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**Measuring method for temperature
coefficient of refractive index of
optical glass—Part 2: Interferometry**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Optical Glass Manufacturers' Association (JOGMA)/Japanese Standards Association (JSA) with a draft prepared from the association standard (**JOGIS 18**) of JOGMA being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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JIS B 7072 series consists of the following 2 parts under the general title *Measuring method for temperature coefficient of refractive index of optical glass*:

Part 1: Minimum deviation method

Part 2: Interferometry

Measuring method for temperature coefficient of refractive index of optical glass—Part 2: Interferometry

1 Scope

This Japanese Industrial Standard specifies a measuring method in which the variation of optical path length with temperature change of optical glass is read by the number of periods of brightness changes of interference fringes using the interferometry method, and the temperature coefficient of refractive index is calculated from the variation of the optical path length.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7072-1 *Measuring method for temperature coefficient of refractive index of optical glass—Part 1: Minimum deviation method*

JIS Z 8120 *Glossary of optical terms*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS B 7072-1** and **JIS Z 8120** apply.

4 Principle of measurement

When light from a light source is perpendicularly incident on the surface of an optical glass specimen polished on a parallel plane having a specimen length L and an absolute refractive index n_{abs} , interference fringes are generated by interference of reflected light from the surface and the back surface. When the specimen is subjected to continuous temperature changes, a change ($2 \times \Delta s$) in the optical path length is caused when the light goes and returns on the light path in the specimen due to the change in the specimen length (ΔL) and the change in the refractive index (Δn_{abs}) of the specimen. This change in the optical path length is read as the number of periods of brightness changes of interference fringes [p (hereafter referred to as number of periods)]. At the same time, the temperature change of the specimen (ΔT) is also read to calculate the temperature coefficient of optical path length change. This temperature coefficient of optical path length change is expressed as a sum of the temperature coefficient of optical path length change attributable to the temperature coefficient of refractive index [$(\Delta n_{\text{abs}}/\Delta T) \times L$] and the temperature coefficient of optical path length change attributable to the linear expansion [$(\Delta L/\Delta T) \times n_{\text{abs}}$] [see Formula (1)]. The temperature coefficient of refractive index can be obtained by subtracting the product of the linear expansion coefficient within a specified temperature range [$\Delta L/(L \times \Delta T)$] and the refractive index from the product of the temperature coefficient of optical path length change ($\Delta s/\Delta T$) and $(1/L)$ [see Formulae (2) and (3)].

$$\frac{\Delta s}{\Delta T} = \frac{\Delta n_{\text{abs}}}{\Delta T} \times L + \frac{\Delta L}{\Delta T} \times n_{\text{abs}} \dots\dots\dots (1)$$

$$\frac{\Delta n_{\text{abs}}}{\Delta T} = \frac{1}{L} \times \frac{\Delta s}{\Delta T} - \frac{1}{L} \times \frac{\Delta L}{\Delta T} \times n_{\text{abs}} \dots\dots\dots (2)$$

It is also possible to express Formula (2) as Formula (3), taking the linear expansion coefficient as α .

$$\frac{\Delta n_{\text{abs}}}{\Delta T} = \frac{1}{L} \times \frac{\Delta s}{\Delta T} - \alpha \times n_{\text{abs}} \dots\dots\dots (3)$$

The change in optical path length in the interferometry method is obtained from Formula (4) using a coefficient (1/2) according to the round-trip optical path in the Fizeau interferometry, the number of periods of the brightness change of interference fringes (p) and the wavelength of the incident light (λ).

$$\Delta s = \frac{1}{2} \times p \times \lambda \dots\dots\dots (4)$$

By substituting Formula (4) into Formula (3), Formula (3) becomes Formula (5) and the temperature coefficient of absolute refractive index can be obtained.

$$\frac{\Delta n_{\text{abs}}}{\Delta T} = \frac{1}{2} \times \frac{p \times \lambda}{L \times \Delta T} - \alpha \times n_{\text{abs}} \dots\dots\dots (5)$$

The refractive index of the specimen in the term ($-\alpha \times n_{\text{abs}}$) for removing the change in optical path length attributable to the linear expansion is an absolute refractive index (n_{abs}) in Formula (5); however, even if a relative refractive index (n_{rel}) is used in the calculation, the difference between the results is minute and the maximum difference in the temperature coefficients of refractive index of general optical glass is limited to about $6 \times 10^{-9} \text{ K}^{-1}$. Therefore, considering the convenience of data handling, the temperature coefficient of absolute refractive index may be calculated by means of Formula (6) in which a relative refractive index is used.

$$\frac{\Delta n_{\text{abs}}}{\Delta T} = \frac{1}{2} \times \frac{p \times \lambda}{L \times \Delta T} - \alpha \times n_{\text{rel}} \dots\dots\dots (6)$$

The temperature coefficient of relative refractive index is calculated by Formula (10) in 8.3 based on the temperature coefficient of absolute refractive index determined here. The absolute refractive indices at the upper and lower boundary temperatures in the temperature range ΔT required in the formula is calculated by means of the formulae given in Annex A using the relative refractive index, $n_{\text{rel}}(T_0)$, measured at the reference temperature T_0 .

The schematic diagram of measurement principle is shown in Figure 1. This figure shows that the intensity of the interference light between the back surface reflected light and the surface reflected light changes due to the phase shift of the light reflected from the back surface of the specimen, resulting from the optical path length change caused by the changes in the refractive index and specimen length when the specimen temperature changes.

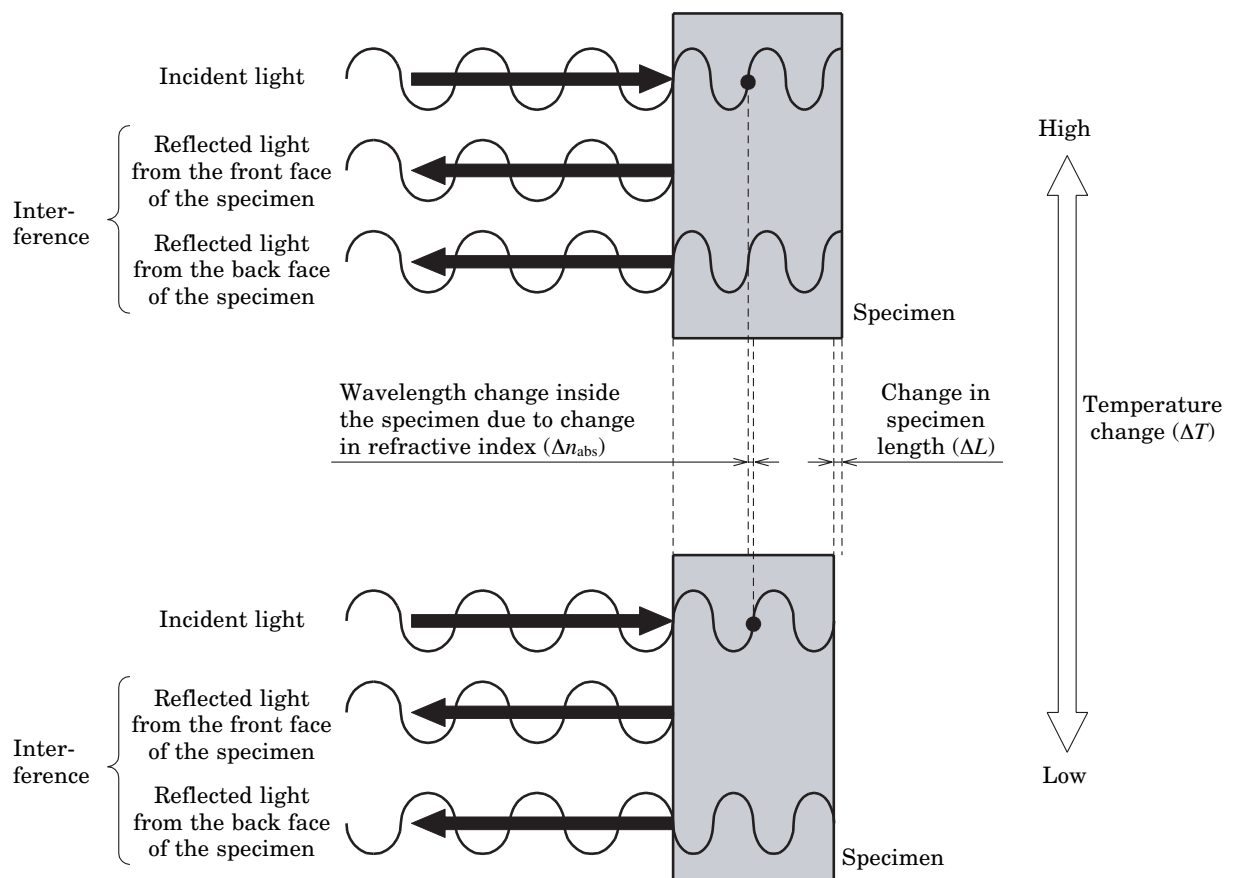


Figure 1 Schematic diagram of optical path length change and interference of reflected light in specimen due to temperature change

5 Measuring apparatus

5.1 General

The measuring equipment shall be of Fizeau interference type which is capable of reading the number of periods of the brightness change of interference fringes with a resolution of 1/10 period or less and in which the specimen itself constitutes the interference space. An example of the schematic diagram of measuring apparatus is shown in Figure 2.

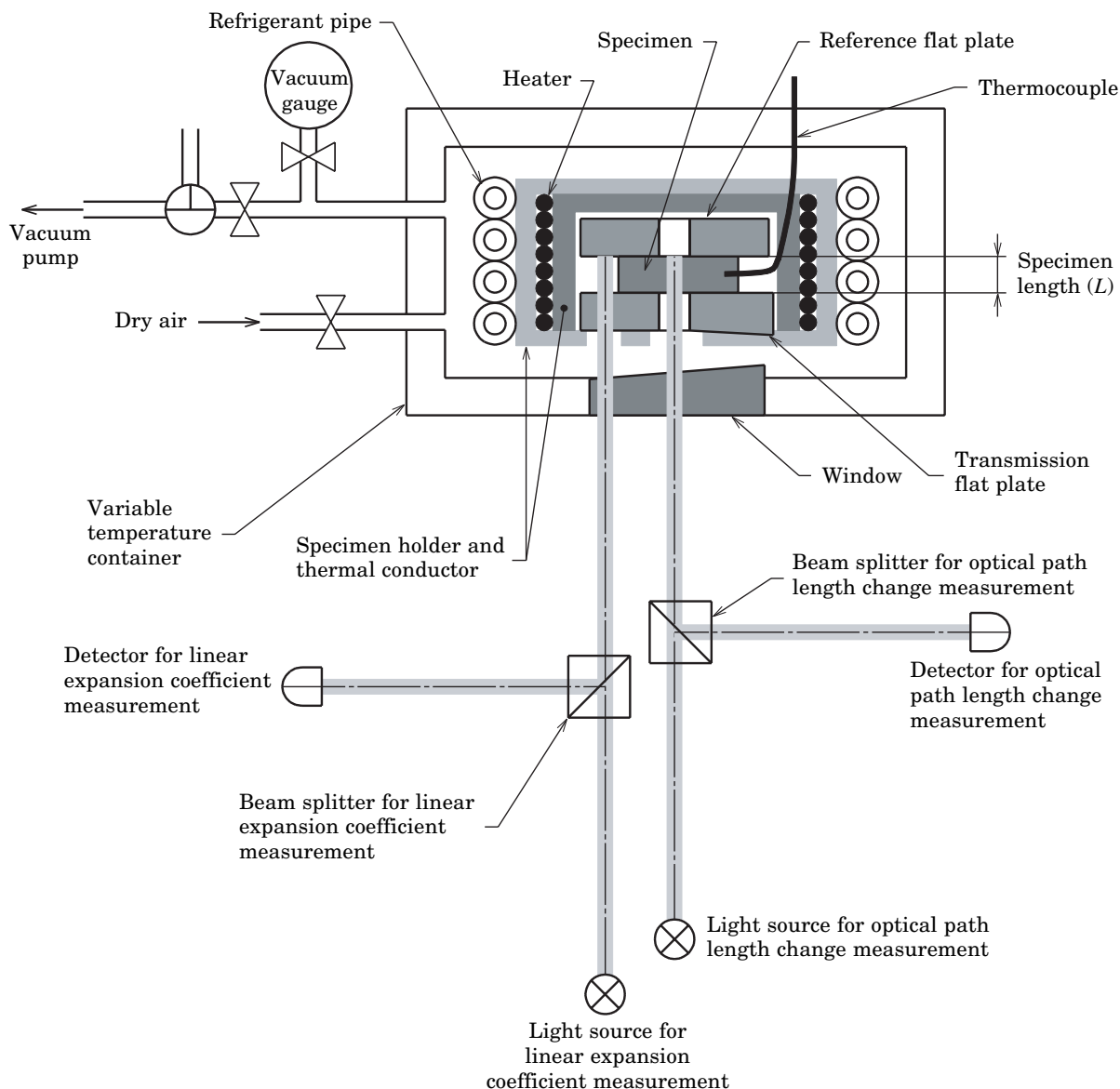


Figure 2 Example of schematic diagram of measuring apparatus of Fizeau interference type

5.2 Light source

Both light sources, one for measuring the change in optical path length and the other for measuring the linear expansion coefficient, shall have sufficient light intensity, monochromaticity and coherence in order to obtain interference fringes at the wavelength and accuracy used for the calculation.

The wavelength of the light source for measuring the change in optical path length, λ , and that for measuring the linear expansion coefficient, λ_α , are not required to be the same.

NOTE Examples of light sources are those given in Tables 1, 2 and 3 of **JIS B 7090**^[1].