『Light Fastness Improvement Method of Aluminum Anodizing and Dyeing Treatment』

Anodizing and dyeing treatment of aluminum alloys has been applying widely to various applications such as mobile phone, digital camera and others, as it can give colorful tone without spoiling its metallic appearance. However, as water soluble organic dyes are applied to dyeing, the color tone will be deteriorated and faded-out by irradiation of light such as ultra-violet ray. As the improvement method of light fastness of dyed aluminum film, we checked the effectiveness of usage of photo-stabilizer or ultra-violet ray absorption agent to aluminum anodized and dyed articles. Under our investigation, we found that the application of hindered amine type photo stabilizer on the dyed article by metallic complex azo dyes among various dyes was extremely effective.

Purpose

In anodizing and dyeing treatment of aluminum alloys, as water soluble organic dyes are applied to dyeing, the color tone will be deteriorated and faded-out by irradiation of light such as ultra-violet ray.

As the improvement method of light fastness of dyed aluminum film, we checked the effectiveness of usage of photo-stabilizer or ultra-violet ray absorption agent to aluminum anodized and dyed articles.

Experiment

[Preparation of Test Specimen]

According to the treatment process shown in Table 1, we applied weak alkaline cleaning, anodizing and dyeing by various dyes (metallic complex azo type, anthraquinone type, phthalocyanine type, xanthene type, triphenyl methane type). And as light fastness improvement method, we applied light fastness improvement treatment by using hindered amine type photo stabilizer, or salicylate type or benzotriazole type ultra-violet ray absorbing agent. After that, we applied nickel acetate type sealing treatment and made the treated items as the test specimen (A1050P 0.5 × 65 × 150 mm).

Table 1 : Treatment Process

Weak Alkaline Cleaning ↓ Water Rinsing	Top Alclean 101 (Okuno's product) : 30 g/L, 60 ℃, 2 min.
Anodizing ↓ Water Rinsing	98%-Sulfuric Acid : 180 g/L, Al3+ : 8 g/L, 20 ℃, 30 min, 1.0 A/dm2 (Film thickness : 10 μm)
Dyeing ↓ Drying	Various TAC Dyes (Okuno's product) : 2 ～ 5 g/L, 55 ℃, 1 ～ 5 min.
Light Fastness Improvement ↓ Drying	Please refer Table 2.
Nickel Acetate Type Sealing	Top Seal H-298 (Okuno's product) : 40 ml/L, 90 ℃, 15 min.

Table 2 : Treatment Condition of Light Fastness Improvement

	No Treatment	A Bath	B Bath	C Bath
Hindered Amine Type Photo-stabilizer	-----	10 g/L	-----	-----
Salicylate Type Ultra-violet Ray Absorbing Agent	-----	-----	10 g/L	-----
Benzotriazole Type Ultra-violet Ray Absorbing Agent	-----	-----	-----	10 g/L
Solvent	-----	Benzene	Benzene	Benzene
Bath Temperature	-----	25 ℃	25 ℃	25 ℃
Treatment Time	-----	1 min.	1 min	1 min

[Light Fastness Test]

We applied light irradiation test on the test specimens by Sun Test XLS+(ATLAS made) using xenon lamp as light resource and Sunshine Weather Meter (Suga Shikenki made) using carbon arch lamp as light resource, and evaluated the color fade-out by color difference before and after test. The color difference (△E※ab) was calculated from L※a※b※ table type color shade (CIE1976) by integrating sphere spectro-colorimeter SP64 (X-rite made).

Result and Consideration

Among various dyes (metallic complex azo type, anthraquinone type, phthalocyanine type, xanthene type, triphenyl methane type), we could confirm the suppression effect of color fade-out on metallic complex azo type dyes by applying light fastness improvement treatment. And also, we could not confirm the significant difference in the suppression effect of color fade-out by the difference of the light resource of xenon lamp and carbon arch lamp.

With reference to the metallic complex azo type dyes which were improved the light fastness remarkably, we wish to show the test results in Photo-1, Photo-2 and Fig-1 ～ Fig-4. The color fade-out of the metallic complex azo type dyes themselves will progress in accordance with increase in the irradiation time of light by decomposition) of dye by photo oxidation. In general, it is said that the hindered amine type photo stabilizer suppresses decomposition of dyes by catching radical formed at photo-oxidation of dye On the other hand, the benzotriazole type ultra-violet ray absorbing agent can prevent absorption of ultra-violet ray by dye by converting the absorbed ultra-violet ray into thermal energy. We think that this difference in the suppression mechanism of color fade-out influences on the strength of light fastness.

In cases of the anthraquinone type and the phthalocyanine type dyes having strong light fastness, and the xanthene type and triphenyl methane type dyes having weak light fastness, we could not detect big suppression effect of color fade-out by even adding of the hindered amine type photo stabilizer or the salicylate type or benzotriazole type ultra-violet ray absorbing agents.

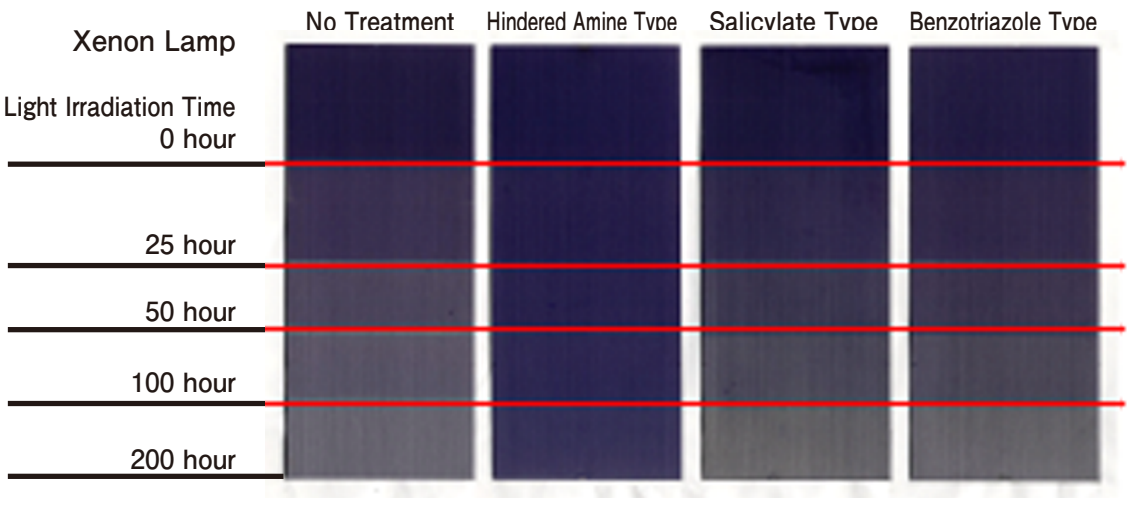

Photo-1 : Influence of Various Light Fastness Improvement Treatments on Light Fastness
[Metallic Complex Azo Type Blue Dyes TAC BLUE-RCD (Blue･501)]

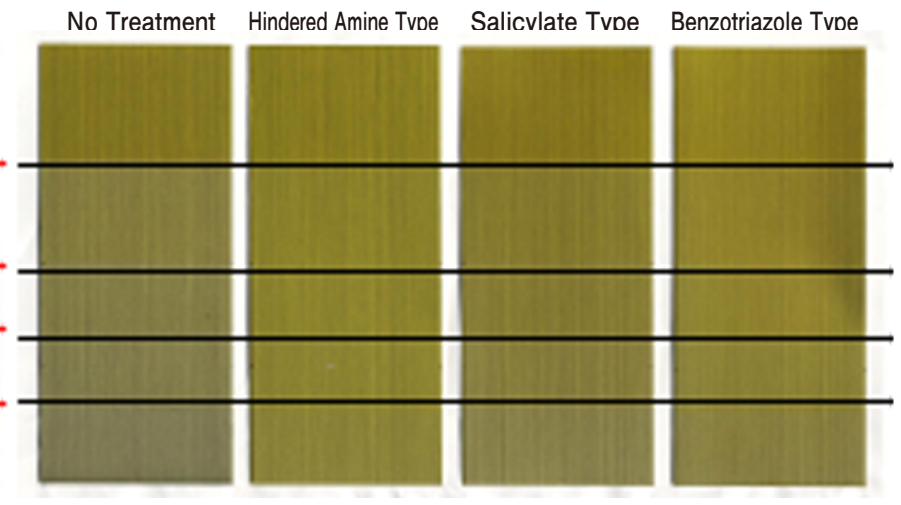

Photo-2 : Influence of Various Light Fastness Improvement Treatments on Light Fastness
[Metallic Complex Azo Type Yellow Dyes TAC YELLOW-RHM (Yellow･201)]

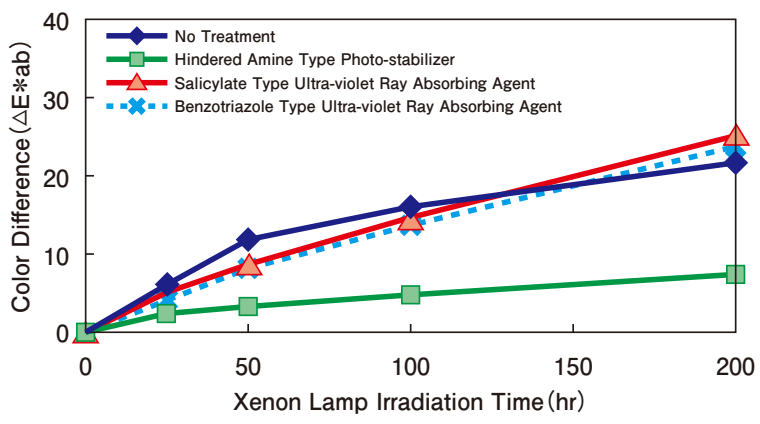

Fig-1 : Relation between Xenon Lamp Irradiation Time and Color Difference
[Metallic Complex Azo Type Blue Dyes TAC BLUE-RCD (Blue･501)]

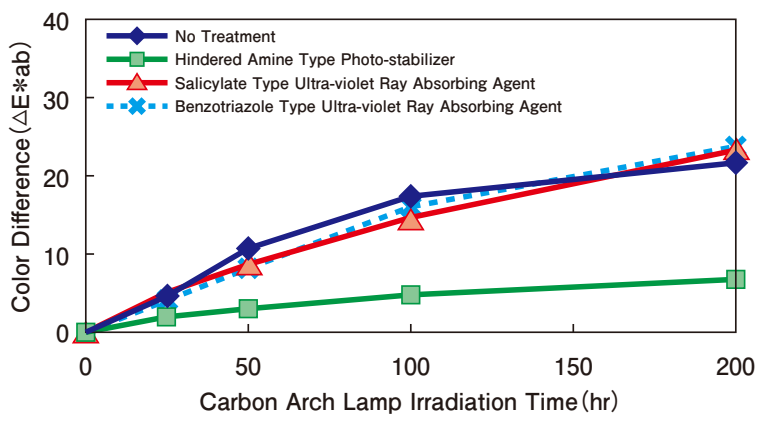

Fig-2 : Relation between Carbon Arch Lamp Irradiation Time and Color Difference
[Metallic Complex Azo Type Blue Dyes TAC BLUE-RCD (Blue･501)]

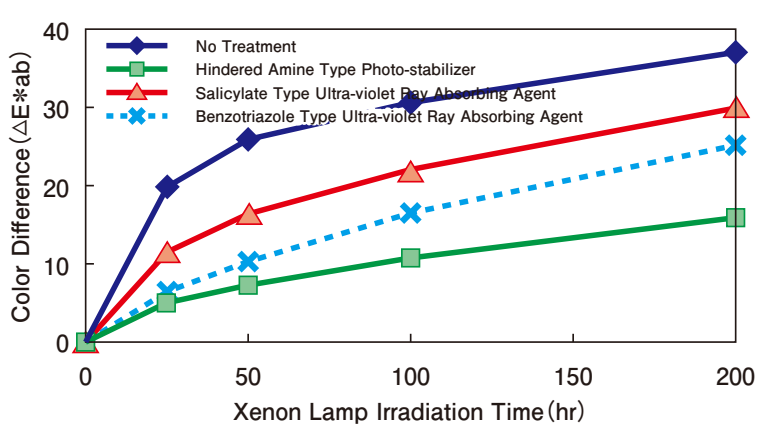

Fig-3 : Relation between Xenon Lamp Irradiation Time and Color Difference
[Metallic Complex Azo Type Yellow Dyes TAC YELLOW-RHM (Yellow･201)]

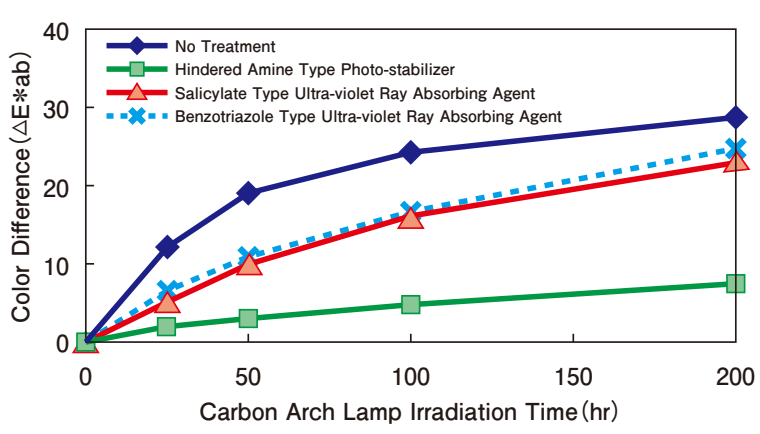

Fig-4 : Relation between Carbon Arch Lamp Irradiation Time and Color Difference
[Metallic Complex Azo Type Yellow Dyes TAC YELLOW-RHM (Yellow･201)]

Conclusion

As light fastness improvement method, we introduced that application of the hindered amine type photo stabilizer on the anodized and dyed articles by metallic complex azo type dyes was extremely effective.

We still have some subjects to be solved on the light fastness improvement treatment bath we used in this test, which we used benzene as solvent and we had to use drying step. In our future innovation, we will study water base solution of light fastness improvement treatment bath in consideration of both environment and industrialization.