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PRESS INFORMATION

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Cord stress and analysis of homogeneity

Improved procedure – reproducible calculation instead of visual assessment

There are various ways to determine the cord stress of a glass and some have been in use for over a hundred years. But does the user know what he is doing? And more importantly: Can the systems be compared with each other? Or is it more dependent on the persons evaluating the results? The IGR has developed a solution which is independent of persons. This method calculates cord stress instead of assessing it.

For glass manufacturers, the determination of stresses and stress differences in glass is highly important, as they have a significant influence on the glass stability and are therefore considered an important quality criteria. Many brewers therefore request their glass suppliers to check even every drop for possible cord stress.

Cords in the glass reflect inhomogeneities in the composition of the glass compared to the surrounding glass. Due to their different expansion coefficients, these inhomogeneities cause stress in the glass during cooling, which can reduce the glass stability.

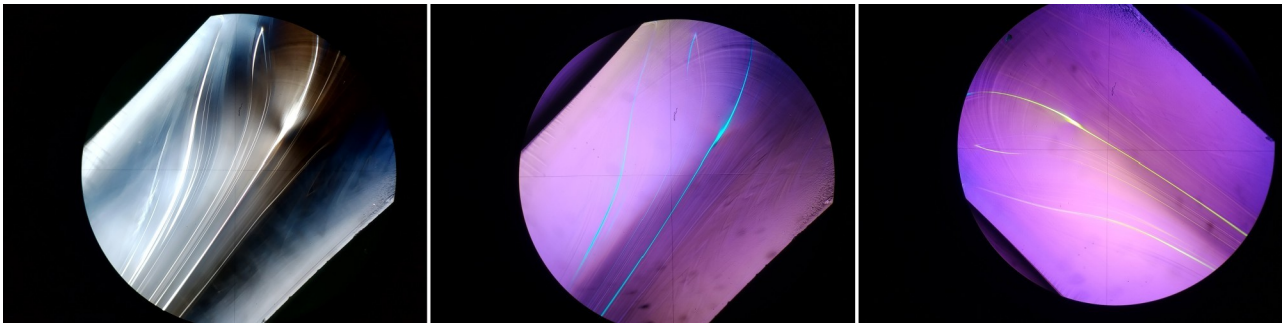

Fig. 1: Cords with polarized light (left) and additionally with 1st order red compensator (middle in NE direction and right in NW direction)

The IGR – Institut für Glas- und Rohstofftechnologie GmbH has therefore been offering stress tests for many years. For this, a cord assessment is performed using polarized light with a microscope.

Up to now, the evaluation in the European area has been predominantly given in grades from 4 to 8 and in the South American and Asian area using a system from A to E, according to Hartford Empire, in analogy to ASTM C 978. However, in North and South America and increasingly in Europe, the assessment of stress is often required to be expressed in *pounds per square inch* (“psi”).

The IGR – Institut für Glas- und Rohstofftechnologie GmbH is now capable of measuring the stress with its new technology and, if requested by the customer, also providing a calculated position-related stress index [psi]. The rating in the system from A to E has also been optimized with this new technology.

Due to their birefringence, cords are visible with polarised light already (Fig. 1). The polarisers installed in the microscope extinguish the light that passes vertically through the sample, while the light diffracted by inhomogeneities remains visible. If the diffraction is high enough, the light appears in different colours. In practical use, however, the diffraction is clearly too low, which is why the cords appear whitish. In order to analyse them more precisely, a compensator is used, such as the 1st order red compensator, which shifts the light colour into a more easily distinguishable range (Fig. 1).

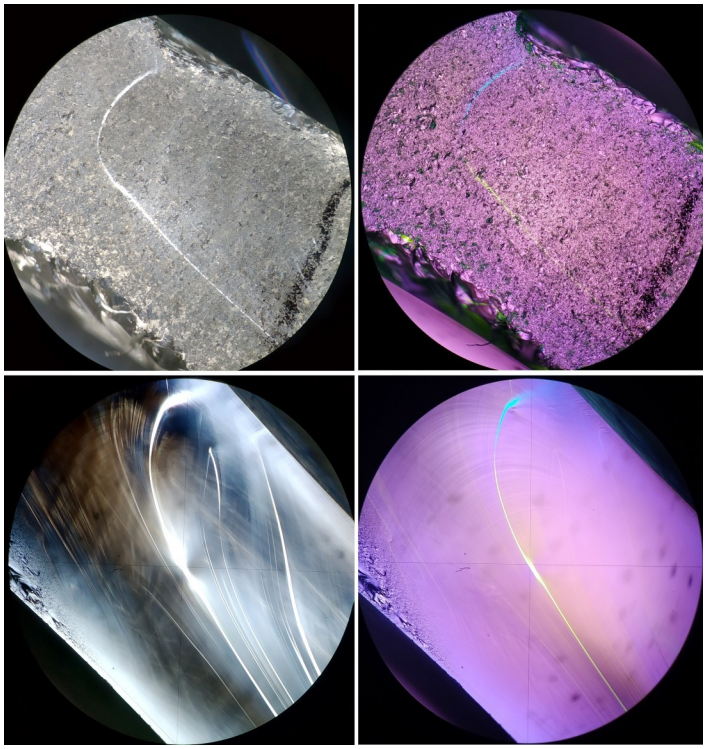

Fig. 2: Difference between samples sawn (top) and samples cut with heating wire (bottom)

The preparation of the ring sections is already essential for the cord analysis, as different results can be obtained due to the production method and the thickness of the sections. Sawing with a diamond blade or cutting with a heating wire to produce the ring sections leads to a visual difference (Fig. 2). Here it is noticeable that the cords in the cut sample are far easier to recognize. In addition, cutting does not lead to breakouts at the edges, which is why cords that are located closer to the surfaces are better to identify and there are no incorrect interference colours along the breakouts (Fig. 2 top right, green areas at the edges). This difference between the preparation methods leads to the fact that companies increasingly demand cutting with a heating wire in order to analyse their samples.

However, under the present preparation conditions, cutting the specimens has the disadvantage that the thickness is not uniform for the entire ring section and must therefore be measured several times for assessments in different sample areas.

Investigations showed that a difference in thickness means an offset of the interference colours, but as such does not mandatorily lead to a difference in results.

During the examination with grades from 4 to 8 (or according to the old system from A to E) by the IGR – Institut für Glas- und Rohstofftechnologie GmbH, the cords are evaluated using a stereo microscope with the help of a 1st order red compensator. Crucial in

this procedure is the tensile stress, which is usually responsible for fractures. Compressive stress causes fractures only at very high values above 2000 psi. Using 1st order red, tensile stress cords in NE direction (parallel to γ of the compensator) appears mostly bluish and in the NW direction mostly reddish (Fig. 3).

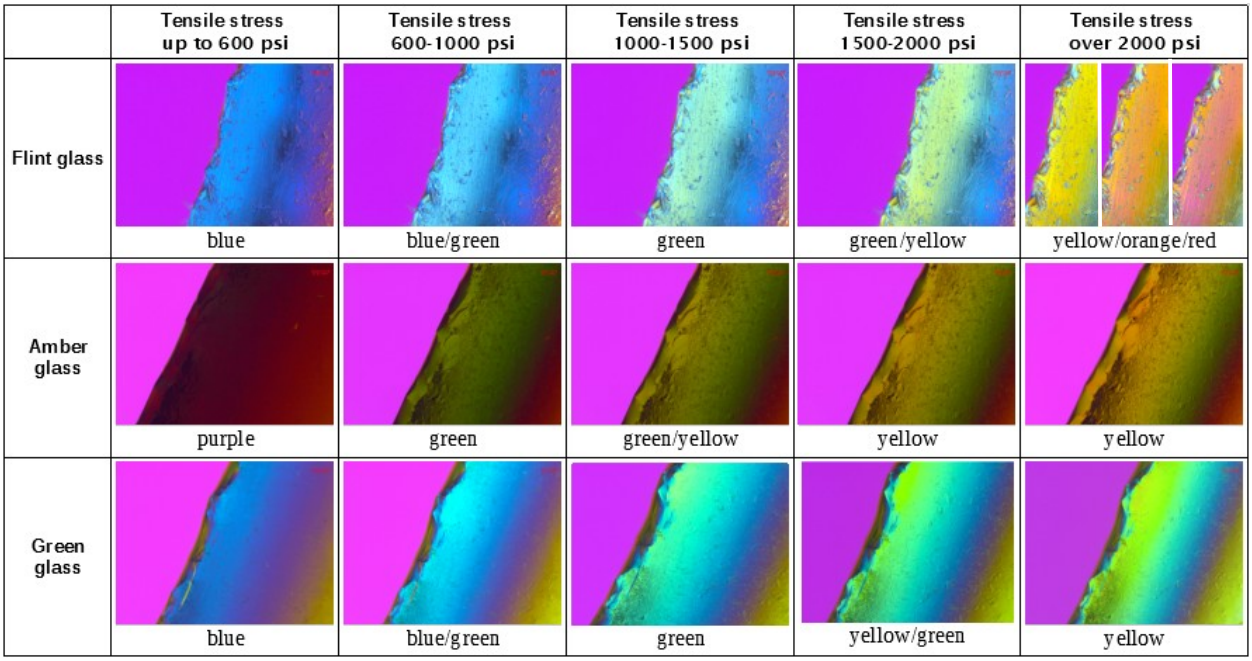

Fig. 3: Estimation of the tensile stress using the interference colours in the NE direction

Only a very general estimation of the stress in psi is already possible using the interference colours during these investigations. For the determination of exact values the IGR – Institut für Glas- und Rohstofftechnologie GmbH uses a Berek compensator, which is a tilting compensator. This compensator can be tilted across the interference spectrum and therefore is able to extinguish the cords in polarized light, assumed the cords are oriented vertical to the compensator (NW-direction). It is possible to determine the tilt to a tenth of a degree, whereafter the refractions can be taken from a table and then converted into the unit psi. This process is mostly automatized at the IGR – Institut für Glas- und Rohstofftechnologie GmbH by using IT. The classification from A to E based on the ring section collection of the Hartford Empire Company is now also performed using these calculated values.

Other technologies are available on the market which measure cords (semi-) automatically and electronically. However, comparisons with these other technologies have shown that only microscopy with a very accurately calibrated polarizing microscope with polarizing oculars can achieve such precise results.

The IGR – Institut für Glas- und Rohstofftechnologie GmbH offers to its world-wide customers, besides these examinations of the cord stresses, also training courses for company personnel on request. These courses cover everything from the selection of the technique to the evaluation of the measured results.