Synthesis and Refractive Index Characterization of EBBA Liquid Crystal

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Abstract

In this paper, the Nematic Liquid Crystal (NLC) N-(4'-ethoxybenzylidene)-4-n-butylaniline (EBBA) with transition temperature range between (36-80) ℃ was prepared and identified using Fourier transform infrared spectroscopy (FTIR).

The prepared compound (EBBA) was used to calculate the values of refractive index at different temperatures and measurements were done in the temperature range (25-80)℃. The result shows, the values of refractive index values decreases with increase temperature in thermal range.

Keywords**:** Liquid crystal, refractive index, temperature sensor.

Introduction

Liquid crystal (LC) is intermediate state between crystalline solid and isotropic liquid. Liquid crystal can flow like liquid and have high orientation order like crystalline solid, so the liquid crystal phase share properties of the liquid and crystal phases. The distinguishing characteristic of the LC state is the tendency of LC molecules to point along a common axis called director. Discovery of LCs in 1888 is commonly attributed to the Austrian botanist Reinitzer. Liquid crystal have many useful properties and applications in many devices such as digital holography [1], optical data storage [2], light modulators [3], LC displays [4]. Temperature sensor [5], and electric field sensor [6].

The Abbe refractometer (American Optical 10450 with accuracy equal to 0.0001) is useful for measurement the refractive indices at different temperature. The thermal nonlinearity of liquid crystal refractive indices is very important for photonic applications, such as design temperature sensors by using photonic crystal fiber with liquid crystal [7].

Method and Experimental Part

Preparation of N-(4`-ethoxybenzylidene)-4-n-butylaniline (EBBA) liquid crystal materials and measurements the refractive indices for this material at different temperatures are carry out with wavelength equal to 589.3 nm.

1-Preparation of N-4'-ethoxybenzylidene

step1: A mixture of (1.1 g) 4-hydroxybenzaldehyde and (2.76 g) of anhydrous K_2CO_3 were dissolved in (4 ml) cyclohexanone, (0.008 mole) of appropriate ethyl bromide was added, and the mixture was refluxed with vigorous stirring for overnight. The mixture was filtered, the solvent was distilled off. The reaction equation and reaction mechanism of prepared N-4'-ethoxybenzylidene show in scheme 1 and 2.

step2: A mixture of N-4'-ethoxybenzaldehyde (1.5 ml) and 4-n-bytylaniline (1.6 ml, 0.01 mole) in absolute ethanol (20 ml) with two drops glacial acetic acid was refluxed with stirring for four hours. The formed precipitation was filtrated and recrystallized from ethanol to give N-(4'ethoxybenzylidene)-4-n-butylaniline.

2-Calculation of refractive index for (EBBA) Liquid crystal

In experimental part, calculation of refractive index values at different temperatures of N-(4'-ethoxybenzylidene)-4-n-butylaniline (EBBA), liquid crystal in nematic phase, which has chemical structure as shown in scheme (3).

The measurements were done in the temperatures range (25^0- 80^0). The result shows that, the Index of refraction values decreases from (1.3284–13198) with temperature increase that. The refractive index of (EBBA) liquid crystal at different temperatures (25^0-80^0) was measured by using

Abbe refractometer device shows in Fig.(1), were recorded using sodium D line with wavelength (ƛ=589,3nm).

In all refractive index measurement, the temperature is constant within ±0.01K using a HAKKE-D1-G thermometer water bath and a Hewlett-Packard model 201 Aquartz thermometer, which is work in the visible light region (4000 - 8000 nm). The refratometer was connected to the water bath.

Result and Dissection

1-Preparation and characterization of N-(4'-ethoxybenzylidene)-4-n-butylaniline (EBBA)

N-(4'-ethoxybenzylidene)-4-n-butylaniline (EBBA) was prepared from the condensation reaction of 4-ethoxybenzaldehyde and 4-n-butylaniline according to the reaction shown in scheme (3)

The mechanism of the synthesis of EBBA was shown in the following scheme (4)

A-Fourier transform infrared spectroscopy (FTIR)

The prepared compound was identified by FTIR spectroscopy. The characteristic bands of EBBA, 4-n-butylaniline, and 4-ethoxybenzaldehyde are shown in Figs.(2),(3), and (4) respectively. Compound of EBBA shows the appearance of band at 3020 cm^{-1} that attributed to the υ (C-H) arom. Groups, bands at. 2954.95, 2927.94, 2858.51 cm^{-1} assigned to the asymmetrical and symmetrical stretching of (C–H) aliphatic, respectively, the imine band appeared at 1616.35 cm^{-1}, bands at 1516.05 cm^{-1}, 1118.71 cm^{-1}, and 829.39 cm^{-1} that are due to υ (C=C), υ (C-O), and out of plane bending of para dis substituted benzene ring respectively. The disappearance of the υ (NH_2) group for amine and υ (C=O) group of aldehyde are also detected.

b-UV-Visible spectroscopy for EBBA

By using uv-visible spectrophotometer device, the absorption region of the EBBA liquid crystal was determined. From Fig.(5) found the absorption value of the LC at the wavelength of maximum absorption (λ_{max}=246 nm).

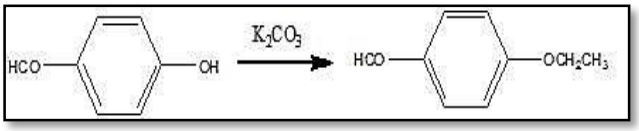
2-Calculation of refractive index for (EBBA) Liquid crystal

By adding drop from (EBBA) in the liquid form upon the slide of device and temperature controlling, many values of refractive indices was measured, as shown in the Table (1). Figs.(6) refers to the relationship between the refractive indices and temperature, (a) in the heating process. (b) In the cooling process. (c) In the average.

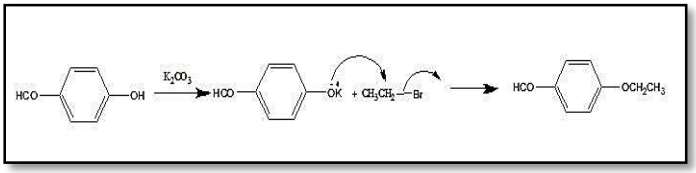
From Table (1) the refractive index of the liquid crystal (EBBA) shows very small variation with temperature, this variation is normal compared with other liquids such as water [8] and (4-Methoxy - Benzylidene -4-Butyl -n- Aniline) (MBBA) liquid crystal [9].

Conclusion

The values of refractive indices decrease with increasing temperature in thermal range (25-80)℃, so this liquid crystal material (EBBA) have good property for different thermo-optics applications such as temperature sensors.

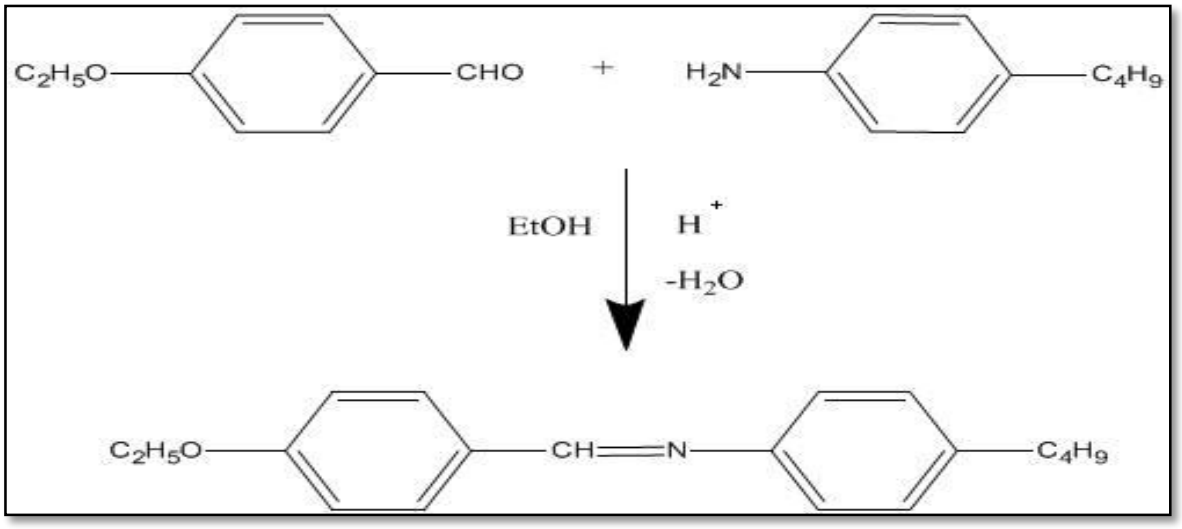


Scheme (1) Reaction equation to the prepared N-4'-ethoxybenzylidene.

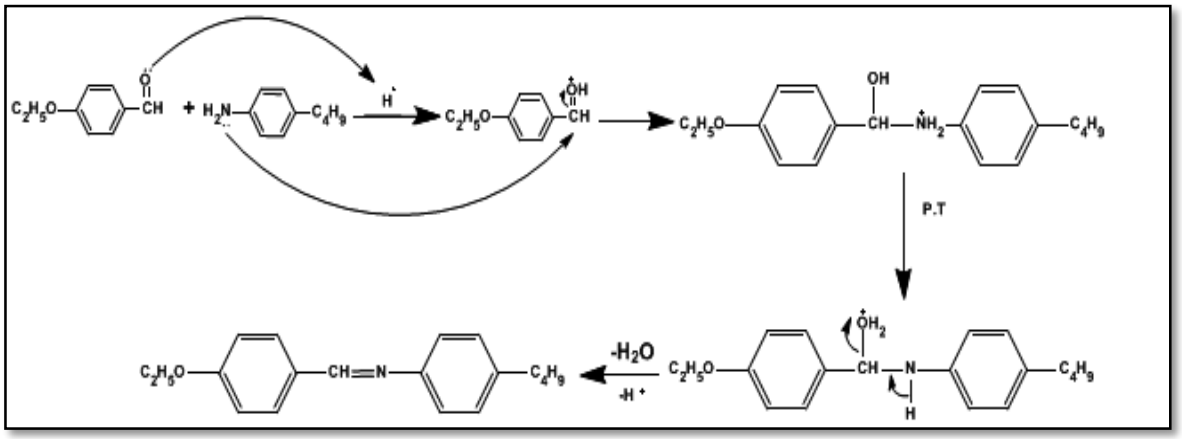


Scheme (2) Reaction mechanism to the formation of N-(4`-ethoxybenzylidene).

Fig.(1): Abbe refractometer device.



Scheme (3) Reaction equation to the prepared EBBA.



Scheme (4) Reaction mechanism to the formation of N-(4`-ethoxybenzylidene)-4-n-butylaniline.

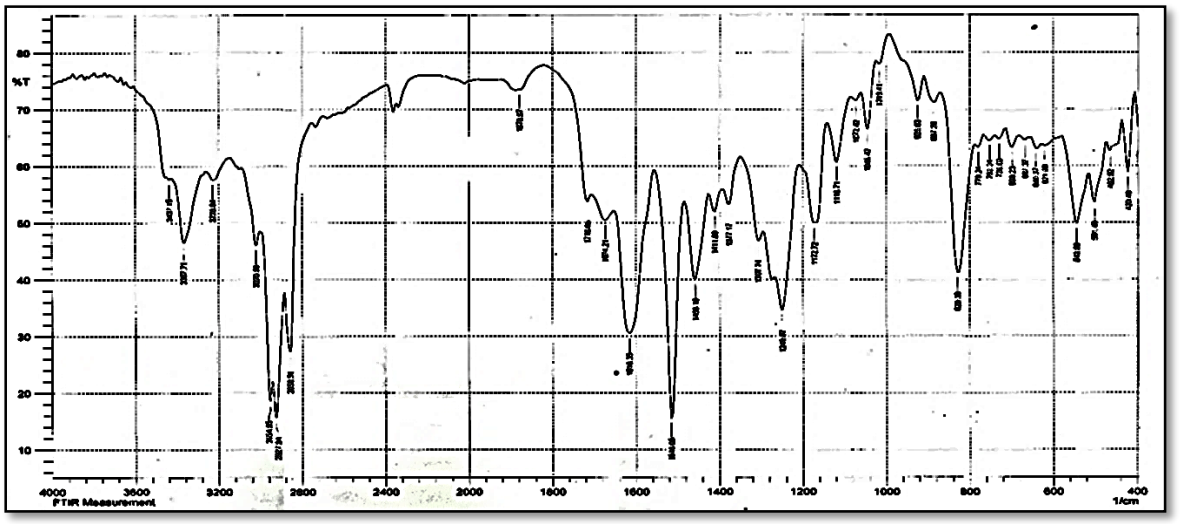


Fig.(2): FTIR spectrum of EBBA.

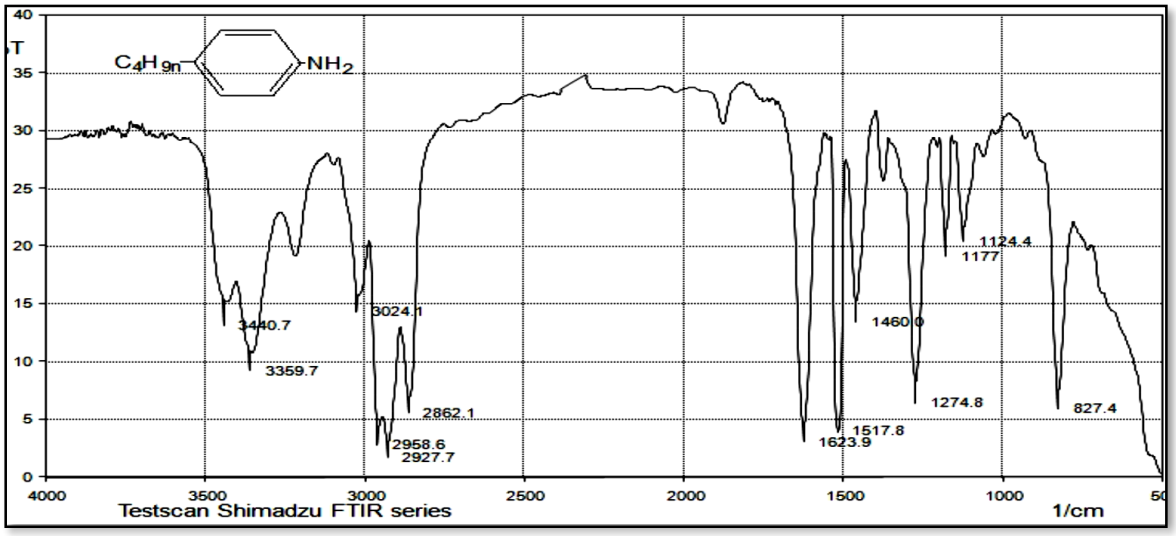


Fig.(3): FTIR spectrum of 4-n-butylaniline.

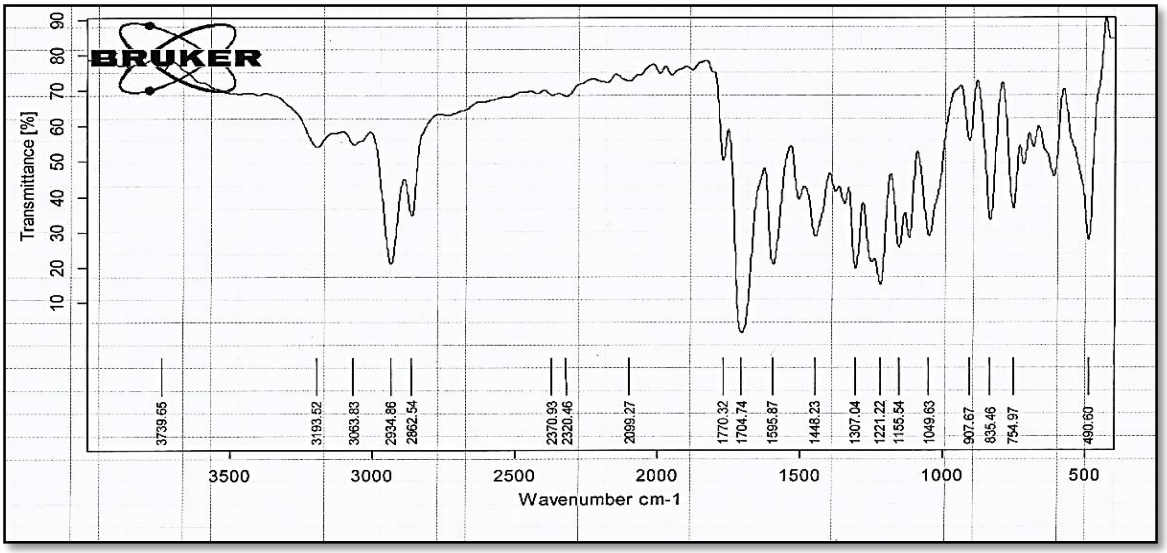


Fig.(4): FTIR spectrum of 4'-ethoxybenzylidene.

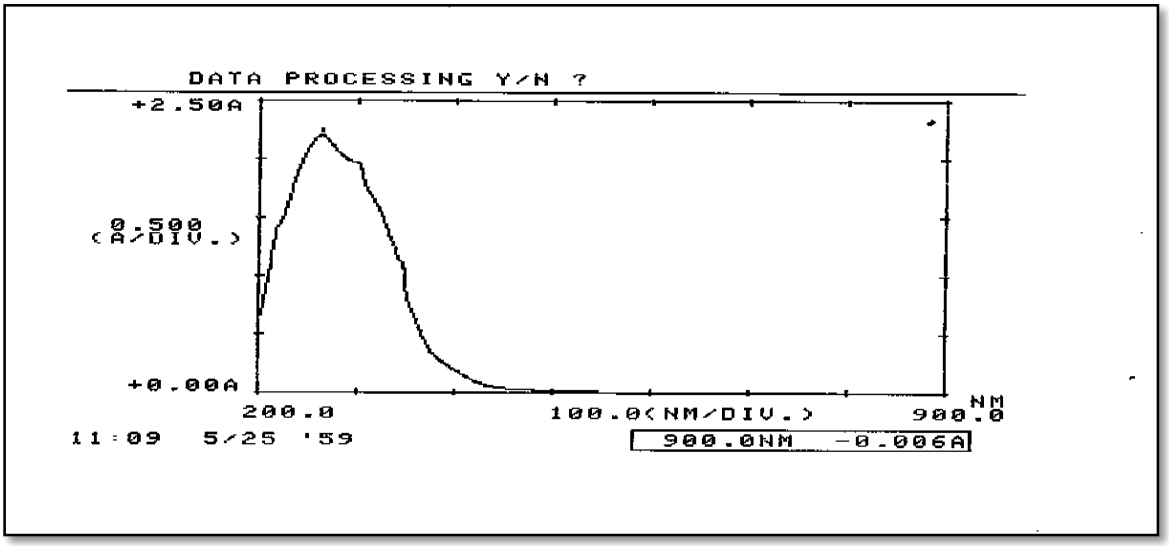


Fig.(5): UV-Visible for EBBA.

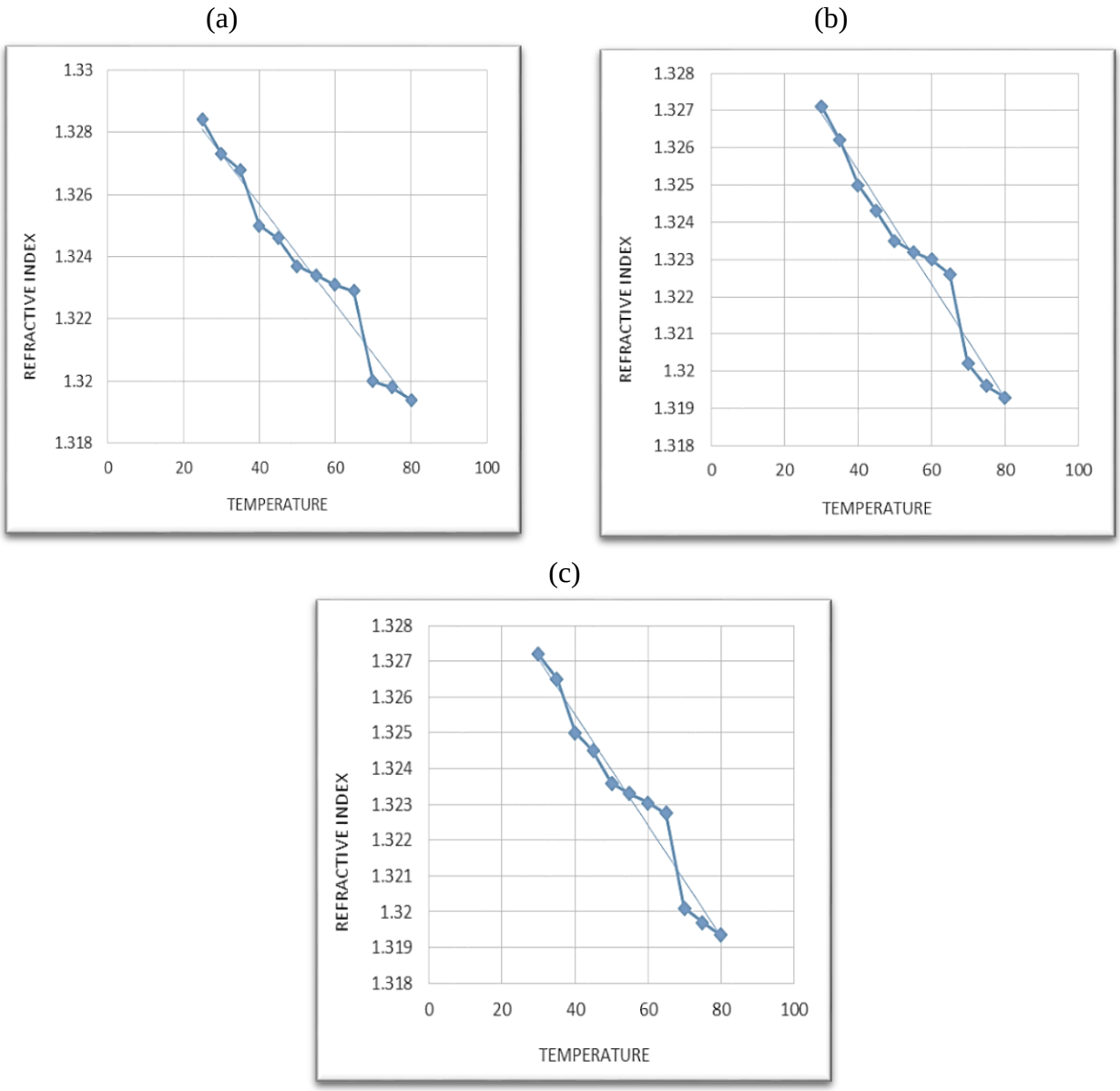


Fig.(6): Show the variation of refractive index with temperature: (a) in the heating process. (b) In the cooling process. (c) In the average.

Table (1)

The values of refractive index with changing temperature.

Temperature (T)	***$n_{heating}$***	***$n_{cooling}$***	***$N\Delta$***
25^0	1.3284	1.3284	1.32840
30^0	1.3273	1.3271	1.32720
35^0	1.3268	1.3262	1.32650
40^0	1.3250	1.3250	1.32500
45^0	1.3246	1.3243	1.32450
50^0	1.3237	1.3235	1.32360
55^0	1.3234	1.3232	1.32330
60^0	1.3231	1.3230	1.32305
65^0	1.3229	1.3226	1.32275
70^0	1.3200	1.3202	1.32010
75^0	1.3198	1.3196	1.31970
80^0	1.3194	1.3193	1.31935

الخلاصة

في هذا البحث تم تحضير المركب البلوري السائل (النيماتي) N–(٤–ايثوكسي بنزلدين)–٤–ن–بيوتل انيلين (EBBA) الذي يكون الطور البلوري السائل النيماتي له بدرجة حرارة انتقالية بمدى (٨٠°م–٣٦°م) وتشخيص التركيب الكيميائي له باستخدام مطياف الاشعة تحت الحمراء FTIR.

المادة البلورية السائلة (EBBA) تم استخدامها في حساب قيم معامل الانكسار بدرجات حرارية مختلفة والقياسات اجريت عند المدى الحراري (٨٠°م–٢٥°م). النتائج توضح ان قيم معامل الانكسار تتناقص بزيادة درجة الحرارة.

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