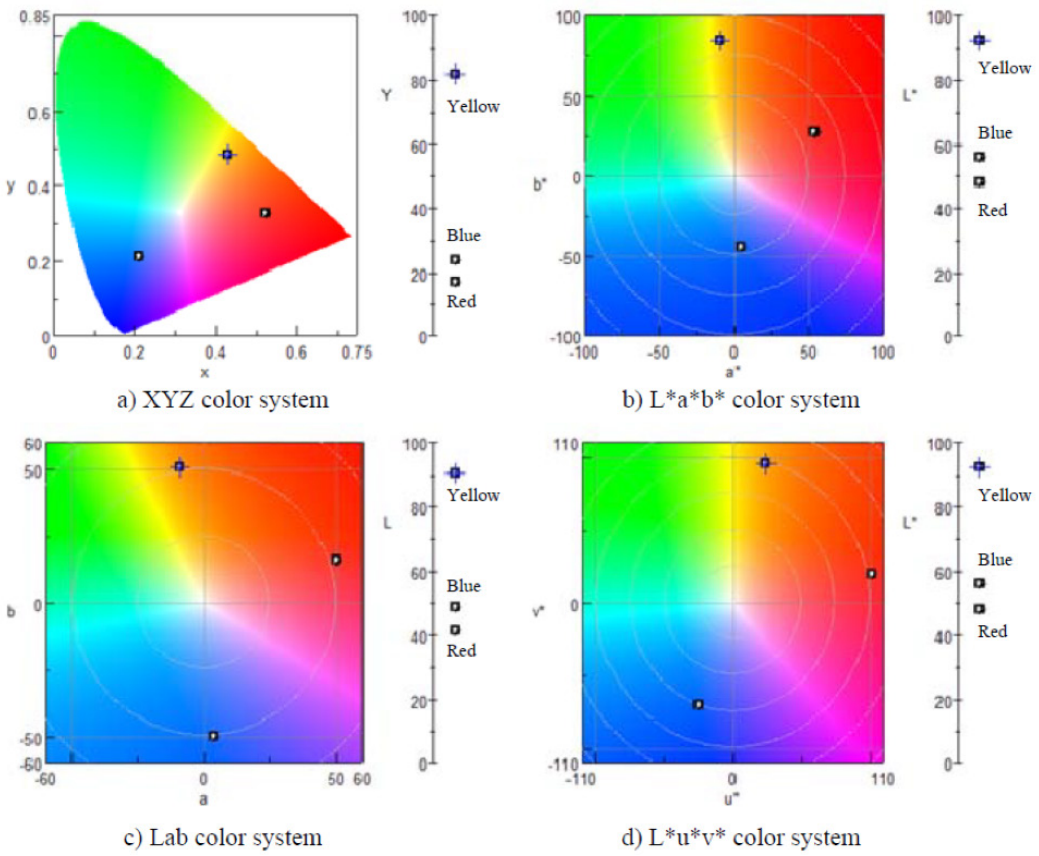

Figure 3. Chromaticity diagrams for each color system and pellet.

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Table 1. Color calculation results of blue color pellet.

	X	Y	Z	x	y	L*	a*	b*	L	a	b	u*	v*
1	23.77	23.94	65.84	0.2094	0.2108	56.03	4.58	-44.94	48.93	3.78	-50.19	-24.75	-70.73
2	23.77	23.94	65.81	0.2094	0.2109	56.03	4.57	-44.91	48.93	3.78	-50.15	-24.74	-70.69
3	23.74	23.91	65.70	0.2095	0.2109	55.99	4.57	-44.88	48.89	3.78	-50.09	-24.71	-70.62
4	23.76	23.93	65.72	0.2095	0.2110	56.01	4.57	-44.87	48.91	3.78	-50.08	-24.71	-70.60
5	23.76	23.92	65.71	0.2095	0.2110	56.01	4.56	-44.85	48.91	3.77	-50.06	-24.71	-70.58
6	23.79	23.96	65.85	0.2094	0.2109	56.04	4.57	-44.92	48.95	3.78	-50.16	-24.75	-70.70
7	23.80	23.97	65.85	0.2095	0.2110	56.06	4.55	-44.89	48.96	3.77	-50.12	-24.74	-70.65
8	23.81	23.98	65.83	0.2095	0.2111	56.07	4.55	-44.87	48.97	3.76	-50.08	-24.73	-70.62
9	23.80	23.97	65.79	0.2096	0.2111	56.06	4.55	-44.85	48.96	3.76	-50.06	-24.71	-70.58
10	23.80	23.97	65.81	0.2095	0.2111	56.06	4.55	-44.86	48.96	3.76	-50.08	-24.73	-70.61
Max-min	0.07	0.07	0.15	0.0002	0.0003	0.07	0.03	0.09	0.07	0.02	0.13	0.05	0.14
Ave.	23.78	23.95	65.79	0.21	0.21	56.04	4.56	-44.88	48.94	3.77	-50.11	-24.73	-70.64
SD	0.02289	0.02509	0.05879	0.00006	0.00008	0.0252	0.0104	0.0312	0.0256	0.0083	0.0456	0.0168	0.0512
CV %	0.10	0.10	0.09	0.03	0.04	0.4	0.23	-0.07	0.05	0.22	-0.09	-0.07	-0.07

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Table 2. Color calculation results of red color pellet.

	X	Y	Z	x	y	L*	a*	b*	L	a	b	u*	v*
1	27.74	17.16	8.17	0.5226	0.3234	48.47	53.78	26.78	41.43	49.99	15.67	101.05	19.17
2	27.78	17.17	8.09	0.5238	0.3237	48.47	53.94	27.08	41.44	50.17	15.80	101.55	19.40
3	27.76	17.15	8.10	05236	0.3236	48.45	53.92	27.02	41.41	50.14	15.77	101.46	19.34
4	27.75	17.15	8.08	0.5238	0.3237	48.45	53.92	27.06	41.41	50.13	15.79	101.48	19.37
5	27.73	17.14	8.10	0.5236	0.3236	48.43	53.90	26.99	41.40	50.11	15.75	101.39	19.31
6	27.70	17.11	8.10	0.5235	0.3235	48.40	53.89	26.94	41.37	50.10	15.73	101.35	19.27
7	27.76	17.18	8.13	0.5231	0.3237	48.49	53.80	26.97	41.45	50.01	15.76	101.21	19.34
8	27.72	17.14	8.11	0.5233	0.3235	48.43	53.85	26.93	41.40	50.06	15.73	101.27	19.27
9	27.72	17.14	8.11	0.5233	0.3235	48.43	53.86	26.93	41.40	50.06	15.73	101.28	19.27
10	27.77	17.19	8.13	0.5231	0.3238	48.50	53.78	26.97	41.46	50.00	15.76	101.18	19.35
Max-min	0.09	0.08	0.08	0.0012	0.0004	0.10	0.16	0.31	0.09	0.18	0.13	0.50	0.23
Ave.	27.74	17.15	8.11	0.52	0.32	48.45	53.86	26.97	41.42	50.08	15.75	101.32	19.31
SD	0.0270	0.0230	0.0274	0.00038	0.00012	0.0288	0.0613	0.0852	0.0278	0.0640	0.0377	0.1545	0.0670
CV %	0.10	0.13	0.34	0.07	0.04	0.06	0.11	0.32	0.07	0.13	0.24	0.15	0.35

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Table 3. Color calculation results of yellow color pellet.

	X	Y	Z	x	y	L*	a*	b*	L	a	b	u*	v*
1	73.34	82.03	14.95	0.4306	0.4816	92.59	-9.44	84.03	90.57	-9.25	50.69	23.70	95.18
2	73.34	82.03	14.95	0.4306	0.4816	92.59	-9.43	84.03	90.57	-9.25	50.69	23.71	95.17
3	73.37	82.06	14.93	0.4307	0.4817	92.60	-9.44	84.11	90.59	-9.26	50.72	23.72	95.23
4	73.37	82.06	14.91	0.4307	0.4817	92.60	-9.44	84.15	90.59	-9.25	50.73	23.74	95.26
5	73.36	82.04	14.93	0.4307	0.4817	92.59	-9.42	84.10	90.58	-9.24	50.71	23.75	95.22
6	73.36	82.05	14.94	0.4307	0.4817	92.60	-9.44	84.09	90.58	-9.25	50.71	23.72	95.22
7	73.38	82.07	14.92	0.4307	0.4817	92.60	-9.44	84.13	90.59	-9.25	50.73	23.74	95.25
8	73.37	92.06	14.93	0.4307	0.4817	92.60	-9.44	84.11	90.59	-9.25	50.72	23.73	95.23
9	73.40	82.07	14.90	0.4308	0.4817	92.61	-9.41	84.18	90.59	-9.22	50.74	23.79	95.27
10	73.41	82.09	14.87	0.4309	0.4818	92.62	-9.41	84.26	90.60	-9.23	50.77	23.81	95.33
Max-min	0.07	0.07	0.08	0.0003	0.0002	0.03	0.03	0.23	0.04	0.03	0.08	0.11	0.16
Ave.	73.37	82.06	14.92	0.43	0.48	92.60	-9.43	84.12	90.59	-9.24	50.72	23.74	95.24
SD	0.0218	0.0201	0.0232	0.00008	0.00006	0.0089	0.0118	0.0678	0.0111	0.0112	0.0241	0.0348	0.0457
CV %	0.03	0.02	0.16	0.02	0.01	0.01	-0.13	0.08	0.01	-0.12	0.05	0.15	0.05

Analysis Conditions: Light Source, D65 (CIE 15:2004, JIS Z 8781-1:2012, ISO 11664-2:2007); Color-matching function, CIE 15:2004, JIS Z 8701:1982; Viewing angle, 2°; Data interval, 5 nm.

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