Micro-Brilliance of Anisotropic Paint Surfaces

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ABSTRACT

Formerly measurements of the appearance of anisotropic paint surfaces were made by macroscopic method, such as goniometric or multiangle spectrophotometers or colorimeters. In this study, we measure these paint surfaces by microscopic method, using micro-spectrophotometer, constructed with imaging spectrograph and CCD camera. In this instrument, incident angle from polychromatic light source and receiving angle from sample by micro-spectrophotometer are variable, and we can measure spectral reflectance factor distribution of reflected light from the sample of about 2/100 mm square. From these spectral reflectance factor distributions, we can calculate tristimulus values and colorimetric values. Samples for this experiment were silver and colored metallic paints and silver pearl-mica paints, which contain different particle size of metal or pearl-mica flakes. From these measuring results, the appearances of these surfaces were studied.

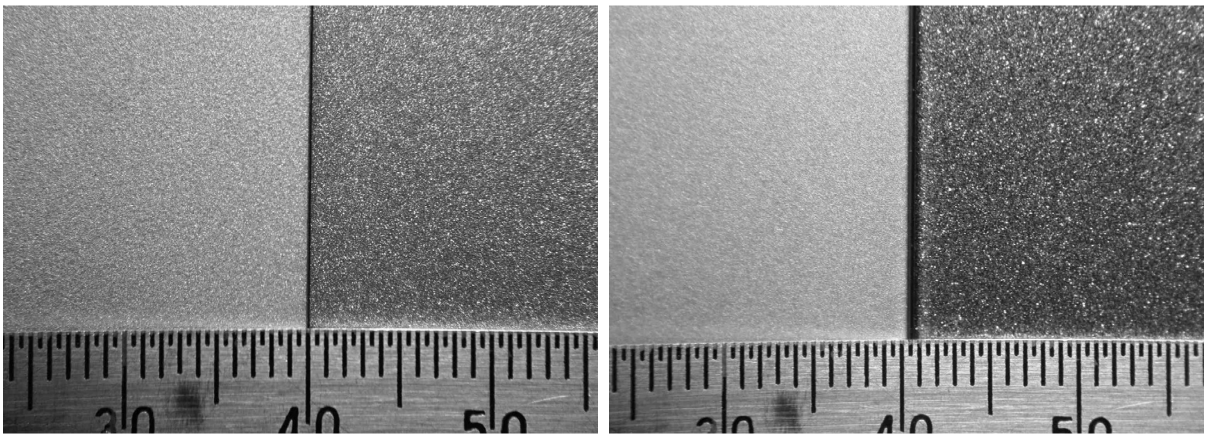
1. INTRODUCTION

About the appearance of anisotropic paint surfaces, such as metallic or pearl-mica pigmented paints, which are usually used for automotive paint finishes, the evaluation of flop perception were made by macroscopic measurement of spatial distribution of reflected light[1)]. But, for paint finishes containing conspicuous flakes of metallic or pearl-mica pigments, microscopic study should be useful. In this report, using microscopic method, micro-brilliance, granularity or glitter of anisotropic paint finishes are investigated.

2. SAMPLES AND INSTRUMENT

For this experiment, metallic and pearl-mica paint panels , as shown in Table 1,were prepared. For metallic samples, color of vehicle is clear, blue and red, and each group contains four steps in average particle size of aluminium flake, fine, medium fine, medium and coarse. For pearl-mica samples, three steps in average particle size of pearl-mica flake are painted on black background, using clear resin. Examples of metallic and pearl-mica samples are shown in Fig. 1.

Fine Coarse Fine Coarse



Silver Metallic Silver Pearl-Mica

Fig. 1: Appearance of Metallic and Pearl-Mica Samples.

Measuring device consists of illuminator, detector and specimen holder. Illuminator is filtered halogen lamp, and illuminate sample polychromatically. Detector is spectrograph ImSpector (Spectral Imaging Ltd.) and two-dimensional CCD camera, and measures spectral reflectance factor about 2/100 mm square of sample area, 512 points in line. Incident and receiving angle are variable in plus and minus 90 degree each. Wavelength range is 400 to 700 nm, and wavelength resolution is ca, 5 nm. Measurement of 512 points in line is made simultaneously, then sample is moved along the plane of measurement by 2/100 mm. This is repeated 512 times, and measurements of 512 x 512 points on the sample are performed. From spectral reflectance factor of each measured point, tristimulus values are calculated for assigned standard illuminant and standard observer, then transformed to colorimetric values, RGB, L*a*b* or L*C*h.

3. RESULTS

For analysis of measured data, the reports by T. Hirayama et al[2,3] were referred. Fig. 2 shows profiles of lightness of typical samples. In this figure, abscissa indicates spatial frequency, and ordinate shows log. Y (tristimulus value Y). Using these profiles, the following parameters were calcurated.

- IPSL: Integration of Power Spectrum of Low Frequency
  From two dimensional Fourier transform of two dimensional brightness distribution, integration of power spectrum in low frequency, in this case 0 to 4.4 lines/mm.
- PHav: Average Peak Height
  Peak volume, of which brightness is larger than threshold, is divided by peak area.
- PAav: Average Peak Area
  Peak area, which is larger than threshold, is divided by peak number.
- PSav: Average Peak Skirt:
  Average diameter of peak area, which is larger than threshold, is divided by average peak height.

These calculated parameters are also shown in Table 1.

4. CONSIDERATIONS

Fig. 3 shows power spectrum of typical samples, under the geometric condition, 45/0. In these figures, vertical line shows integration range, for calculation of IPSL. It is considered, that these power spectrum changes may be related to the appearance of brilliance of sample surfaces, of which flake shape is dominant.

Table 1: Identification, Flop value and Micro-Brilliance of Samples (Geometric Condition ; -45/0).

upper coart	particle size		ID	F_{LP}	IPSL	YIPSL	PHav	PAav	PSav	YPSav
Silver Metallic	Fine	10	A1	0.0471	0.0881	0.2202	50.4261	12.1797	0.0404	0.0531
	Medium Fine	16	B1	0.0780	0.1509	0.2690	43.8287	13.7360	0.0480	0.0605
	Medium	17	C1	0.0888	0.1603	0.2222	40.8757	13.7220	0.0492	0.0563
	Coarse	27	D1	0.0982	0.2839	0.3722	45.2823	17.7253	0.0506	0.0619
Blue Metallic	Fine	10	A2	0.0447	0.0955	0.1001	29.1708	8.5100	0.0549	0.0615
	Medium Fine	16	B2	0.0771	0.1748	0.1126	27.2801	12.4199	0.0695	0.0721
	Medium	17	C2	0.0868	0.1627	0.0710	23.5937	10.3758	0.0755	0.0744
	Coarse	27	D2	0.0937	0.3909	0.1201	29.1952	15.3221	0.0711	0.0740
Red Metallic	Fine	10	A3	0.0457	0.1010	0.1273	32.3483	10.5498	0.0567	0.0761
	Medium Fine	16	B3	0.0711	0.1369	0.1007	25.6201	11.7229	0.0722	0.0882
	Medium	17	C3	0.0848	0.1556	0.0672	24.7006	12.2947	0.0793	0.0865
	Coarse	27	D3	0.0919	0.2638	0.0937	24.2789	16.3291	0.0878	0.0997
Silver Pearl-Mica (on Black)	Fine	10	Fb	0.0319	0.0614	0.1065	38.6750	7.3478	0.0418	0.0489
	Medium	18	Gb	0.0683	0.1565	0.1724	34.4112	13.4667	0.0594	0.0678
	Coarse	50	Hb	0.0840	0.3036	0.1399	28.6321	16.9520	0.0801	0.0946

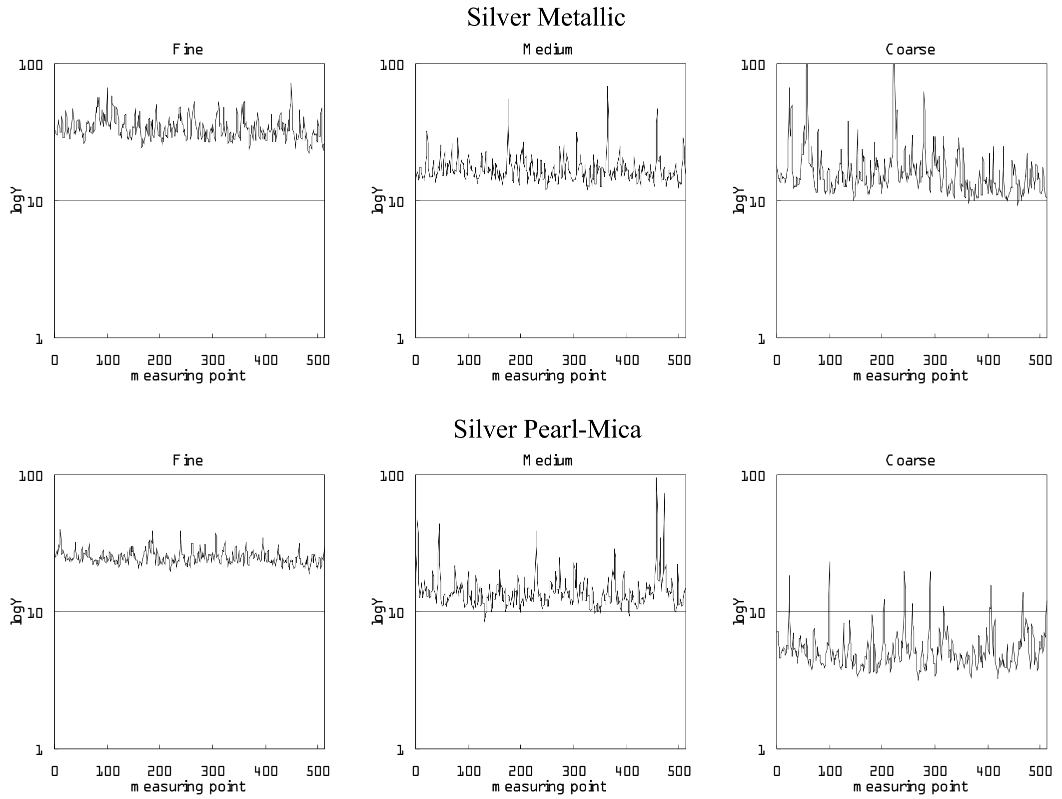


Fig. 2: Profiles (Y vs. Spatial Frequency) of Metallic and Pearl-Mica Samples (Geometric Condition ; -45/0).

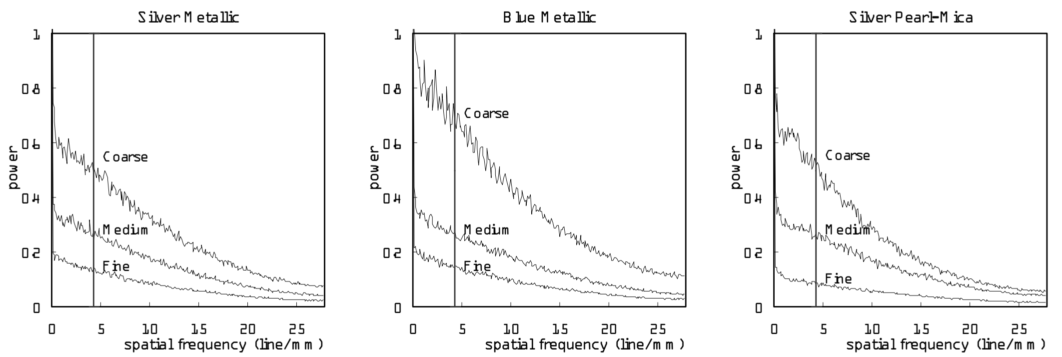


Fig. 3: Power Spectra of Metallic and Pearl-Mica Samples (Geometric Condition ; -45/0).

Fig. 4 shows calculated parameters, IPSL, PHav and PAav, of silver metallic, blue metallic and silver pearl-mica samples. In this figure, F_{LP} means flop value (lightness flop), calculated from macroscopic measurement. In this case, parameters were calculated from profiles, which were obtained from the relation between lightness Y and spatial frequency. Therefore, PHav for silver metallic is higher than that for blue or red metallic, because of absorption in resin layer, but PAav is not so different for silver, blue or red. In the former report, we said lightness flop is firstly affected by the arrangement of flakes in resin layer. In this report, IPSL seems to be mainly affected by the arrangement or particle size of flakes in resin layer, but PHav does not affected by them.

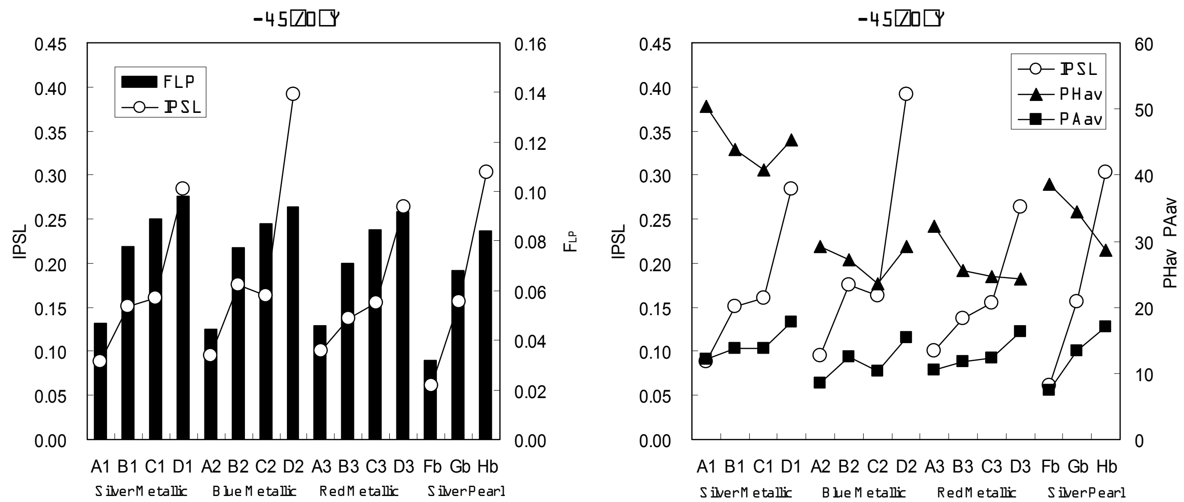


Fig. 4: Flop Value and Micro-Brilliance of Metallic and Pearl-Mica Samples (Geometric Condition ; -45/0).

Acknowledgements

This work is based on portions of the study, titled "To develop and standardize universal testing methods for multicolor (anisotropic color material) color measurement methods" by the Japan Paint Inspection and Testing Association and the Japan Chemical Industry Association, on consignment from the New Energy and Industrial Technology Development Organization (NEDO) to promote development. The support is gratefully acknowledged.

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