



Max Levy Autograph, Inc.

Care, Storage & Re-Calibration of Glass Metrology Measurement Standards

700MLA0087-001


(Rev. B — 07/14/04)

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1.0 Introduction:

Glass substrates provide an excellent basis for linear metrology standards. The high level of flatness and surface quality set glass apart from other materials. To get the highest degree of accuracy from a glass Metrology Standard, it is important to understand the unique properties of glass and how these properties affect a standard both in the short term and the long term.

Depending on the application, there are several varieties of glass that can be used. Soda lime glass is the most common form of glass used in metrology standards. For applications that demand the highest level of positional accuracy and surface quality, fused silica (quartz) may be used. For environments with extreme temperature shifts, Borofloat glass should be used.

Soda Lime Glass is an amorphous solid. Its lack of a crystalline structure results in a small amount of internal flow over time. Over the course of several years, glass will shrink, slump, warp, and bend. The glass itself is full of internal stresses from the manufacturing process that are slowly released over time. The release of stress causes the glass to change size in a logarithmic fashion until all stresses have reached equilibrium. Most of the total change in the glass size will occur during the first year after production (see Figure 4.1). For this reason, Max Levy Autograph ages all glass at least one year prior to use.

For extremely high accuracy applications, fused silica is recommended. Fused silica has a CTE that is an order of magnitude lower than soda lime glass. Often, however, fused silica is cost prohibitive.


Finally, Borofloat glass may be used in extreme temperature applications. Borofloat has an extremely high maximum working temperature and thermal shock resistance.

2.0 Applicable Documentation:

Drawing# 100MLA0167-001
thru
Drawing# 100MLA0167-016 (Storage Cases)

3.0 Materials and Equipment Required:

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Environmentally Controlled Storage Area

4.0 Procedure:

To ensure minimal deformation of glass the following guidelines should be observed.

Usage

For the highest level of accuracy, glass standards must be used at the same temperature at which they were calibrated. The standard temperature calibration of glass standards is 68°F (20° F). Ambient temperature must always be compensated for when using glass scales. For soda lime glass, the Coefficient of Thermal Expansion is 5.2×10^{-6} in/in/°F. For a 500 mm scale, this translates to a total change in length of .0001 in / °F (.0015 mm / °C). Barometric pressure and relative humidity do not have any noticeable effect on the size of the glass plate.


Calibration standards made from fused silica have a significantly lower CTE. For the same 500 mm scale in quartz, the total change in length is roughly .00001 in/ °F (.0003 mm/ °C).

When inspected, glass should be placed on a flat surface. A bow in the glass of more than .015” can significantly alter the location of the pattern on the glass.

Storage

Glass Metrology Measurement Standards should never be allowed to lean on an angle for any significant amount of time. It is also not acceptable for glass to be stored vertically. It is best to keep Glass Metrology Measurement Standards in a clean, stable, temperature controlled area that is at or near 20° C. Glass should be kept flat in a properly sized storage case. Storage in this manner will minimize the dimensional changes in the patterned glass over time and allow for the extension of the re-calibration period. Leaving glass leaning or stored vertically may cause the piece to flex and/or slump under its own weight; and, over time, the piece most likely will develop a permanent bend and or gravity induced slump. When glass is stored vertically the piece may not bend but it is certainly subject to gravity slump and may shrink significantly more in the vertical direction than in the horizontal

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direction. Since the flexibility and cold flow of glass increases with temperature it is recommended that the glass be stored at or near 20° C.

Calibration

All Glass Metrology Standards should be reviewed and periodically re-calibrated to determine the changes in location, if any, of the target features on the standard. Doiron (Reference 4.1) has found that glass can shrink 10 parts per million (ppm) or more over a three year period after its manufacture. Most of this change in the length of a glass scale will occur during the first year after its manufacture. By using significantly aged glass, much of the problem is eliminated.

Based on the use of aged glass and experience with Metrology Standards, Max Levy Autograph recommends the following calibration interval for most applications:

- Calibration is not required within the first 5 years unless the glass has received undue stress from improper handling.
- A complete recalibration is recommended after 10 years of use.
- Subsequent calibrations are not required.

The actual interval that should be used for a glass scale is determined by the degree of accuracy required for the application. Figure 5.1 shows the worst-case change in length to be expected from a glass scale. This chart assumes that the glass scale has been stored and handled correctly.

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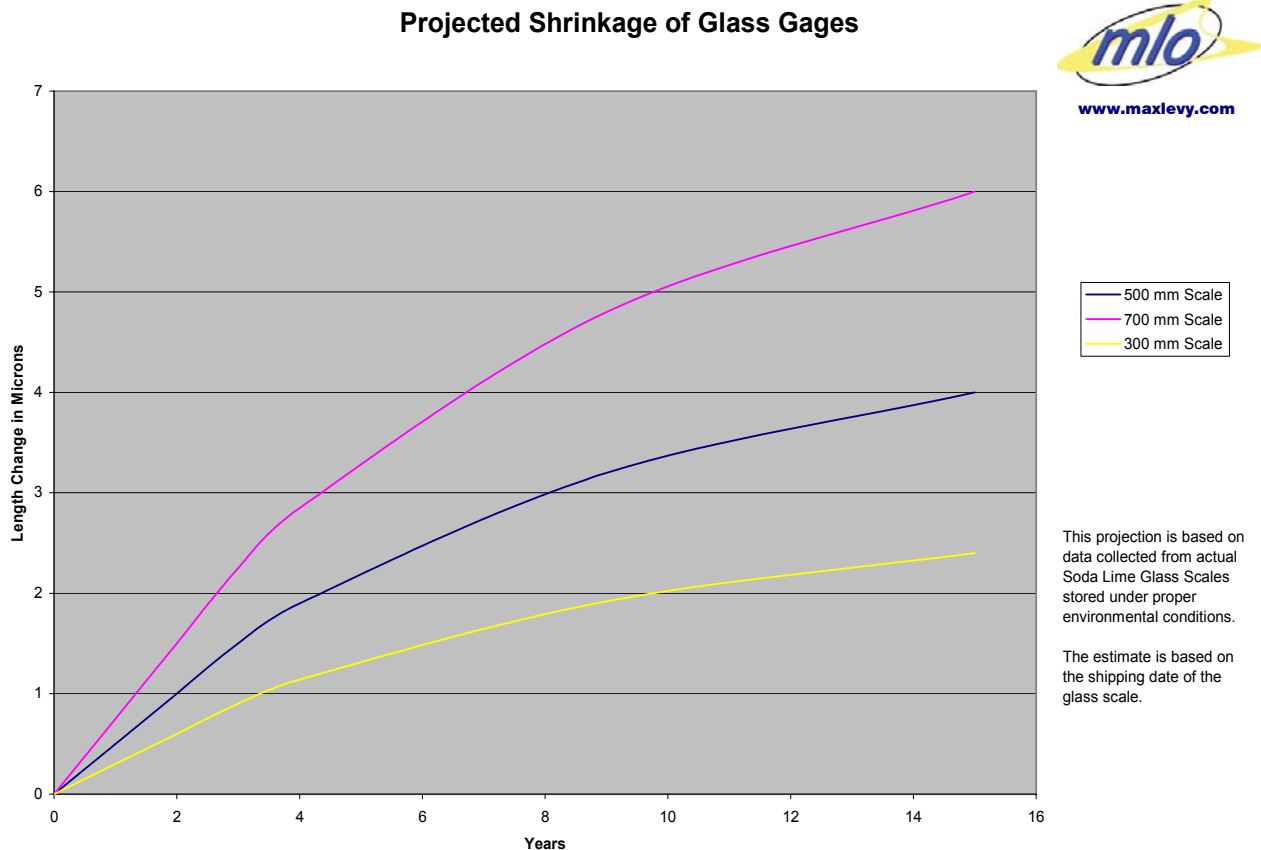
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Figure 4.1 Projected Shrinkage of Glass Scales



5.0 Reference Material:

5.1 Doiron, T. (1997) *Glass and Dimensional Metrology*; Quality Magazine: Vol.36.

5.2 Neumann F. (1996) *Glass: Liquid or Solid—Science vs. an Urban Legend*;
<http://www.ualberta.ca/~bderksen/florin.html>

5.3 Plumb, R.C. (1989) *Antique Windowpanes and the Flow of Supercooled Liquids*. Journal of Chemical Education, 66(12): 994-996