한국가구학회지(Journal of the Korea Furniture Society)
Vol. 26, No. 4 October, 2015, 467-473

Characteristics of Color Differences of Rainbow-Colored Veneers by Fading Test

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Abstract: Natural dyeing is considered to be an alternative to chemical staining in terms of harmful VOC-free and environmentally-friendly ingredient. This study was concerned with an evaluation of color performance of naturally dyed- and painted veneer for cylindrical laminated veneer lumber etc. according to the used condition in terms of existence of light and heat in drying. From the results, the color changes by the color of dyed veneer and the type of paint are likely to be affected by fading condition of light or heat. In the future, long-term outdoor exposure test needs to be additionally followed in order to evaluate durable usability of colored veneers.

Keywords: *natural dyeing, chemical staining, naturally dyed- and painted veneer, color changes, fading condition of light or heat*

1. Introduction

Research on the cylindrical laminated veneer lumber (LVL) of a shape filled with small diameter thinned log at center or a center-hollow shape aimed at structural use etc. was accomplished (Korea Forest Research Institute 2011-2013). In addition to this use, when the cylindrical LVL is cut in radial direction, the round-shaped dish plate would be made. When this plate is diversely colored, this material could be changed into good handicraft or interior use such as table top, wall decoration, cylindrical clocks, etc.. Also, if cylindrical LVL is wrapped with 2 or 3-ply dyed fancy veneer, this LVL could be made into columns in substitution for log. For these purposes, rainbow-colored veneers were manufactured with natural dyes.

2015년 7월 23일 접수; 2015년 9월 30일 수정; 2015년 10월 1일 게재확정
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In relation to this study, the resistance to abrasion and surface hardness at cross section and tangential section of cylindrical LVLs which were treated with transparent-type paintings were assessed (Suh et al. 2012). Also, resistances to discoloration of Korean pine, radiata pine, and yellow poplar veneers treated with paints of crack seal clear paint and Osmo paint (UV protection paint), using natural dyes of sappan wood, Amur cork tree, and indigo, after fading tests for 96 hours were studied (Kim et al. 2013). In addition, 9 types of natural dyes which are Amur cork tree, sappan wood, picramnia wood, marsh marigold, persimmon, gallnut, persimmon · gallnut, polygonum indigo, and pyroligneous liquor were colored on radiata pine veneers with aids of Korea Traditional Dye Institute. Then light fastness on natural dye-colored and painted cylindrical LVLs specimens was evaluated through the light-fading test (Kim et al. 2012). It was reported by the above

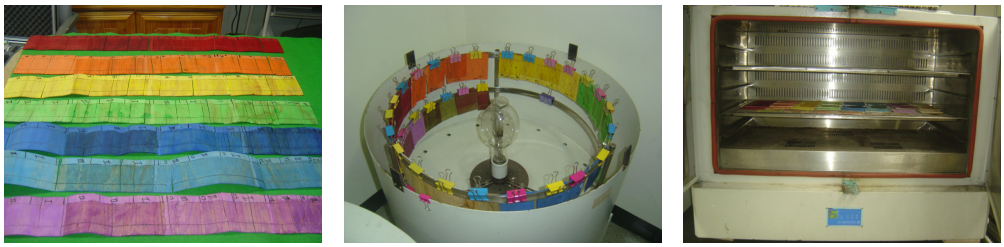


Fig. 1. Dyed- and painted veneer specimens and fading test instruments by light and heat.

test that a significant color differences were found out at dyeing of sappanwood and persimon. Also, Korean pine, radiata pine, yellow poplar, and Japanese cypress veneers were colored with natural dyes which were extracted from sappan wood, polygonum indigo, gardenia-mixed Amur cork tree, and then painted with crack seal and UV protection oil. Arc-light fading test for 8 days was performed with these dyed- and painted veneers and color differences were investigated (Suh et al. 2013). In this natural dyeing- and painting tests, color difference of gardenia-mixed Amur cork tree was generally the highest, and that of polygonum indigo was the lowest. The color difference-decreasing effect by finishing was shown in crack seal clear and UV protection oil. In result, the maximum values of color difference after fading for 8 days were recorded between 16 to 20, which are remarked 'very much' of 12.1 or more when reviewed with 'National bureau of standards unit in USA'. In order to evaluate appropriateness of these rainbowish natural dyed- and painted veneers for interior or exterior use, the fading test by arc light was carried out in this study. Also, the heating in oven dryer were performed by heating conditions encountered at a processing to manufacture colored panel such as drying or hot pressing. Their color changes after both fading tests were evaluated.

2. Materials and Methods

Radiata pine veneers (thickness 2.6 mm) obtained from plywood manufacturing company were used for dyeing, and then rainbow-colored with natural dyes prepared at Korea Traditional Dye Institute (Suh et al. 2015)(refer Fig. 1). 7 tones-colored veneers were dried under sunlight, and then fading tests by illumination of arc light for 8 days and an increased heating of 60°C-80°C-100°C by 2 days each were performed, respectively. After fading test, color differences were measured by portable spectro photometer (model : Konica Minolta CM-700D).

3. Results and Discussions

3.1. Fading test by illumination of arc light indoors

When viewing the chromaticity of natural dyed veneers, Lightness (L*) was the highest at yellow color, a* was the highest at orange color, and b* was the highest at yellow color. On the contrary, L* was the lowest at red color, a* was the lowest at green color, and b* was the lowest at blue color.

Color difference after fading test for 8 days generally except for yellow colored- and non-dyed- veneers were the greatest at non-painting treatment, and the lowest at treatment of crack-seal clear paint or exterior osmo paint. The range of color differences at the hue of colored

Table 1. Chromaticity of Natural Dyed Veneers

Types of hue color	L*	a*	b*
Non-dyeing	75.8 / 71.5	5.5 / 6.8	22.5 / 20.0
Red	52.0 / 50.0	16.6 / 17.7	8.6 / 8.4
Orange	67.0 /67.3	26.6 / 30.9	26.0 / 27.3
Yellow	76.6 / 77.6	5.4 / 4.2	39.0 / 40.7
Green	70.2 / 70.9	-15.5 / -14.6	24.4 / 23.0
Blue	53.5 / 54.7	-4.5 / -4.2	-12.6 / -13.2
Indigo	62.5 / 60.4	-8.7 / -8.5	-6.1 / -9.2
Purple	63.1 / 61.6	13.4 / 15.0	-1.3 / -3.5

Note) The figures of front and behind of slash (/) are chromaticity values of veneers before fading test by light and heat, respectively.

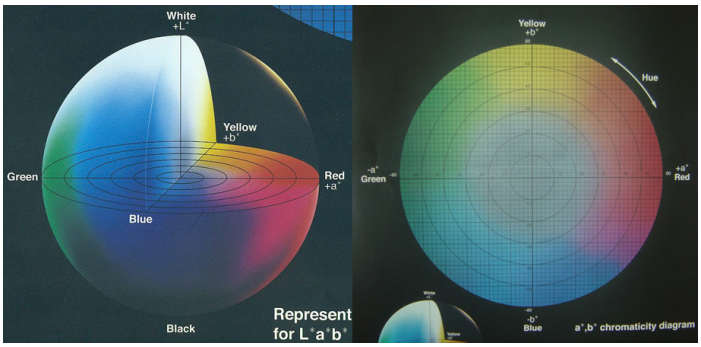


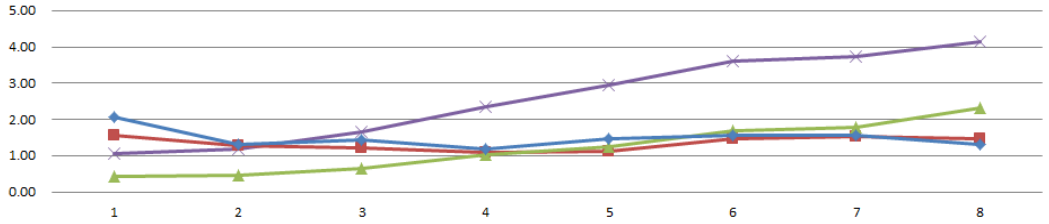
Fig 2. Chromaticity diagram marked with L*, a* and b*.

veneer was purple (0.3-10.8), blue (0.6-5.1)), orange (0.7-4.9), indigo (0.2-4.7), non-dyeing (0.6-4.2), red (0.4-4.1), green (0.7-3.6)), yellow (0.6-2.4).

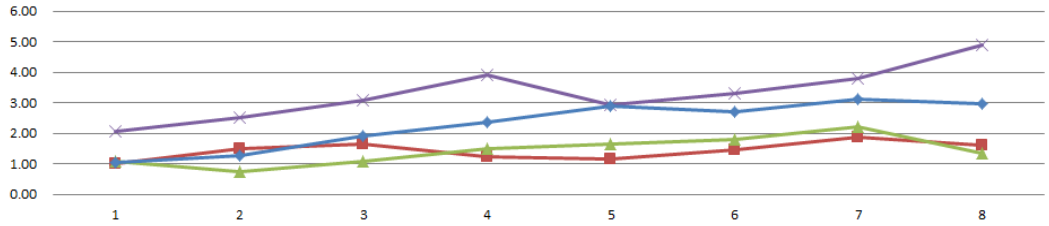
When assessing the obtained color difference values by 'National Bureau of Standards Unit in USA' as in Table 2, the purple color of 10.8 ($\triangle E^*_{ab}$) was remarked at 'much' grade. The other colors except for purple color were classified as 'appreciable' grade. The yellow color of 2.4 ($\triangle E^*_{ab}$) was included in 'noticeable' grade.

3.2. Fading test by heating in oven dryer

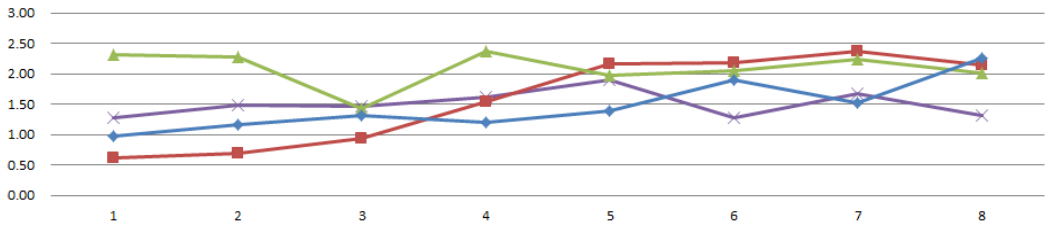
The color differences of colored veneers from test of increased heating at 60°C-80°C-100°C by 2 days each were shown in Fig. 3. The range of color differences at the hue of colored veneer was purple (0.8-9.6), green (0.8-8.3), indigo (1.0-8.2), yellow (0.5-7.8), blue (0.6-5.4), non-dyeing (0.6-5.3), orange (0.6-2.4), red (0.5-1.5). Compared to fading test results by arc light, discolorations at red- and yellow-colored veneers by heating in oven dryer were lower, however the other hue colored veneers represented greater discoloration on the occasion of heating. In particular, greater discoloration was brought about by heating at yellow colored veneer which is harmonized with a basic color of radiata pine veneer compared to an illumination of light. The purple colors were most unstable at both treatments of arc light illumination and heating. The reason why the purple color was most unstable might be oxidation of alkaline ingredient in the polygonum indigo dyeing process. According to heat treatment, dif-



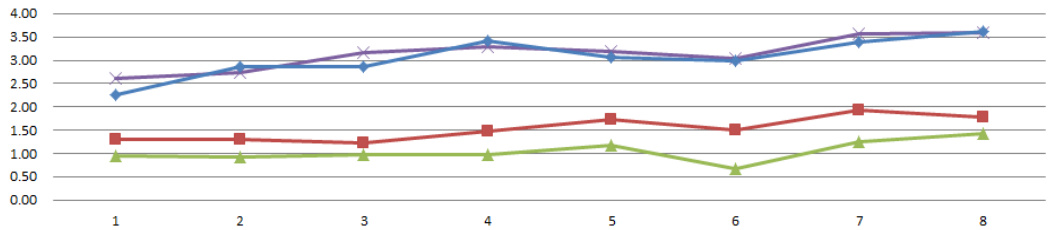
Red-colored veneer



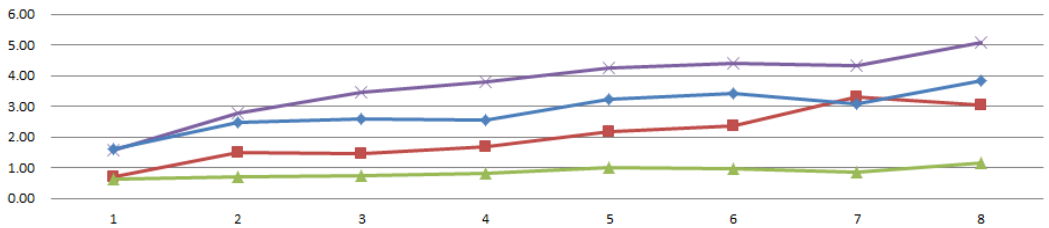
Orange-colored veneer



Yellow-colored veneer



Green-colored veneer



Blue-colored veneer

Fig. 3. Color differences according to 4 types of painting of dye-colored veneers after fading tests by illumination of arc light for 8 days.

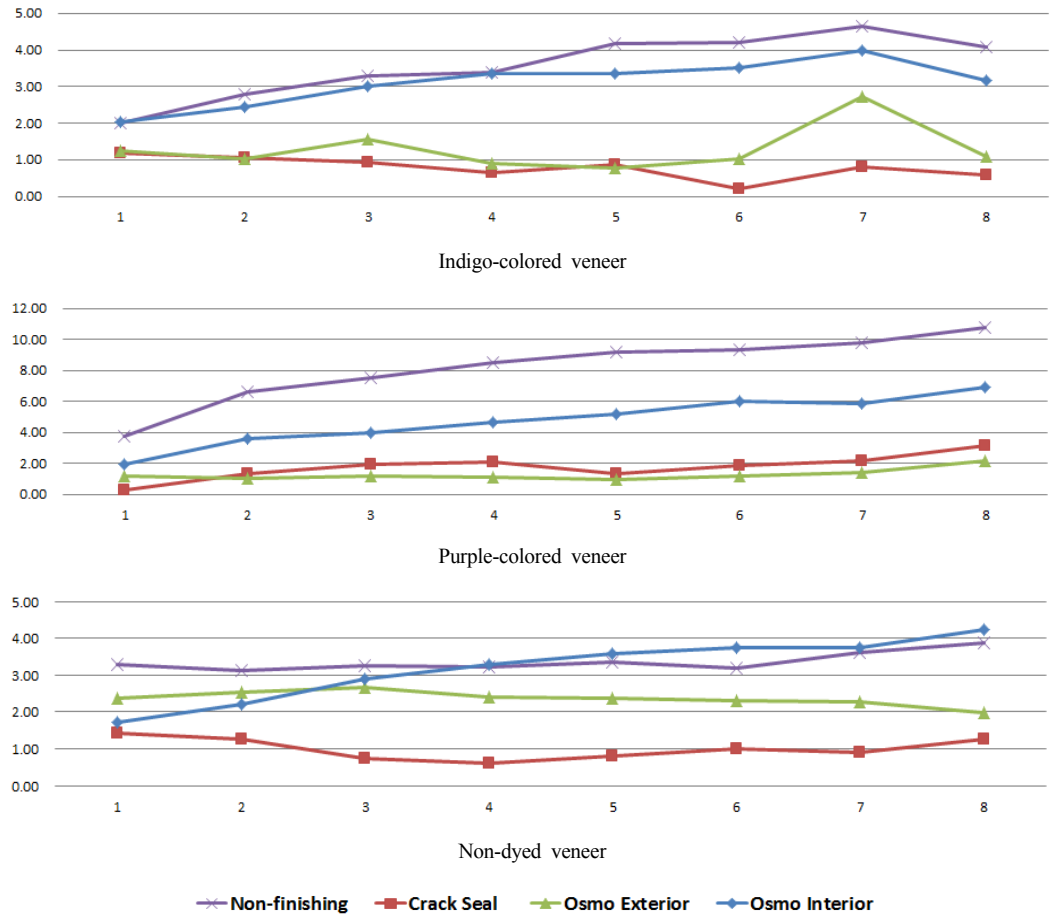


Fig. 3. Continued.

ferently from discoloration test by arc light, osmo paint for interior and exterior use led to a great discoloration tendency.

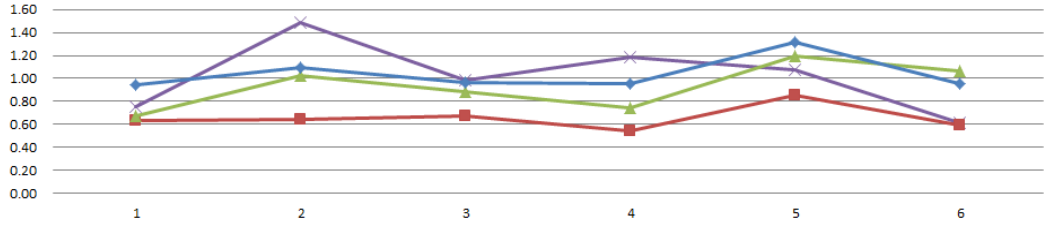
In the assessment of color differences applying Table 2, Purple, green, indigo, and yellow colors were within the range of 'much' grade. Yellow color and non-dyeing showed 'appreciable' grade. Orange and red colors were contained in 'noticeable' and 'slight' grade, respectively.

Table 2. National Bureau of Standards Unit in USA

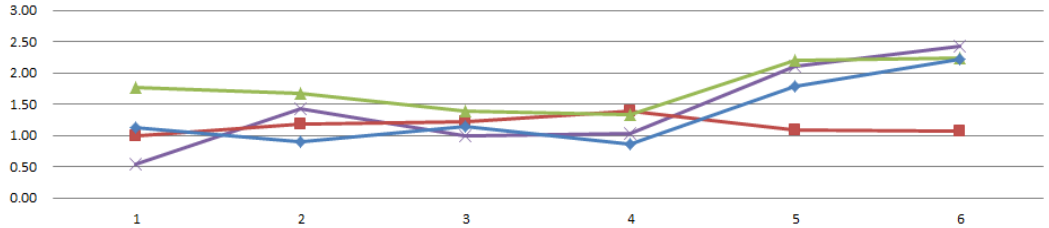
ΔE^*_{ab}	Critical remarks of color differences
0.0~0.5	Trace
0.6~1.5	Slight
1.6~3.0	Noticeable
3.1~6.0	Appreciable
6.1~12.0	Much
12.1 or more	Very Much

4. Conclusions

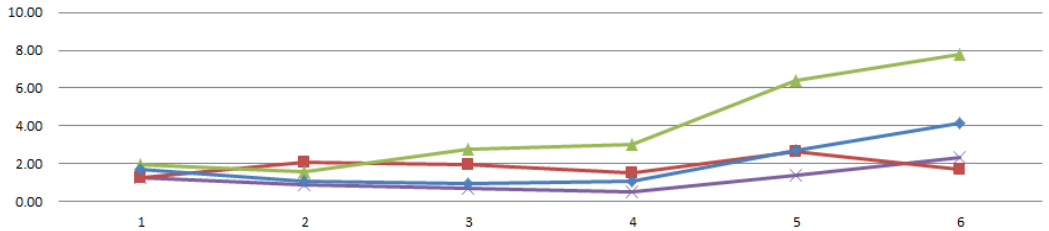
Natural dyeing is considered to be an alternative to chemically staining in terms of harmful VOC-free and environmentally-friendly ingredient. This study was concerned with an evaluation of color performance of naturally dyed- and painted veneer for cylindrical laminated veneer lumber etc. according to the used condition in terms of



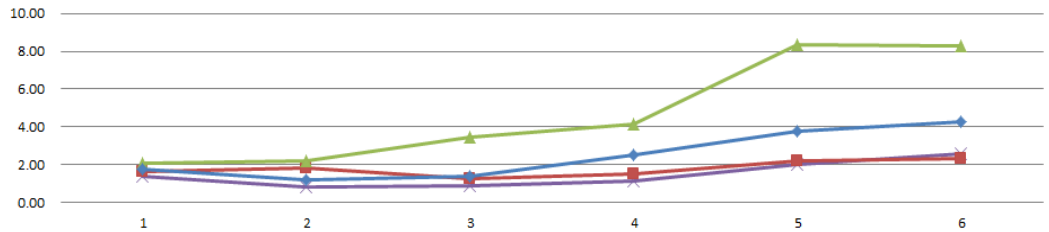
Red-colored veneer



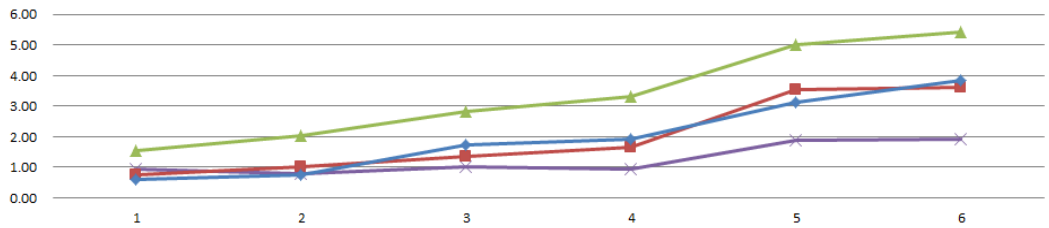
Orange-colored veneer



Yellow-colored veneer



Green-colored veneer



Blue-colored veneer

Fig. 4. Color differences according to 4 types of painting of dye-colored veneers after fading test by increased heating of 60°C-80°C-100°C by 2 days each.

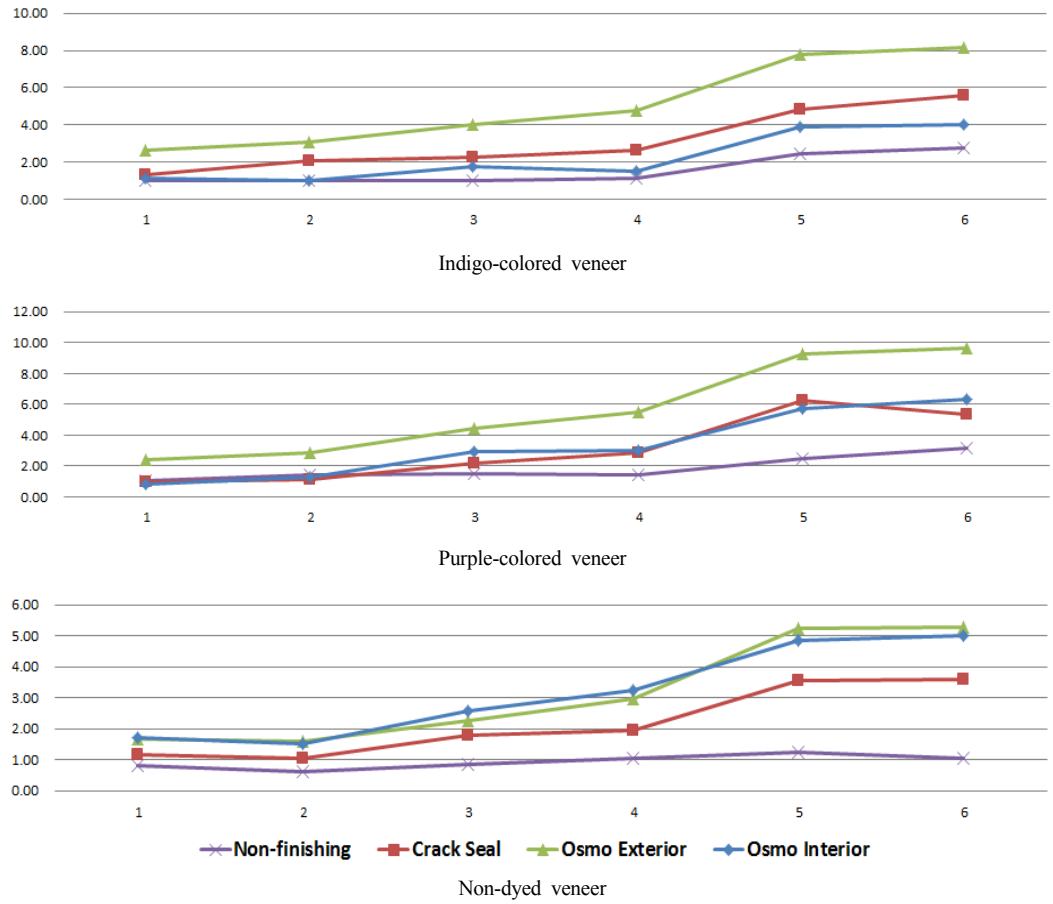


Fig. 4. Continued.

existence of light and heat in drying. From the results, the color changes by the color of dyed veneer and the type of paint are likely to be affected by fading condition of light or heat. In the future, long-term outdoor exposure test needs to be additionally followed in order to evaluate durable usability of colored veneers.

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