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Measuring method for the homogeneity of glasses by laser interferometry

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Measuring method for the homogeneity of glasses by laser interferometry

1 Scope This Japanese Industrial Standard specifies the measuring method for the homogeneity of the refractive index of glasses by laser interferometry.

NOTE : The normative references of this Standard shall be as follows.

JIS Z 8401 *Rules for rounding off of numerical values*

JIS Z 8703 *Standard atmospheric conditions for testing*

2 Terms and definitions For the purposes of this Standard, the following terms and definitions apply.

(1) **homogeneity of refractive index of glass**

maximum of the refractive index variations, excluding linear changes, among refractive index variations within the predetermined area in a single glass sample

(2) **refractive index matching liquid**

transparent liquid with the refractive index which is equivalent or approximate to the refractive index of a glass sample

The refractive index shall be a value in the wavelength of a laser.

(3) **flatness correction plate**

plane-parallel plate obtained by polishing an optical glass with high homogeneity to a high degree of accuracy (for example, 1/20 of a laser wavelength), which is stuck to a sample by using an index-matching liquid as an intermediate liquid, for the purpose of correcting the flatness of the sample

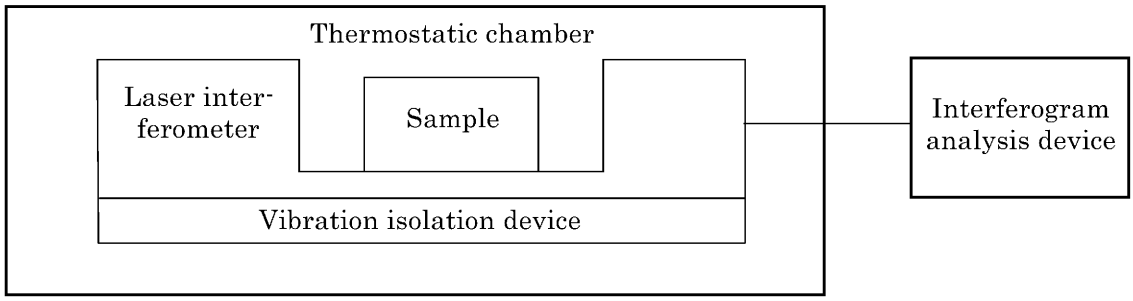
(4) **PV value of wavefront**

difference between the maximum and the minimum deviations of the wavefront, observed when light transmits through a sample once with an interferometer, from the approximated plane

3 Principle The PV value of wavefront of a luminous flux that transmits through a sample with sufficient flatness is measured using a laser interferometer, and the homogeneity of the refractive index of the sample is obtained.

4 Measuring apparatus The measuring apparatus shall consist of a laser interferometer, an interferogram analysis device, a sample, a vibration isolation device, a thermostatic chamber, etc. as shown below (see figure 1).

Figure 1 Example of composition of measuring apparatus



(1) **Laser interferometer** The laser interferometer to be used shall have a laser as a light source and an optical system in which the wavefront of a luminous flux forms a plane. Examples of such interferometer are given in Annex.

(2) **Interferogram analysis device** The interferogram analysis device to be used shall be capable of obtaining the PV value of wavefront from an interferogram.

(3) **Thermostatic chamber** The thermostatic chamber to be used shall be capable of maintaining the interferometer and the sample at a certain temperature of the standard condition specified in **JIS Z 8703**, preferably within tolerance of ± 0.5 °C (Class 0.5 temperature).

(4) **Vibration isolation device** The vibration isolation device to be used shall be capable of eliminating the effect of the vibration from the outside to the interferometer and the sample system. It should be provided for performing high accuracy measurements.

5 Preparation of sample The sample shall be cylindrical or prismatic, and its thickness (height) direction shall be the direction of observation (the optical axis of the luminous flux of an interferometer). The thickness in the direction of observation shall be sufficient to obtain the accurate measured value.

The both end faces (the faces vertical to the optical axis) of a sample shall be polished so that the flatness of not more than 1/20 of a laser wavelength (when the wavelength is 632.8 nm, approximately 0.032 μm) is obtained.

When the above-mentioned precision polishing is not performed, flatness correction plates shall be stuck to the sample using an index-matching liquid as an intermediate liquid, to be supplied for measurement. An example of using flatness correction plates is given in Annex. At this time, the refractive index of the index-matching liquid should conform to that of the sample so that the measurement of homogeneity is not affected.

Furthermore, in order for bonding the flatness correction plates to the sample stably by using the refractive index matching liquid, the flatness of the sample should be approximately 20 μm or less.

6 Operation The operation shall be performed as follows.

(1) **Preparation of sample measuring system** Remove dirt from the sample surfaces, and leave the sample at the location of the same temperature as that in the measurement environment for a sufficient time until the temperature of the sample is brought to that of the measuring environment, and also the temperature within the sample has become uniform.

When using flatness correction plates, remove dirt from the surfaces of the plates, and place them under the above-mentioned condition along with the index-matching liquid and the sample.

(2) **Installation of sample measuring system** Install the sample in the interferometer so that the predetermined area of the sample fits within the luminous flux of the interferometer.

When using flatness correction plates, stick the flatness correction plates to the sample with the index-matching liquid inserted between the sample surfaces and the flatness correction plates. At this time, do not allow air bubbles in the intermediate liquid.

(3) **Preparation of measurement** Leave the installed sample to stand until its temperature has returned to the temperature of the measurement environment.

When using flatness correction plates, allow the installed sample with plates to stand until the thickness of the layer of the refractive index matching liquid between the matched surfaces no longer changes.

(4) **Operation of measurement** Adjust the optical system of an interferometer so that the number of interference fringes of an interferogram becomes appropriate, and then perform the measurement.

(5) **Operation of analysis** Obtain the PV value of wavefront of the luminous flux which transmitted through the sample measuring system from the interferogram.

7 Measurement The measurement shall be performed as follows.

(1) The measurement should be performed twice or more by repeating the series of operations described in (4) and (5) of clause 6. When the average is taken as a measured value, it should be so stated in the test report.

(2) The wavefront irregularities of the optical system of the interferometer and the wavefront irregularities due to the homogeneity of the refractive index and the flatness of a flatness correction plate serve as errors of the test results. Therefore, for the wavefront of the luminous flux which transmitted through the sample, these errors should be corrected, and the PV value of wavefront should be obtained from the wavefront after correction. An example of the measurement of the PV value of wavefront is given in Annex.