Fresco a fruit of Renaissanse art, successfully industrialized.

Sistine chapel in the Vatican, Rome, Italy (16C)

TOKUYAMA has successfully industrialized fresco, a fruit of Renaissance art, for the first time in the world by merging the following cutting-edge technologies:

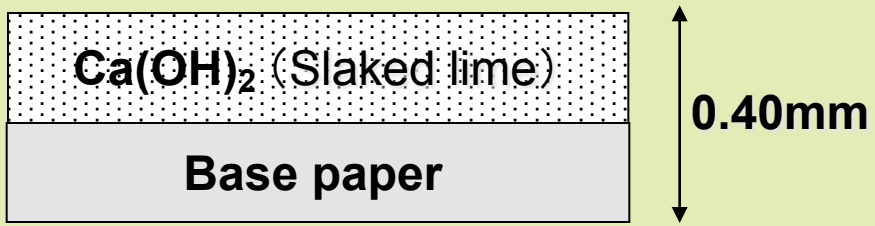
1. Forming slaked lime into sheets
2. Pigment ink-jet technology

This success has enabled the reproduction of fresco by using an ink-jet printer. The name **“Fresco Giclee”** has been given to this technique. This product is slaked lime sheeting that is printable by using an ink-jet printer.

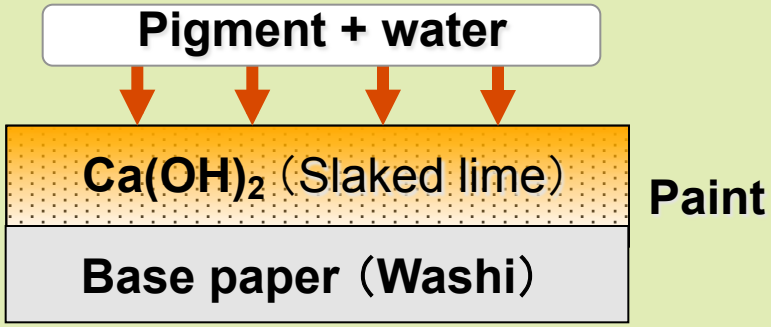
Technique of “Fresco Giclee（FG）”

①Slaked lime have combined on the base paper.

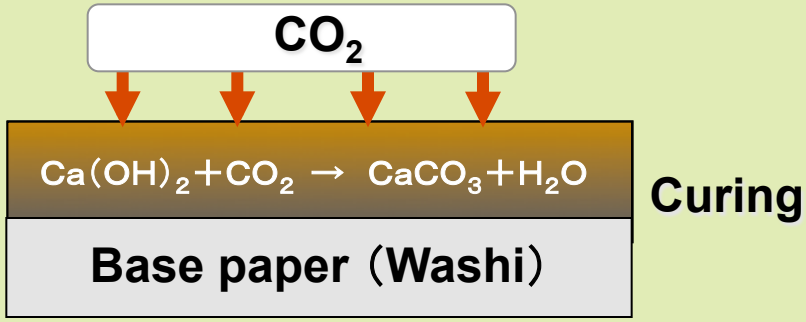
Product size W=914mm L=10m



②Print on the surface of the "slaked lime" by "Ink-jet Printer of water" within 1 day.



③ Pigments are made fixed by the carbonation reaction.



Comparison of “Tempera” with “Fresco”

Tempera

『 The Last Supper / Da Vinci 』

This painting was painted on a dry slaked lime wall by “tempera” that is created by pigments and egg yolk.

Good : Easy painting
Bad : Early degradation

This method became popular as oil painting

Fresco

『 The Last Judgment / Michelangelo 』

This painting was painted on a wet slaked lime wall by pigments mixed with water and no binder.

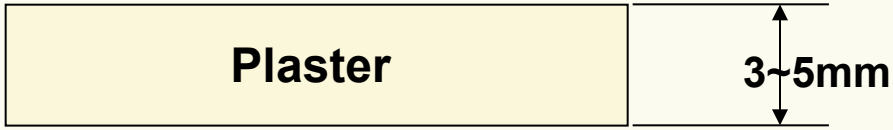
Good : High color sustainability
Bad : Many constraints for painting

Few painters are using this method

Technique of “Fresco”

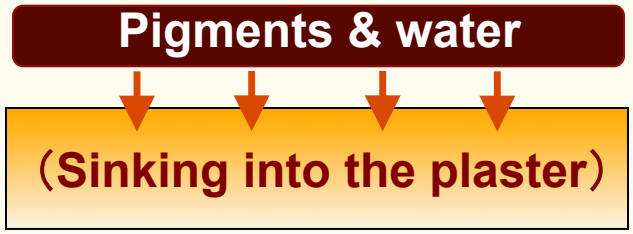
①Coating

A wall is coated with plaster (main component : slaked lime) only the area which can be painted in one day.



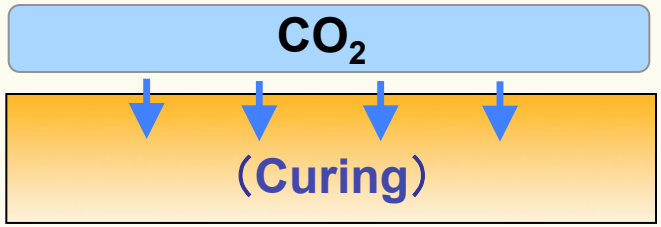
②Painting

Painting is finished before curing. (about 8 hrs.)



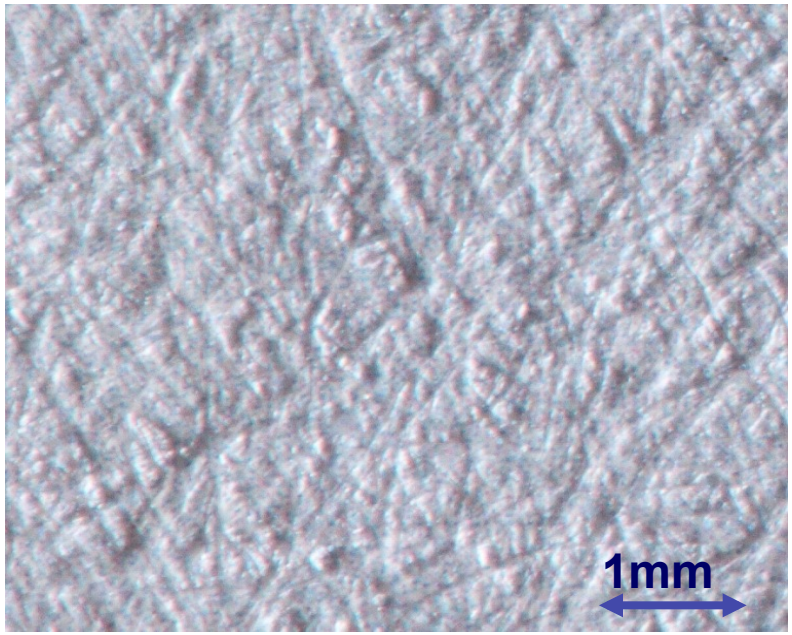
③Curing

After painting, the picture is cured with CO_2 by carbonation.

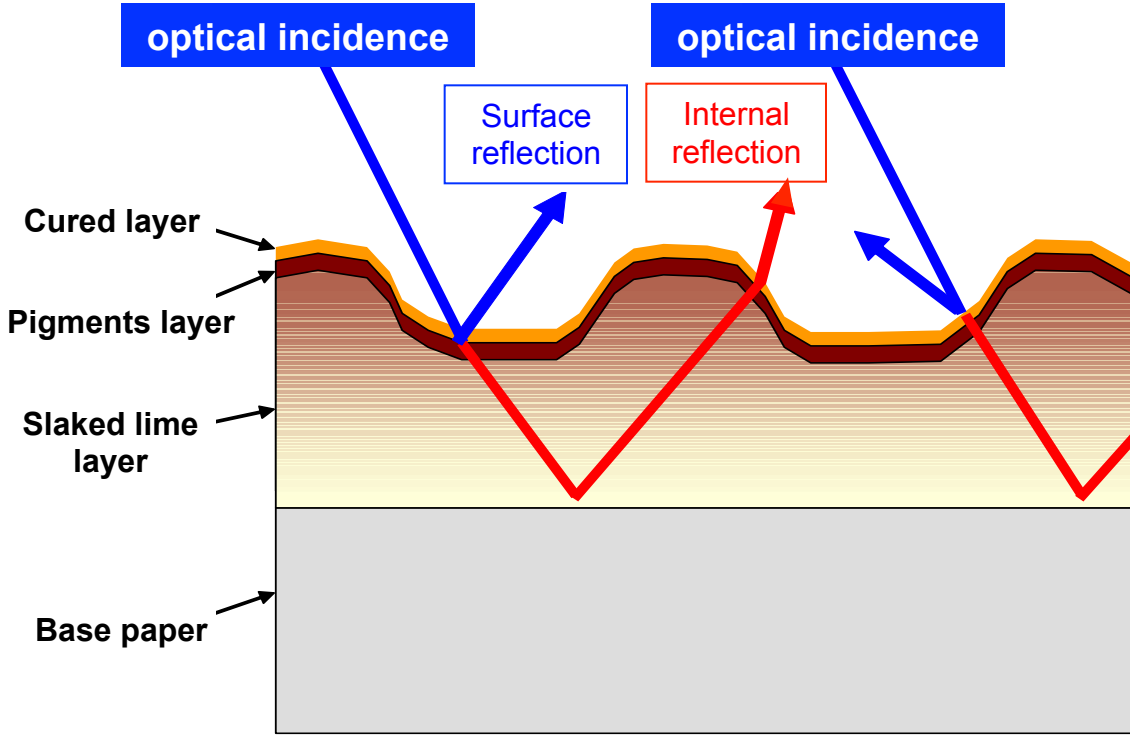


$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

Natural depth feel by “Fresco Giclee”

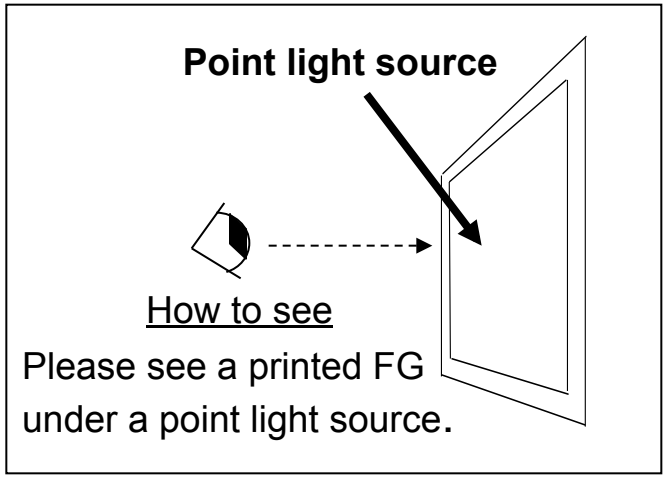


magnified image of printed FG surface

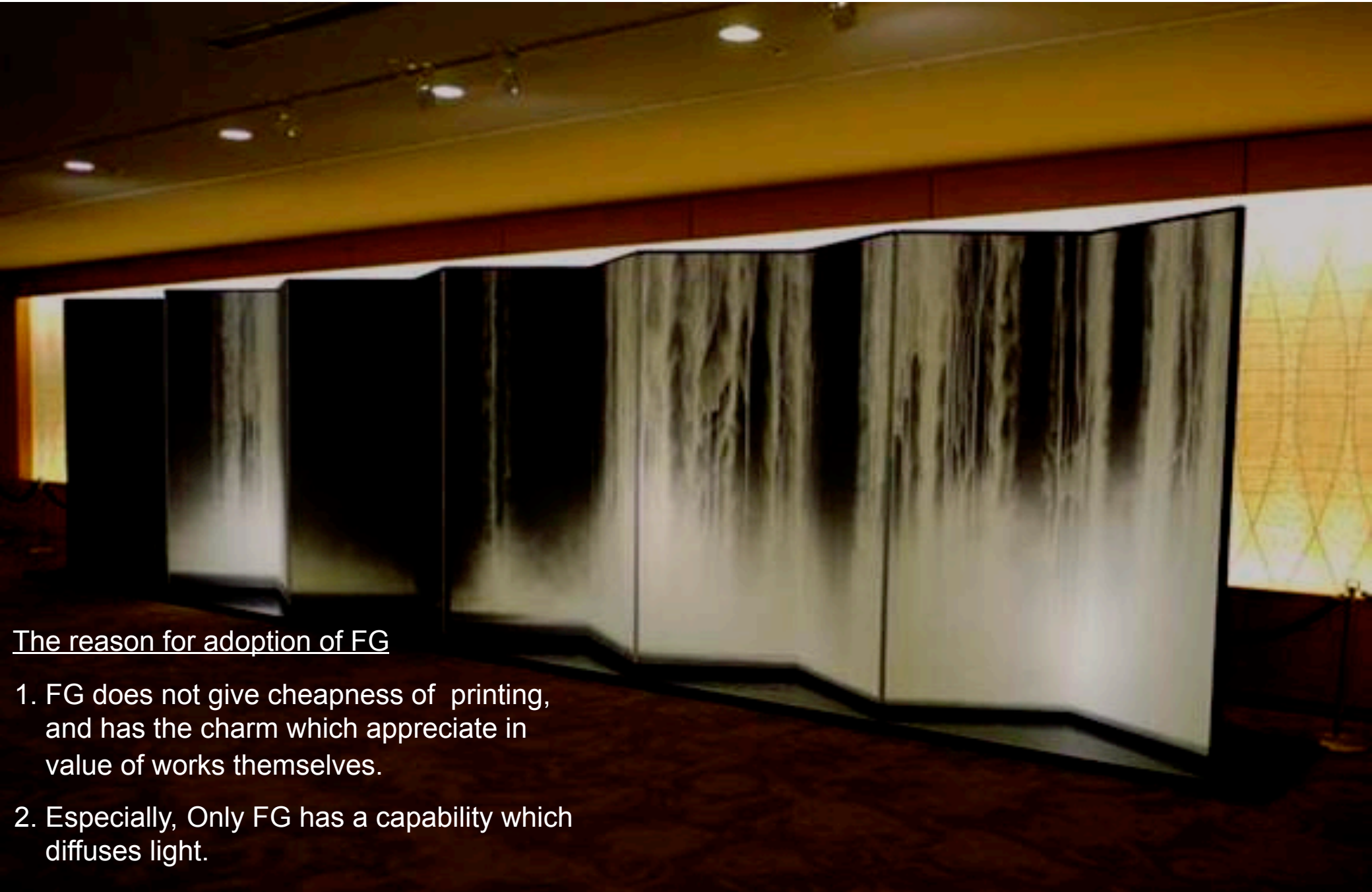


- Surface asperity of FG hides the ink dot of IJ printer.（dot size : about 30μm）

Discontinuous asperity of surface of FG（asperity size : 50~300μm）and light permeability of slaked lime layer causes dispersion of incident light intricately as shown in an upper right figure, and it gives natural depth feel like photorealism.



The works of FG by Mr. Hiroshi Senju (Japanese-style painter) in APEC2010



<u>The reason for adoption of FG</u>

1. FG does not give cheapness of printing, and has the charm which appreciate in value of works themselves.
2. Especially, Only FG has a capability which diffuses light.

The works of FG by Mr. Hiroshi Senju in Haneda airport

<u>The reason for adoption of FG</u>

The works need highly light proof that FG has because sunlight shine on them through windows.

The works of Fresco by Mr. Hiroshi Senju a certain hotel in Tokyo

The works of Fresco by Mr. Hiroshi Senju “EKOIN” in Tokyo

Pictures which can be removed

The concept of “Fresco Print”

Traditional method

Color sustainability of “fresco”

fusion

Newest technology

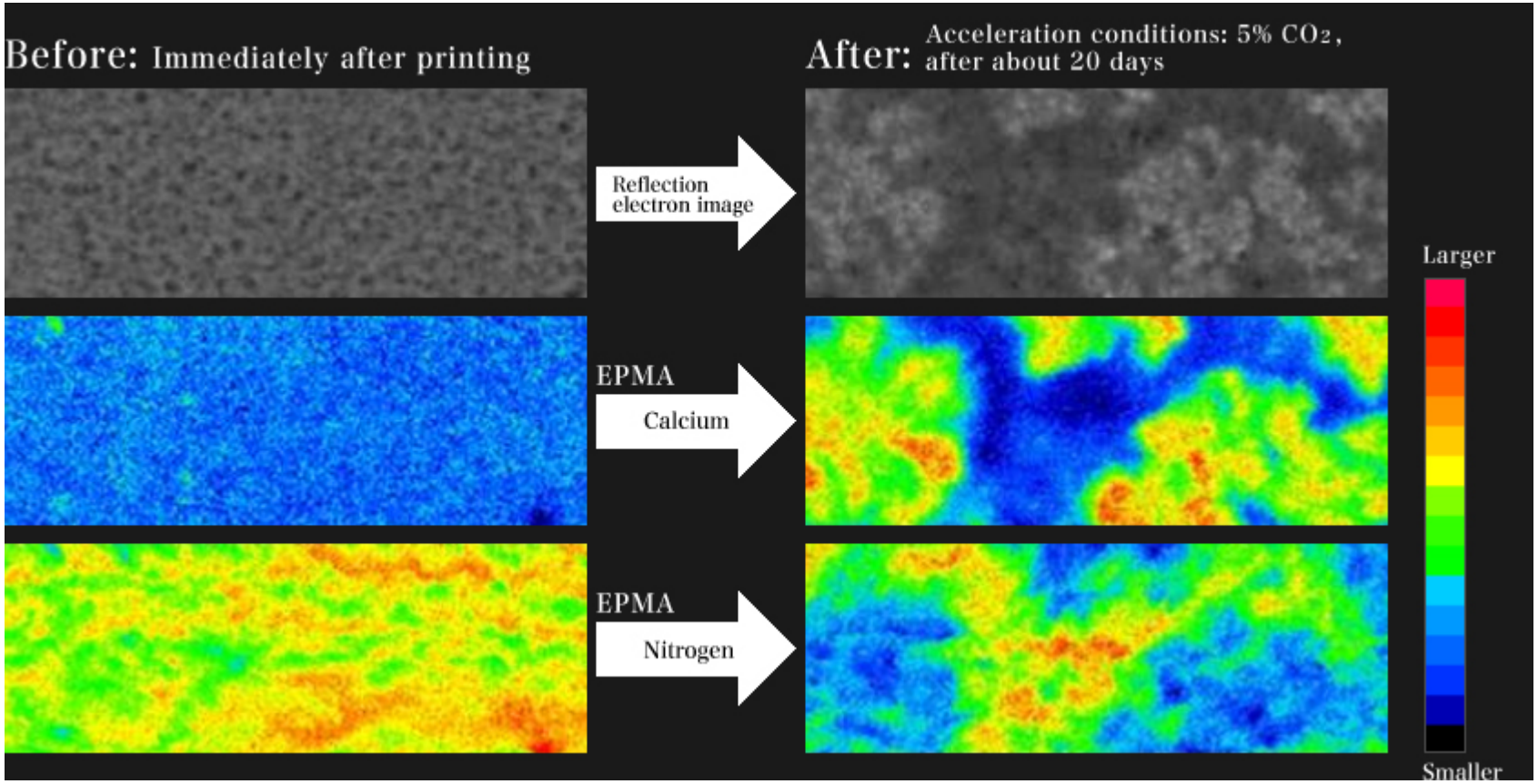
Manufacturing technology of slaked lime sheet

Digital - inkjet printing technology

Goal of Fesco Giclee

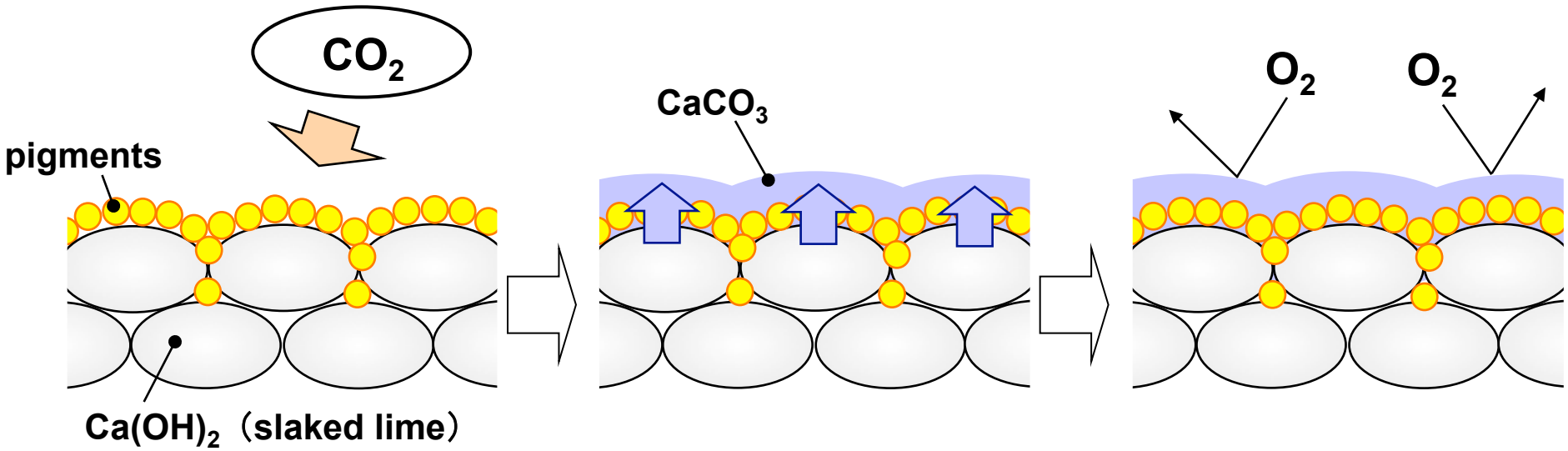
“Durability that exceeds generation”

Element Analysis on the Plaster Surface Before／After the Carbonation



Utilizing an **Electron Probe Micro Analyzer (EPMA)**, we performed element analysis before/after the carbonation on portions where pigment ink exist overall by using sheets on which pigment ink was printed.
Calcium and nitrogen were utilized as the detection element.
Immediately after printing (before the carbonation), almost no contrast could be seen on the reflection electron image. A large amount of nitrogen contained in the pigment ink was detected, whereas not much of calcium was detected.
After the carbonation, however, a clear contrast appeared on the reflection electron image. A large amount of calcium was detected in the bright areas of this image, while a large amount of nitrogen was detected in the dark areas.
This result suggests that a thin film of **$CaCO_3$**, which was extracted by the reaction of the plaster with **CO_2** in the air. This film covers the pigment ink surface.

Mechanism of improvement in image preservation



$Ca(OH)_2$ is carbonated by CO_2 in air passes through the pigments layer.

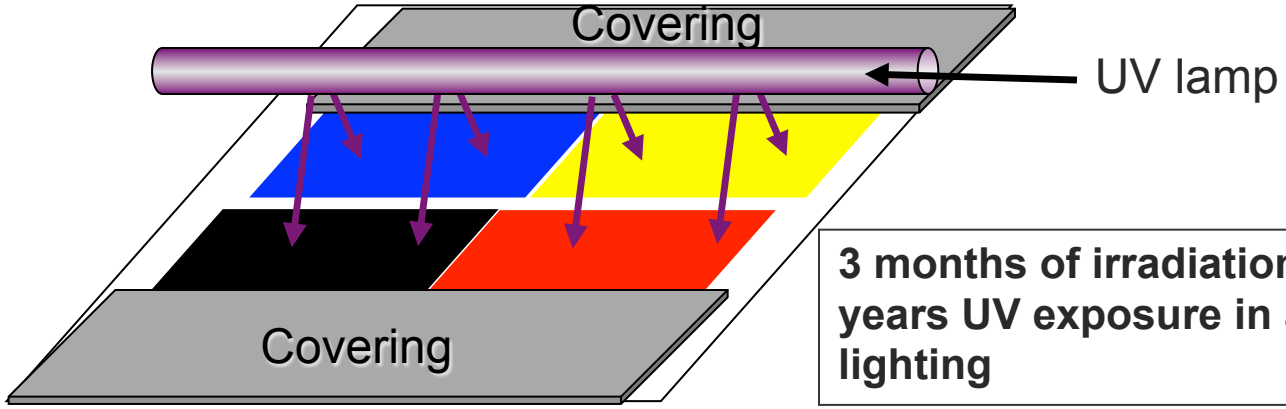
By the Carbonation reaction, $CaCO_3$ layer is formed on the surface. And this layer includes pigments.

The $CaCO_3$ layer protects the pigments from degradation. And visible light can pass through the layer.

In the case of printing by IJ printer which is used pigment ink, FG shows light proof higher than general IJ papers. From the results of elemental analysis for the printed surface of FG, the pigments (organic compound) are covered with the $CaCO_3$ layer which is produced by carbonation after printing, and it reveals that this layer prevents the pigments from oxidation degradation.

Color Feeding Test by Irradiating UV

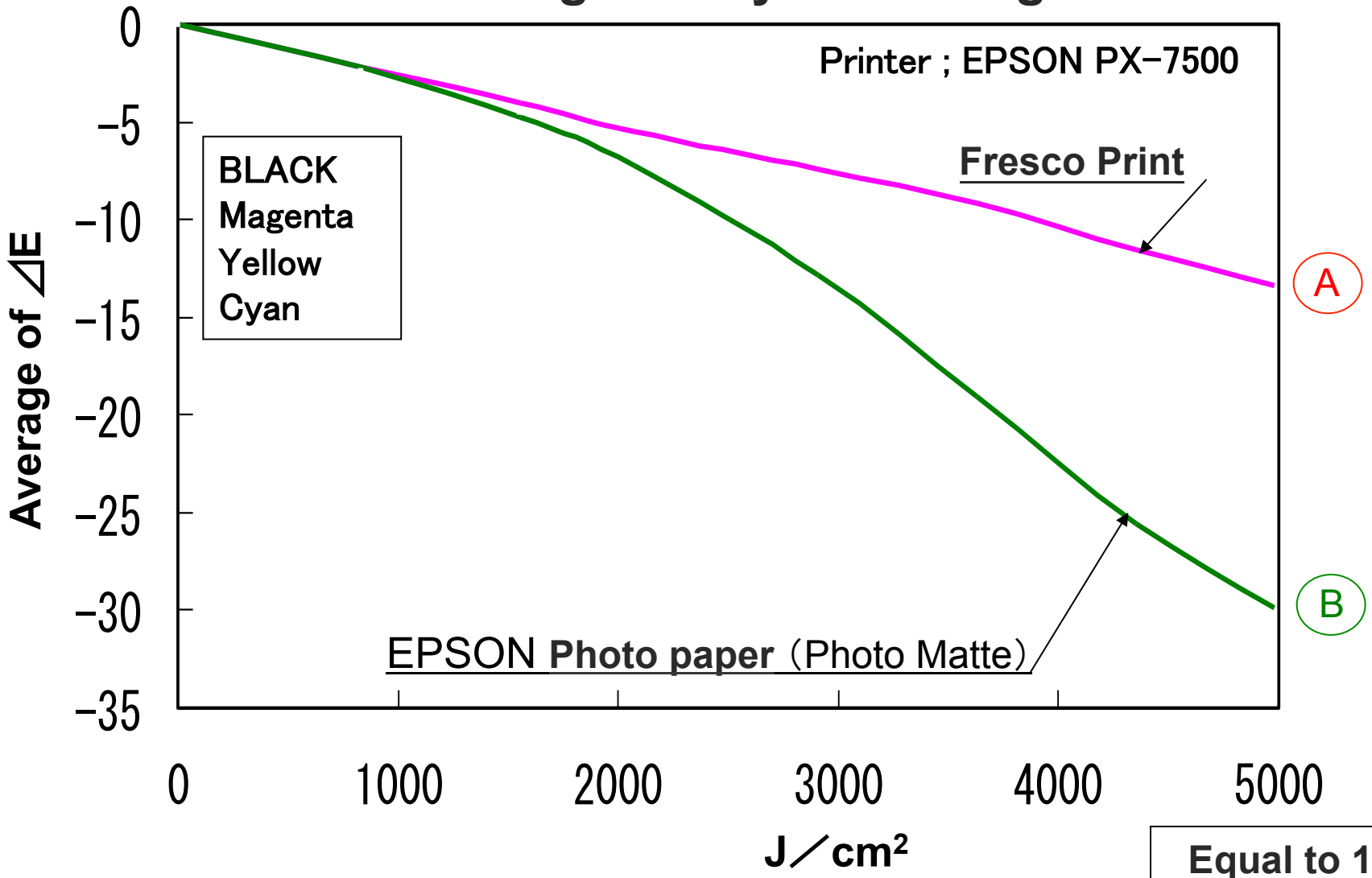
①Comparison test
Fresco Print vs. EPSON Photo Paper
②Printing
Print black, magenta , cyan and yellow patterns on both sheets by Epson ink jet printer, then cover a half.
③Irradiate UV for 3 month.
④Analyze ⊿E* at covered and uncovered area by color computer, and compare averages of ⊿E* as a index of fading.



3 months of irradiation in this test is equal to 120 years UV exposure in an atmosphere of normal lighting

Fresco Print vs. Photo paper

Color Feeding Test by Irradiating UV

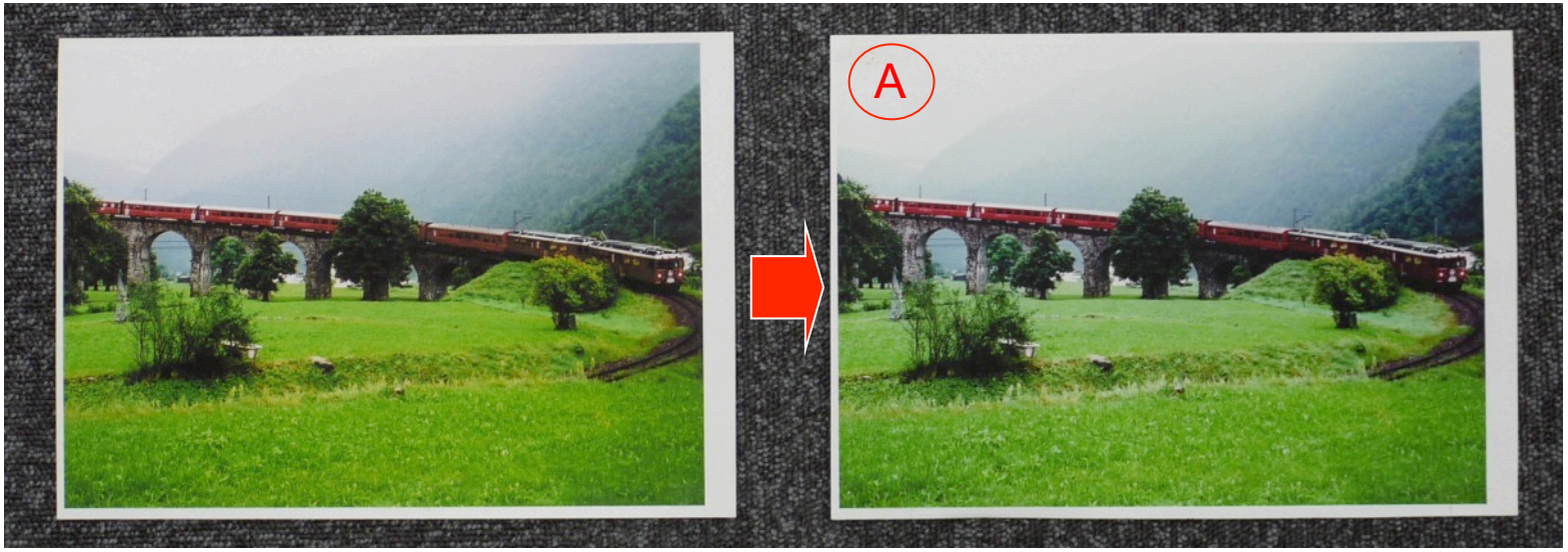


Equal to 120 years UV

Fresco Print

Printer ; EPSON PX-7500

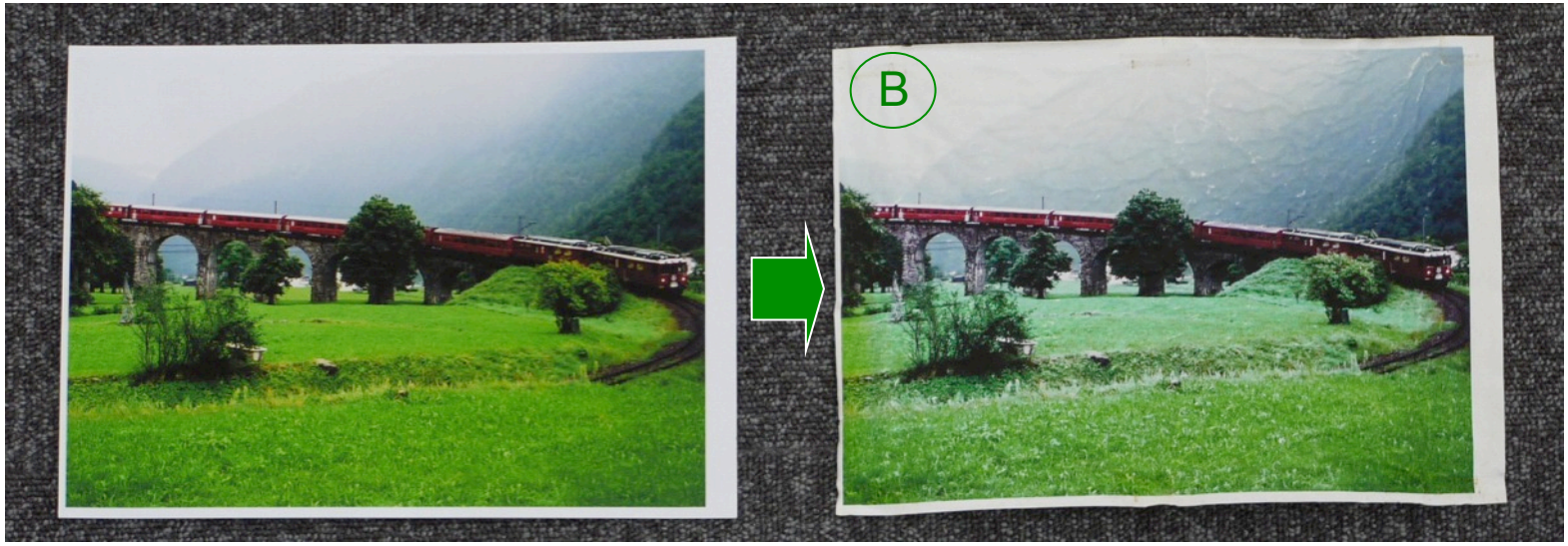
Before | **After The Color Feeding Test (5,000J)**



EPSON Photo matte

Printer ; EPSON PX-7500

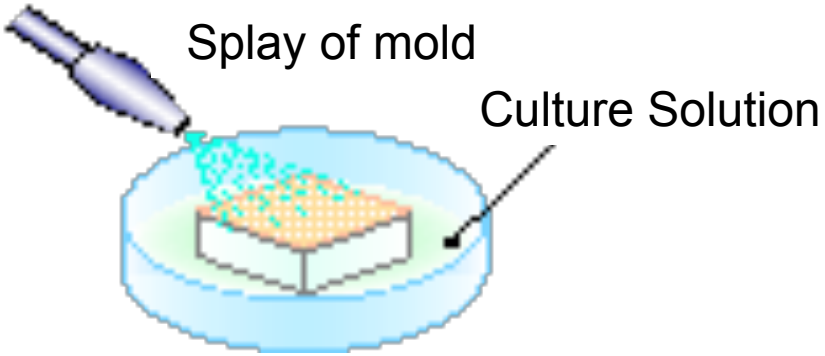
Before | **After The Color Feeding Test (5,000J)**



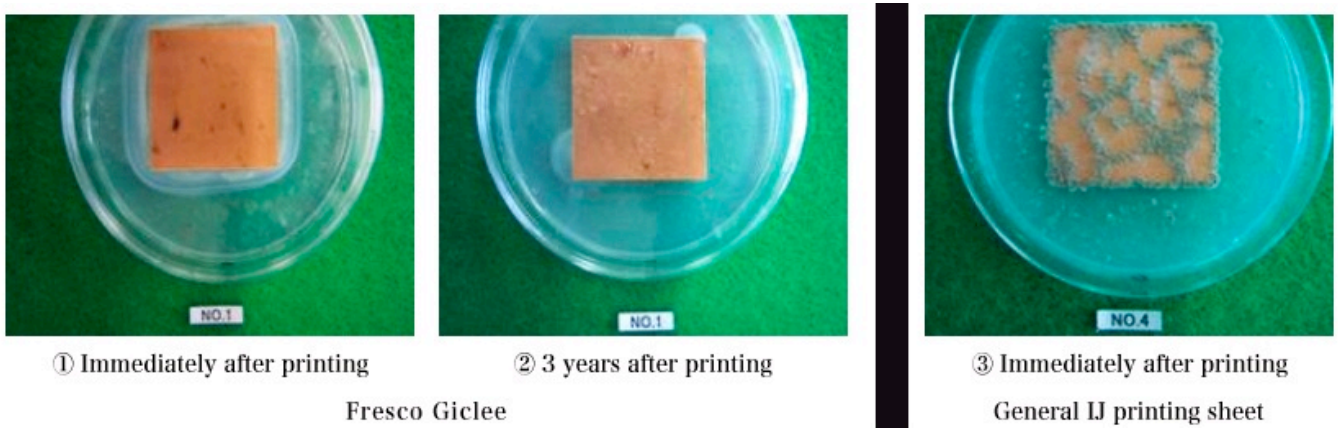
Anti-Fungal Performance Test

Upon the evaluation of preservation property of printed work, mold under an environment of high humidity is another concern along with light resistance.
Since ancient times, plaster has been known for its excellent anti-fungal performance. For example, plaster was used for the interior finish material of a warehouse where precious equipment was stored. We performed an anti-fungal performance test in accordance with JIS Z 2911 (the fungus resistance test method) in order to confirm if the printed FG sheet could demonstrate anti-fungal performance.
Each specimen of printing media of 1 and 3, printed with yellow ink, was tested immediately after printing. Specimen 2, which is a sample that had been printed and stored in the room three years before, was also tested. The purpose of this test was to confirm the durability of anti-fungal performance.

Test method : This test was performed at the Japan Testing Center for Construction Materials based following procedure.



Test method: In accordance with JIS Z 2911
(the fungus resistance test method)
Fungi sprayed: Blue mold, black mold, and yeast mold
Culture: Agar
Culture period: 3 weeks
Specimens: 1. Fresco Print Type R, immediately after printing
2. Fresco Print Type R, 3 years after printing
3. General IJ printing sheet, immediately after printing



① Immediately after printing ② 3 years after printing

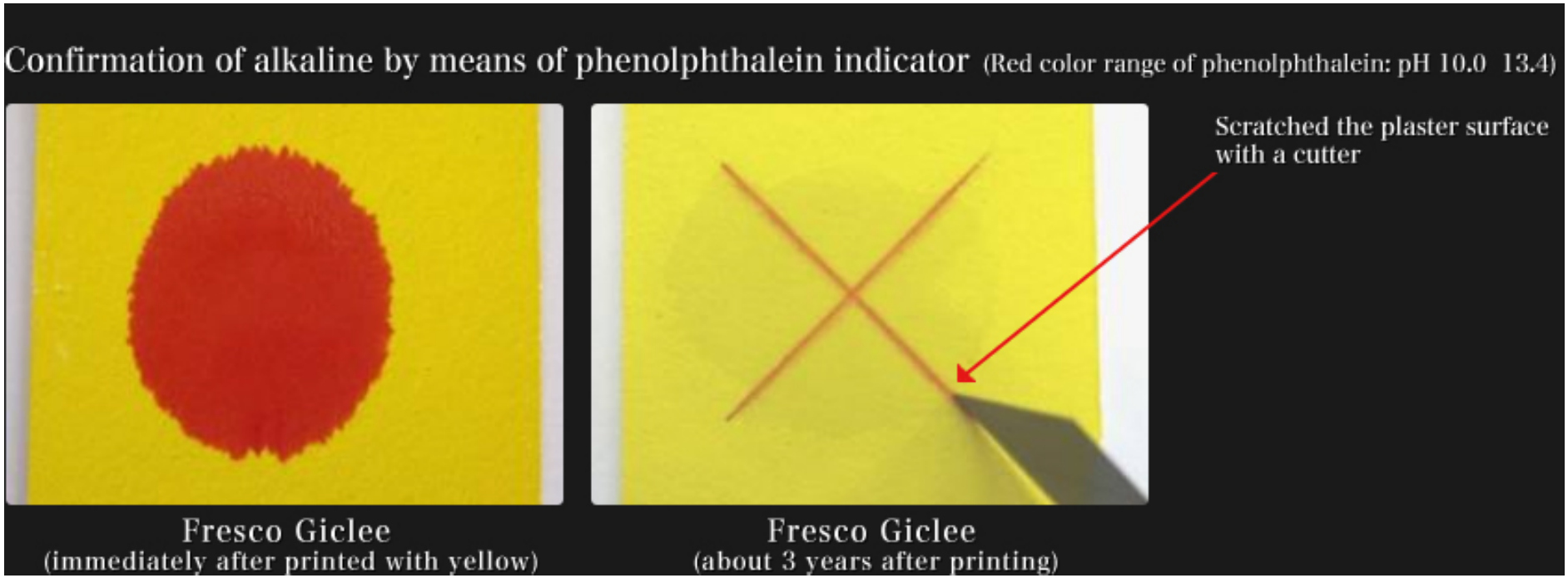
Fresco Giclee

③ Immediately after printing

General IJ printing sheet

In Fresco Print sheet specimens, both immediately after printing and 3 years after printing, no mold was confirmed. On the other hand, mold significantly grew on the general IJ printing sheet, as shown above.

Factors to Demonstrate Anti-Fungus Performance



Fresco Print is composed mostly of unhardened plaster (slaked lime). For this reason, the Fresco Print sheet is alkaline in nature immediately after it is taken out of the air-tight package. When a drip of phenolphthalein indicator was dropped on the sheet, it turned to red. On the other hand, the Fresco print that was taken out of the package 3 years before did not change its color to red even though the same indicator was dropped. However, the inside of the cut made on the neutralized surface turned to red. This result shows that the inside of the plaster remained alkaline in nature.
This is highly probable that this is the factor that helps maintain the anti-fungus performance even though the surface has been neutralized (a large amount of fungi cannot grow under an alkaline environment).

It was reported by the Japan Society for Finishing Technology that stuccoes demonstrate anti-fungus performance by maintaining alkaline even 30 years after construction. Given this report, we also believe that Fresco Giclee can maintain its anti-fungus properties over similar long periods.

END