Light Fastness Improvement Method of Aluminum Anodizing and Dyeing Treatments

Anodizing and dyeing treatment of aluminum alloys has been applied widely to various applications such as mobile phones, digital cameras 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 dye article by metallic complexazo dye 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 this 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 alkalis, anodizing, dyeing by various dyes (metallic complexazo type, anthraniline 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 (A050F 0.5 x 0.5 x 150 mm).  

**Table 1: Treatment Process**

<table>
<thead>
<tr>
<th>Weak Alkali Cleaning</th>
<th>Anodizing</th>
<th>Dyeing</th>
<th>Light Fastness Improvement</th>
<th>Nickel Acetate Type Sealing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Alkillon 103 (Okuno’s product)</td>
<td>30 g/L</td>
<td>60 °C, 2 min.</td>
<td>Various TAC Dyes (Okuno’s product): 2 g/L</td>
<td>Top Seal H-298 (Okuno’s product): 40 mL/L</td>
</tr>
</tbody>
</table>

**[Light Fastness Test]**

We applied light irradiation test on the test specimens by Sun Test XLS (ATLAS) made using xenon lamp as light source and Sunlight and Sunlight Weather Meter (Suga Shikenso) made using carbon arc lamp as light source, and evaluated the color fade-out by color difference before and after test. The color difference (ΔE (L*a*b) was calculated from CIELAB table color code shade (CE15976) by integrating sphere spectrophotometer SPD4 (V-line).

**Result and Consideration**

Among various dyes, metallic complexazo dyes, anthraniline type, phthalocyanine type, xanthene type, triphenyl methane type, we could confirm the suppression effect of color fade-out on metallic complexazo dyes by applying light fastness improvement treatment. Also, we could not confirm the significant difference in the suppression effect of color fade-out by the difference of the light source of xenon lamp and carbon arc lamp.

With reference to the metallic complexazo 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 fading of the metallic complex type dyes themselves will progress in accordance with the increase in the irradiation time of light by decomposition of dye by photodegradation. In general, it is said, that the hindered amine type photo stabilizer suppresses decomposition of dye 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 ultraviolet-ray by dye by converting the absorbed ultraviolet-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 anthraniline type and the phthalocyanine type dye 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.

**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 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 dyeing bath. In our future innovation, we will study water base solution of light fastness improvement treatment bath in consideration of both environment and industrialization.

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