# Maintenance Manual for Glass & Ceramic Color Transfer Standards

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## Introduction

For many years technologists who need to measure and control color have used optical glasses and ceramic tiles as color transfer standards. Color standards fabricated from vitreous materials are practical because of their durability, maintainability, and long-term stability.

Whenever a precision optical component is cleaned, its critical surface may be damaged. If consistency and long-term stability are important, proper cleaning procedures must be employed. Storing and handling color standards as described below reduces the frequency of cleaning, preserves the standards, and maintains their stability. With proper care vitreous color standards should remain stable and in good working condition for many years.

## Inspection

To inspect a glass or ceramic optical standard for the presence of lint or dust, illuminate the surface with a diffuse light source. (Reflected northern daylight works well for this. An illuminated magnifier (ring lamp) can also be useful.) Hold the tile by the edges of the Delrin® holder, and view the optical surface at several angles to minimize surface glare.

# Contamination

Two types of soiling alter the reflectance characteristics of precision optical standards:

1. Dust, dirt, skin oils, grease, and films of aerosols (from unfiltered air or commercial cleaners) alter the reflectance properties of vitreous color standards. These changes usually can be reversed using appropriate cleaning techniques. Careful storage and handling procedures minimize contamination and the need for cleaning.

2. Exposure to abrasives, chemical vapors, skin acids or liquid acids, liquid alkalis, high temperatures, and some types of radiation can induce irreversible color changes. If the optical surface of the standard has not been damaged physically and the damage to the glass or glazed surface is not severe, the standard can usually be re-calibrated and returned to use.

# Physical Damage

Ceramic and glass optical standards (including CERAM® tiles) are vulnerable to etching by acidic and alkaline aqueous solutions. Exposure of ceramic glazes to dilute acids can cause leaching of metallic oxide, sulfide, or selenide pigments. The optical surfaces can be etched permanently following exposure to dilute acids that contain even small concentrations of dissolved metallic fluorides. (Hydrofluoric acid has long been used to etch glass and fused silica.) Immersion of vitreous transfer standards in strongly alkaline solutions that contain dissolved metallic phosphates (e.g., $Na_3PO_4$) or hydroxides (e.g., NaOH) may cause etching.

Exposure to organic solvents may damage the printed labels and the Delrin® plastic holders in which our standards are mounted.

Glass and ceramic optical standards are vulnerable to scratching by abrasives, including kitchen/bathroom cleansers. Any scratching or abrasion of the glazed or polished optical surface causes permanent damage and ruins the standard. To avoid this, keep your work area free from grit and dirt such as household dust or cement dust, and use only the materials and procedures recommended below for cleaning. Never clean your standards using ordinary paper, cloth, or commercial cleaners.

# Handling

Always wear lint-free gloves when you handle glass and ceramic color standards during spectroscopic measurements. We recommend using high-quality woven cotton film gloves or cotton or nylon cloth inspector's gloves. After several hours of use, launder cloth gloves to remove soiling and contamination by perspiration and skin oils.

Whenever you use liquid cleaning agents, wear disposable powder-free polyethylene or nitrile lab gloves. For impermeability to chemical solvents we recommend disposable nitrile gloves. Wash your gloved hands with soap and warm water to remove traces of powder or other contamination. Rinse with clean water and dry the gloved hands with a clean, lint-free towel. Discard disposable gloves after a single use.

# Storage

We jacket individual glass and ceramic color transfer standards in lint-free optical component bags. We package sets of color standards in dust- and light-tight boxes fabricated from high-impact plastic. (Descriptions and photographs of our standards are published on the Avian Technologies L.L.C. website <www.aviantechnologies.com>. Click on the image at the bottom of the web page for additional information.)

After a measurement, return each color standard to its container. After a work session, insert each standard in its protective jacket. Store the closed boxes in a controlled environment that is clean, dark, and dry. For long-term storage we recommend using locked cabinets housed inside the lab, office, or warehouse. If the storage environment is dusty or subject to airborne contaminants, seal each boxed set of standards inside a 3-mil laboratory grade zip-loc polyethylene bag.

# Cleaning

For routine dust removal use a clean camel's hair or anti-static brush and/or non-flammable compressed fluorocarbon propellant. If you store and handle standards properly, frequent treatment with liquid cleaners should not be necessary.

When a glass or ceramic standard becomes contaminated with skin oil, immediately clean it with isopropyl alcohol. Always wear disposable lab gloves during this procedure since isopropyl alcohol dissolves skin oils and cosmetic creams causing contamination of the optical surface. Because isopropyl alcohol is irritating and toxic, wear eye protection and avoid prolonged exposure to its vapors.

Clean the soiled standard with a fresh absorbent, non-abrasive wiper moistened with a few drops of isopropyl alcohol. Wipe the optical surface gently in a single path using a circular motion. (Do not use a scrubbing motion. Any abrasive grit adhering to the wiper may permanently scratch the optical surface.) Remove excess alcohol using a fresh, dry wiper and inspect the standard. If you observe smears, streaks, or fingerprints, clean the standard with liquid detergent as described below. Discard each wiper after a single use.

Remove water spots with a fresh non-abrasive wiper moistened with one drop of dilute distilled white vinegar. Immediately rinse the cleaned surface with distilled water. Remove excess moisture with a fresh wiper, and proceed immediately to the isopropyl alcohol cleaning procedure that is described above. Never soak optical standards in dilute vinegar (or another acid) that contains dissolved metallic fluorides, and avoid prolonged exposure of your standards to skin acid or acidic solutions.

Remove fingerprints, heavy soiling, or grease stains with a fresh non-abrasive wiper moistened with unscented lab detergent. Use a gentle scrubbing action, but avoid scratching the optical surface if the soiling contains abrasive material. For heavy soiling use several treatments — always with fresh wipers. Rinse the cleaned surface with distilled water. Remove excess moisture with a fresh wiper, and proceed immediately to the isopropyl alcohol cleaning procedure as described above.

# Long-term Stability

Precision optical standards are fabricated from glass and ceramic materials, which have long been noted for durability and chemical stability. As these color standards age, their optical properties do not undergo spontaneous change.

As noted above, temporary (reversible) changes in color and appearance may result from surface contamination. Permanent changes may result from physical damage to the optical surface (etching or scratching) or from chemical changes following exposure to chemically reactive liquids or vapors or certain types of radiation.

In practical terms the long-term stability of vitreous color standards is mainly influenced by the work environment and the procedures used to store, handle, and clean the standards. In adverse work environments gradual changes in color and appearance may be unavoidable. We encourage you to standardize your maintenance procedures based on the guidelines presented here.

For critical applications we recommend that you purchase color standards that have been calibrated with certification at a commercial metrology laboratory.

The contract calibration services offered by the National Institutes of Standards and Technology and the National Research Council of Canada are very expensive. In North America Avian Technologies L.L.C. and Mt. Baker Research L.L.C. offer high quality, traceable calibration services. If very long-term stability of color and appearance is important, we recommend that you engage a suitable metrology laboratory to re-calibrate your standards on an annual basis.

# Temperature Stability

The colorants used in glass and ceramic transfer standards include stable inorganic chemicals such as metallic oxides, sulfides, and selenides. Colored vitreous materials may exhibit reversible changes in color that accompany changes in temperature. This characteristic, which is termed thermochromism, is significant in color metrology.

Malkin, et al. reported the thermochromic behavior of BCRA Series II tiles, which are manufactured by CERAM Technology Ltd. (See: F. Malkin, J.A. Larkin, J.F. Verrill, and R.H. Wardman, "The BCRA-NPL Ceramic Colour Standards, Series II — Master spectral reflectance and thermochromism data," Journal of the Society of Dyers and Colorists, 113, 84 – 94 (1997).)

According to Malkin, et al. red, orange, and yellow tiles exhibit greater sensitivity to temperature than other colors. Intensely colored tiles exhibit greater sensitivity than pastels or white and grey tiles. Consult the original reference for quantitative details, and remember that standard glazes are used in all ceramic color standards including CERAM tiles. (See: R.A. Eppler and M. Obstler, "Understanding Glazes," The American Ceramic Society, Westerville, Ohio, 2005, ISBN 1-57498-222-2, <www.ceramics.org>).

More recently, Dr. David Wyble (Rochester Institute of Technology) measured the temperature sensitivity of the ceramic color standards introduced during 2007 by Mt. Baker Research L.L.C. and Avian Technologies L.L.C. Dr. Wyble performed these new measurements with a custom instrument that operated in the (0°/45°) bi-directional geometry. His measurements correlate well with the results published by Malkin, et al. for CERAM tiles. We look forward to the detailed report of this important new study.

# Appendix—Recommended Chemicals & Supplies

Isopropyl alcohol: Use spectroscopic grade or the best available medical grade available at your pharmacy. (Note: Commercial laboratory supply firms offer spectroscopic grade solvents in Teflon® squirt bottles. While spectroscopic grade isopropyl alcohol is preferred, it is very expensive.)

Distilled water, de-ionized water, or filtered tap water: Available in plastic containers at supermarkets and pharmacies.

Mild liquid soap or detergent solution: Avoid commercial cleaning agents that contain scents, acids, or strong alkalis. Unscented liquid hospital soap is okay. Prepare a working solution by dissolving 1 teaspoon of liquid soap in 1 quart of distilled water. Store the solution in a laboratory grade plastic squirt bottle.

Fluorocarbon propellant: We recommend using canned 1,1,1,2-tetrafluoroethane, such as SPI Easy Duster® (Structure Probe, Inc. <www.2spi.com/spihome.html>). Although 1,1,1,2-tetrafluoroethane is non-flammable and minimally toxic, avoid chronic exposure to the vapors. (Visit the Structure Probe, Inc. website to access a material safety data sheet.) Don’t shake the propellant container. Do use a ventilated hood or work in a well-ventilated lab, and avoid flammable propellant products, including difluoroethane.

Dilute Acetic Acid: Dilute distilled white vinegar with distilled water to 1% acetic acid concentration. (Note the restrictions listed in the cleaning procedure.)

Camel's-hair or anti-static brush: We recommend StaticWisk® brushes (Kinetronics Corporation <www.kinetronics.com>). When your brush becomes contaminated with dust or skin oil, wash it gently in accord with the manufacturer's instructions.

Dust- and lint-free, absorbent, non-abrasive lens tissues and wipers: We recommend Pec*Pads® (Photographic Solutions, Inc. <www.photosol.com>) and SPI-CleanWipes Polyester Wipers® (Structure Probe, Inc. <www.2spi.com/spihome.html>). After you open a new package, store the unused wipers in a sealed 3-mil laboratory grade polyethylene zip-loc bag.

Lint-free cotton and nylon inspector's gloves. (For sources visit the following websites: <www.criticaltool.com>, <www.galeton.com>, or <vwrlabshop.com>.)