STRAINOPTIC TECHNOLOGIES, INC.

HOW TO IMPROVE CUTTING QUALITY IN FLOAT GLASS

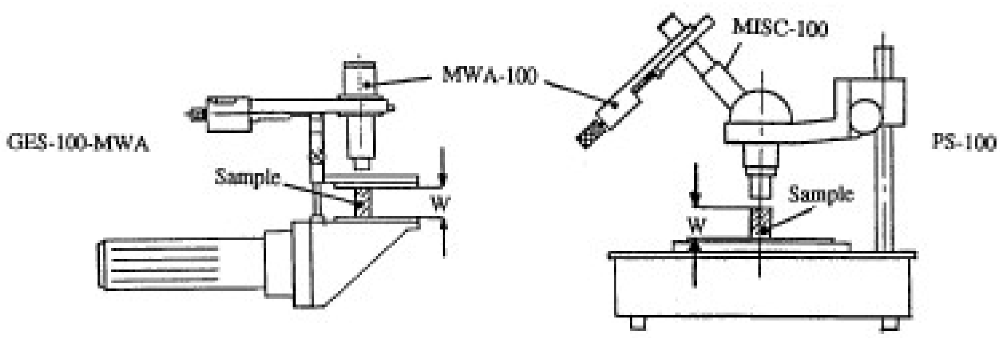
TECHNICAL NOTE AN-100

Unlike optical glass subjected to a fine annealing cycle, glass coming out of a float line is not completely stress-free. Residual stresses vary across the ribbon, and are the result of the temperature distribution in the hot end and the cooling zone near the strain-point temperature. Excessive stresses can cause cutting difficulties and reduced production yields. While average stresses through the glass may be automatically monitored on-line with equipment such as the Strainoptic SCA-1500 stress measurement system, optimum cutting quality can be ensured by a simple quality assurance procedure to measure the mid-plane tension in a sample glass slice.

The procedure described here will help simplify measuring mid-plane tension in float glass, as well as annealed flat glass products, where low stresses are difficult to measure using only automated equipment.

1. Cut a sample strip approximately 1 inch (25 mm) wide by 6-12 inches (150-300 mm) long.

2. Please the strip *on its side* in the Strainoptic PS-100 polarimeter equipped with a microscope and MWA-100 compensator, OR in the Strainoptic GES-100-MWA edge stress meter as shown below. Make sure that the sample is placed directly under the objective lens, with original surfaces parallel to the axis as shown.



3. Focus the microscope on the top edge surface of the glass. If the top or bottom edge surface is not smooth and cleanly broken, then grind these surfaces flat and wet them with refractive index matching fluid (available from Strainoptics) to make the surfaces transparent.

4. Observe the stress pattern through the eyepiece of the measuring wedge MWA. Set the counter of the MWA to "000" (zero) and observe the black fringe (Figure 1).

5. Turn the knob of the MWA until the widest part of the black fringe is centered under the vertical crosshair, as shown below in Figure 2. Now read the counter -- this number is *D* counts.

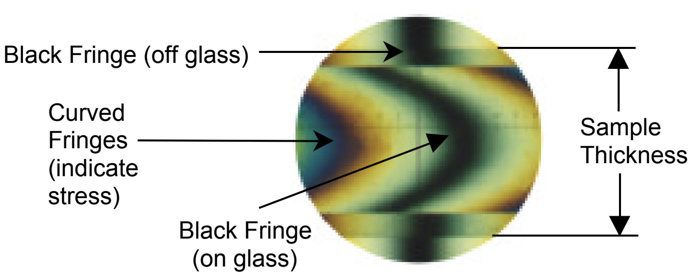


Figure 1

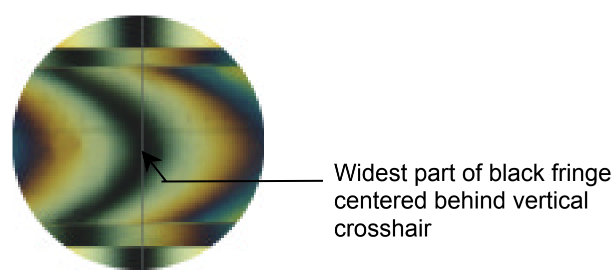


Figure 2

6. Using the MWA counter number *D*, apply these simple equations to calculate the retardation *R* of the sample (in nm) at the mid-plane:

(metric) $R_{nm} = D * \text{compensator constant} \left({}^{nm}/_{count}\right)$

(U.S. conventional) $R_{fringes} = D * \left({}^{fringes}/_{count}\right)$

The mid-plane tension is: $S_{midplane} = {}^{R}/_{W*C}$ *(MPa)* where *W* = sample width and *C* = Material stress constant

The surface compression is: $2 * S_{midplane}(MPa)$

Using the metric system, width is expressed in millimeters (mm), retardation is expressed in nanometers (nm), and stress is measured in megapascals (MPa). For U.S. units, width is in inches (in), retardation in fringes (570 nm = 1 fringe), and stress is measured in pounds per square inch (psi).

Consider the following numerical examples:

The following sample calculations illustrate both metric and U.S. unit measures.

In these examples, the MWA *compensator constant is 5.7 nm/count* (which equals 0.1 fringes/count).

Width of the sample = *W*	Wedge reading = *D*	Retardation D * (wedge constant) = *R*	Material Stress Constant (float glass) = *C*	Stress Computation = S_{midpla}
32 mm	18	R_{nm} = 103 nm	C_B = 2.60 Brewster	$\frac{R_{nm}}{W_{mm} * C_B}$ = 1.2 MPa
1.25 inches	18	$R_{fringes}$ = 0.18 fringes	$F_{fringes}$ = 1270 psi/fringe	$\frac{R_{fringes} * F_{fr}}{W_{in}}$ = 182 psi
1.25 inches	18	R_{nm} = 103 nm	F_{nm} = 2.2 psi/nm	$\frac{R_{nm} * F_{nm}}{W_{in}}$ = 180 psi

In the examples above, the mid-plane tension is measured. Since stresses are in equilibrium, the total tensile and compression forces must add up to zero. It is implied then that the surface compression is approximately 2 times larger than the mid-plane tension.

These technical notes have been developed to assist Strainoptic instrument users when measuring low-stress or annealed glass products. The staff at Strainoptic Technologies or one of our representatives is available for assistance if you have any questions or require additional information.

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