Silver tarnishing by paper and paperboard

1. Scope

1.1 This method is for identifying papers and boards that will tarnish or stain silver. The appearance of the tarnish or stain of silver by a test specimen of the sample is reported, together with the distribution of the tarnishing or staining. Reducible sulfur activity is a common cause of tarnishing.

1.2 Certain sample types, such as water repellent or metal-coated papers, or board may require modification of the test procedure. In most cases, water repellent or metal-coated samples may be tested without wetting the test specimen and by prolonging the time in contact with the silver to at least 24 h. When such sample types are tested, state any modification of the procedure which is used in the report.

1.3 The principles involved in this test method might be used to test samples for their staining or corrosion properties with respect to other metals, such as steel, copper, nickel, brass, etc. In such cases, it is necessary to use plates or forms of the particular metal or alloy in question and to make such modifications as may be required for the particular purpose. For example, in the case of metal that would rust, the paper might not be wetted; it could instead be heated in an atmosphere of high humidity.

1.4 Specific details of testing for tarnishing or staining papers are beyond the scope of this test method. The information in 10.2 and 10.3 is given only as examples of extensions of the test method which may be possible.

2. Significance

This test method provides a semi-quantitative method to determine if paper or paperboard will cause tarnishing of the surface of silver.
3. **Apparatus**

3.1 *Metal plates*, solid silver or silver plated brass flat plates, approximately 15 × 15 cm (6 × 6 in.). Two plates are needed for each test and are probably sufficient for occasional tests of paper. Several sets are necessary where frequent testing is desired.

3.1.1 *Silver plated brass plates*, produced as follows: commercial rolled-sheet brass 6.35 mm (0.25 in.) thick is buffed smooth and as free from tool marks as practical, then plated with pure silver to a thickness of about 0.125 mm (0.005 in.), buffed again, and replated with another 0.125 mm of pure silver. A smooth, continuous layer of pure silver about 0.25 mm (0.010 in.) thick, which can be repeatedly cleaned and polished, should be obtained. To determine the amount of plated silver, weigh the brass plate before and after plating. A layer of silver 0.25 mm thick weighs about 2.5 kg/m². The brass plates may be plated on one or both sides.

3.1.2 *Solid silver plates*, approximately 15 × 15 cm (6 × 6 in.).

3.2 *Oven*, forced draft, capable of maintaining a temperature of 38 ± 2°C about (100°F) or 70 ± 5°C (about 150°F) protected by isolation from laboratory fumes.

3.3 *Desiccator*, glass, or other container with a tightly fitting cover, and ceramic or glass stand.

3.4 *Forceps*, wooden or plastic.

3.5 *Weight*, approximately 2.5 kg (5 lb).

4. **Reagents and materials**

4.1 *Silver polish*, a silver-polishing powder or paste, which will not scratch pure silver and does not contain cyanides or protective coatings such as silicone. A paste made up of the finest grade of Tripoli powder, such as that used for polishing metals for metallographic work, and distilled water containing a small amount of NH₄OH is recommended.

4.1.1 Tripoli powder is the common name for particulate SiO₂ used in polishes for a wide range of materials including wood, “rocks,” and metal surfaces. Tripoli powder comes in a wide range of particle sizes and purities between about 90% and 99%, major impurities being other oxides such as aluminum, calcium, and iron. The use of Tripoli powder in this test dates from the origination of the procedure in 1939, and there is no added information on the use of Tripoli powder for polishing the plates used than that in section 4.1. While a Tripoli powder paste can be prepared, commercial metal (silver) polishes are quite suitable, but the requirement that they not leave any cyanides or protective coating on the silver is critical. Any material deposited on the silver by the polish that would coat it in any way would eliminate its use in a test for tarnishing.

4.2 *Water*, distilled or deionized.

4.3 *Silver foil*

4.4 *Aluminum foil*, area to contact test specimen must be cleaned free of oil by wiping with clean cotton or lens paper soaked in a suitable solvent.

4.5 *Solvent*, the solvent historically specified in this method was 1, 1, 1-trichloroethane. **SAFETY CAUTION:** 1, 1, 1-trichloroethane represents a significant health and environmental hazardous material. The use of solvent has been retained for historical reasons. Toluene and hexane have been suggested as replacements. Toluene, however, also has been implicated as a potential health and environmental hazard because of the potential for contamination with benzene. If an alternative cleaner has been used, the name/type of this alternative should be noted in the report.

5. **Test specimen**

5.1 Obtain the sample in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, or Related Product.” Do not touch the areas to be tested with the fingers; instead, use clean forceps and protect the sample from contamination which may be in the atmosphere.

5.1.1 Whenever there is any doubt regarding the presence of sulfur compounds in the air, it is advisable to hang one or more small strips of clean, highly polished silver foil in the laboratory in which the test pieces are prepared, and in the oven with the test specimens. If tarnishing or staining of these strips occurs, the air entering the oven should be purified, or the oven should be placed where the air causes no tarnishing of the silver.

5.2 From the sample, select at least five representative test specimens, each about 160 mm (6.5 in.) square.
6. Procedure

6.1 Thoroughly clean the silver surface of each plate and polish it to a high luster, then rinse the plate with alcohol, rerinse with 1, 1, 1-trichloroethane, or another suitable silver cleaner, that does not leave a residue, and dry, first in the laboratory, and finally in the oven.

**SAFETY CAUTION:** Never place the plates in the oven until all traces of any organic solvent, some of which are flammable or explosive, have evaporated from the plates. Generally, drying the plates with a soft absorbent tissue, and then allowing the plates to remain in the laboratory air (see 5.1.1) for 60 minutes should be sufficient to remove solvent traces. When in doubt, allow the plates to dry for a longer time prior to placing in the oven.

6.2 For paper less than 160 g/m².

6.2.1 Hold one of the 160-mm-square test specimens by means of the forceps and wet it uniformly with distilled water so that the specimen is saturated but not dripping wet. This can be done with an all-glass atomizer operated by pump (not a rubber bulb) or by steaming the specimen over the outlet of a wash bottle containing boiling water.

6.2.2 As soon as the specimen is saturated with water, place it on the silver surface of one plate, taking care to have as few wrinkles or air bubbles as possible. Then lay the other plate, silver surface down, upon the specimen.

6.2.3 Adjust the temperature to 70 ± 5°C and place the test assembly in the oven protected from access to laboratory fumes. The paper should dry completely in not less than 3 h.

6.2.4 When the specimen is dry, examine the silvered surface of each plate for tarnishing or staining. Record the color and character of the stains. A digital image (digital photograph) is quite suitable for making this record, although a drawing may be made as part of the sample record. Alternately, a permanent record may be made for future reference by placing tracing paper over the plate after the test and tracing the spots or stained areas. If isolated spotting occurs, record the approximate size of the spots and count their number on each plate.

6.3 For paperboard and papers greater than 160 g/m².

6.3.1 Heat the dessicator or glass container in the 38°C (about 100°F) oven for at least 1/2 hour.

6.3.2 Place the specimens between the plates, building up a stack of five or six of these sandwiches with the top and bottom layers containing no specimen.

6.3.3 Place this stack on the dessicator stand in the glass container or dessicator. Place 12-15 mm (1/2 in.) of distilled water in the container. The stand should prevent the samples from actually coming into direct contact with the water.

6.3.4 Place an approximately 2.5-kg weight (which has been carefully covered with several layers of aluminum foil) atop the specimen stack. A good contact between sample and the plate throughout the entire test must be assured. Use a small amount of stopcock grease to seal the cover to the test specimen container or dessicator.

6.3.5 Heat the complete test apparatus at 38°C about (100°F) for 24 h. By using this closed system, a relatively pure, highly humid air source is consistently available. This reduces the possibility of laboratory air contaminating the test. See 5.1.1.

6.3.6 Examine the silvered surface of each plate for tarnishing or staining. See Section 6.2.4.

7. Report

Report the number of specimens tested; the color and character (e.g. spots, large areas, etc.) of tarnishing or staining, if any, and the number of tarnished or stained areas, as the maximum and minimum number found in any one test specimen and the total number found in all specimens tested. State if alternative cleaning procedures and/or chemicals were used.

8. Precision

No precision statement has been determined due to the qualitative nature of the determination of the results of the procedure.

9. Keywords

Paper, Paperboard, Silver tarnish tests, Reducible sulfur
10. **Additional information**

10.1 Effective date of issue: April 24, 2012.

10.2 See also TAPPI T 406 “Reducible Sulfur in Paper and Paperboard.”

10.3 Changes in the 2011 revision are editorial and include: safety precautions for use if working with certain organic solvents, moving certain “additional information” into the body of the document, removal of reference to a withdrawn ASTM method, moving the requirement for performing the method in the absence of certain air pollutants from a note to a numbered clause, addition of missing equipment (a 70°C oven), and other minor organizational changes.

*Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.*