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Refractometry of Lens Material by Using Interferometric Techniques

***Arvind Kumar Deshmukh and R.S. Kasana**

Department of Physics and Electronics
School of Mathematical and Physical Science
Dr. Hari Singh Gour Central University Sagar MP India 470003
**Corresponding Author E-mail: arvindkumar1278@gmail.com*

Abstract

The refractive index is an important optical parameter for various kind of liquid, lens and transparent materials etc; it is an characteristic constant of optical materials which has the universal appeal in different field of science and technology namely glass-industries, instrumentation, refractometry etc. a technique for determining the refractive index of lens has been reported in this paper. For this purpose a simple approach has been exercised to establish a relation between the refractive index of lens and separation of interferometric fringe by using three-beam interferometry and liquid immersion techniques. The difference between successive interferometric fringe and standard refractive index of liquid filled in glass cell is of high significance. The technique of liquid immersion with interferometry has been adopted for evaluating the refractive index of lens material.

Keywords: Lens, liquid immersion, fringe, refractive index.

Introduction
This paper reports a non-destructive liquid immersion technique with three-beam interferometry for determining the refractive index of Lens material. Due to importance of refractive index in glass industries, optical and chemical engineering etc, it provides the scale of purity and reproducibility of material. A quick and accurate measurement of this important parameter is required in many fields of science and technology. The refractive indexes of lens have been measured by using various techniques. This paper presents an extended work of Kasana et-al [22] which presents a technique for determining the refractive index of liquids. The liquid immersion techniques [1-3] have been modified for determining the refractive index

of lens material. Khashan and Nassif [4] measured the refractive index of solids and liquids very accurately using a double layer interferometer. Shayam Singh [5-8] described various methods for the measurement of refractive index of liquids and solid with two beam interference and minimum use of optics but the in two beam method it is difficult to measure the position of a fringe. The three beams Zernike's interferometer [9] is used with liquid immersion techniques in proposed method because it is easy to set up and is very stable. Richerzhangen [10] has described a method for measuring the absolute refractive index of liquid with Michelson interferometer.

Recently several ways have been used for finding the refractive indices of liquid and solid by using grating coupled surface plasmon [11], acousto-optic diffraction techniques and interferometric techniques has been reported [12-14] by Kasana et-al and Musso et-al. Many attempts have been make from time to time which have been reported in literature [15-21]. All these aforementioned techniques are expensive and need lot of preparation. They require prior knowledge of various optical parameters in order to determine the refractive index of liquids or solids. In the proposed interferomeric technique we have centred our attention for the study of refractometry of lens materials. For this purpose-simple approach has been exercised by using three beam interferometry and liquid immersion method and establish a relation between refractive indexes of lens and fringe separation.

Theory

For the lens index formula from Kasana et al [2010], we know that the focal length of the lens inside the liquid is given by

$$\frac{1}{F} = (n - n_L)(c_1 - c_2) + (n - n_L)^2\, t\, c_1 c_2 / n \qquad [1]$$

Where, F= Focal length of Lens, t = Thickness of the lens, n = Refractive index of lens, n_L = Refractive index of liquid, C_1, C2 = Curvature of the lens surfaces, By considering either a thin lens or Plano convex lens, equation (2) is given as:

$$\frac{1}{F} = (n - n_L)(c_1 - c_2) \qquad [2]$$

For i^{th} and j^{th} liquid

$$\frac{1}{F_i} = (n - n_i)(c_1 - c_2) \qquad [3]$$

$$\frac{1}{F_j} = (n - n_j)(c_1 - c_2) \qquad [4]$$

By using equation (1),(4) and (5) we get

$$n = \frac{n_j d_j - n_i D_i}{D_j - D_i} \qquad [5]$$

Where, n $_{jth}$ liquid = Refractive index of jth liquid, D $_{jth}$ liquid = Separation between successive fringes in jth liquid, n = Calculated Refractive index of lens immersed in liquid, D $_{ith}$ liquid = Separation between successive fringes in ith liquid /medium, n $_{ith}$ liquid = Refractive index of ith liquid /medium. Equation [5] gives the relation for determining the refractive index of lens, which shows the refractive index of lens is depends on the fringe separation in ith , jth liquid and refractive index of liquid filled in glass cell. All the calculations are made on the basis of equation [5].

Optical Configuration and Procedure

For this purpose the optical configuration and procedure is adopted from Kasana and Deshmukh [22]. The optical layout of proposed technique is consisting of laser light, slit and glass cell filled with liquid. The test lens is immersed in liquid inside the glass cell, which is placed on the optical bench. The parallel light after passing from the slit, crossed by the glass cell and than test lens and liquid combination. This parallel light crossed by a lens and liquid produce an interference pattern consisting of equal spaced, parallel straight fringes to back focal plane of test lens. The main concern of it the diffraction phenomenon which is originated by slit having d (distance between slit) is equal to element of low frequency ruling grating. All the components have been named in figure 1 It self.

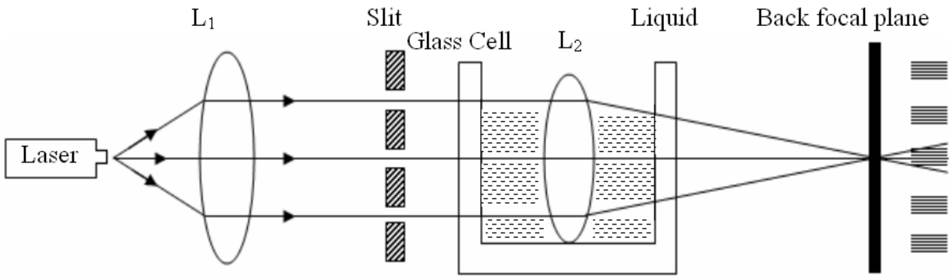

Figure 1: Optical configuration used for evaluating the refractive index of lens.

For each investigation new liquid is filled in the glass cell. Thus every time the fringe pattern is shifted to new focal plane of test lens corresponding to liquid. The separation between successive fringes can be measured by x-y recorder. All the investigation has been made at room temperature which is mentioned in observation title.

Result and Discussion

In the present experiment, we have centred our attention for determining the refractive index of lens material. Equation [5] gives the relation for determining the refractive index of lens. The calculate refractive index of test lens is shown in table 2 corresponding to different pairs of medium. We found that the value of calculated refractive index of test lens is always correct about up to fourth place of decimal. It is also observed that the refractive index of j^{th} liquid/medium must be greater than the refractive index of i^{th} liquid/medium. By using general equation [5] be found that the refractive index of test lens is n = 1.5245, which equal to the standard value of the refractive index of test lens.

Table 1: The average value of the fringe separation corresponding to medium.

S.No.	Medium Name	Average value of fringe separation corresponding to medium D(mm)	Standard value of refractive index of medium
1	Air	1.5650	1.000
2	Water	4.2440	1.3311
3	Xylol	25.7556	1.4927
4	Banzol	32.2240	1.4991

Table 2: Calculated refractive index of test lens corresponding to pair of medium.

S.No.	Possible pair names of medium		Calculated refractive index of test lens n (by using equation 5)
	i^{th} medium/ liquid	j^{th} medium/ liquid	
1	Air	Water	1.5245
2	Water	Xylol	1.5245
3	Xylol	Benzol	1.5245
4	Air	Xylol	1.5245
5	Air	Benzol	1.5245
6	Water	Benzol	1.5245

Conclusion

In the proposed technique the fringe separation is only measured parameter. This method is independent from wavelength of light source, focal length of lens etc. so it is clear that the error in calculation of refractive index of lens is reduced. The accuracy of refractive index is calculated by proposed technique up to fourth place of decimal. This method is very easy to get optical configuration, economic and quick to identify the refractive index of lens. Some limitations are associated with this method that is discussed below.

a. The pair of medium or liquid is always used for determining the refractive index of the lens material.
b. It is the necessary condition for choosing the pair of medium that the refractive index of j^{th} medium is must be greater then the refractive index of i^{th} medium or liquid.

Reference

[1] R. S. Kasana and K.J. Rosenbruch, Applied Optics, USA, 22, 3526 (1983).
[2] R. S. Kasana et-al, Applied Optics. USA, 23, 757 (1984).
[3] M. A. Khashan and A Y Nassif, Applied Optics. , 39, 5991 (2000).
[4] S. Singh, Physica Scripta, 65, 167 (2002).
[5] S. Singh, Res. J. Chem. Environ, 7, 62, (2003).
[6] R. S. Kasana and K.J. Rosenbruch, Optics Communications, 46, 239 (1983).
[7] Shyam Singh, Journal of Optics., 34, No-4, 193 (2005).
[8] S. Singh, South African Journal of Science., 100, 18 (2004).
[9] B. Vittoz , Rev. Optics, 3, 253 (1956).
[10] B. Richerzhagen, Applied Optics. 35, 1650 (1996).
[11] H. Kano and S. Kawata, Jpn. J. Applied Physics, 34, 331 (1995).
[12] R. S. Kasana and K. Soni, Atti Della, Fondazione Giorgio Ronchi, ANNO, LIX – N. 6, 805, (2004).
[13] R. S. Kasana et-al, Optics Communications, 236, 289 (2004).
[14] M. Musso et-al, Meas. Science and Technology, 11, 1714 (2000).
[15] R. S. Kasana and D. K. Jain, Optics Communications, 199, 237 (2001).
[16] L. Levesue et-al, Applied Optics. 33, 8036 (1994).
[17] Ming- Hong Chiu et-al, Applied Optics. 86 N-13, 2936 (1997).
[18] V. Lib Deng, Applied Optics. 37, 998 (1998).
[19] Z. Otremba, Opt. Express, 7, 129, (2001).
[20] Buckley, JS. Energy fuels, 13, 328 (1999).
[21] H. Wang, J. Optical Soc. Am. A., 11, 233 (1994).
[22] R. S. Kasana and Arvind Kumar Deshmukh, International Journal of Pure and Applied Physics, 6 (3), 263 (2010).