IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 14, Issue 1 Ser. III (Jan. – Feb. 2022), PP 01-04
www.iosrjournals.org

Coconut Oil as a Substitute for 5cb Liquid Crystal in Certain Applications

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Abstract:
Over the years the breakthrough in optical technology with liquid crystals as the major material has been of great interest. In this research we investigate the optical properties of coconut oil in the UV and NIR region with of view of finding a substitute for certain types of liquid crystals. The coconut oil was thermally tuned within the UV and NIR region and the responses were studied using the spectrophotometer. The coconut oil after heating at 80^{o}C and then cooling down to 26^{o}C showed a similar absorbance behavior when compared with MY(methyl yellow) and MR(methyl red) in 5CB liquid crystal at 1% wt. It was further shown that at 50^{o}C the coconut oil showed a similar transmittance behavior compared with 5CB liquid crystal. This opens up the possibility of using the coconut oil as a substitute for 5CB liquid crystals within the UV and NIR regions respectively.

Key Word*: coconut oil, liquid crystal, transmittance, absorbance, 5CB*

Date of Submission: 25-01-2022 Date of Acceptance: 07-02-2022

I. Introduction

The term liquid crystals is a puzzle since basically we have three states of matter namely solid, liquid and gas. However, there is the intermediate state between solids and liquids otherwise known as the liquid crystal state [1] Liquid crystals(LC) are materials that have properties which are in between a conventional liquid and the crystalline solid state and they are known to flow like liquid and have molecular alignments of solids, having a short range positional order [2,3]. The dual nature and response of liquid crystals(LC) to electromagnetic fields and temperature changes provide great opportunities for applications in various electro-optical devices such as LC displays, epoxy resins, thermal mapping, thermal sensors, medicinal uses, optical imaging, solar cell etc [4,5,6]. Kedzierski[7] studied the optical properties of a liquid crystal with small ordinary and extraordinary refractive indices and small optical anisotropy. The ordinary and extraordinary refractive indices were measured as a function of temperature by the use of Abbe refractometer and wedge nematic cells, where an increase in temperature resulted to an increase in the birefringence. Apostol, et al [8] carried out a research on the Synthesis of Liquid crystals from coconut oil and the presence of Infrared (IR) spectrography confirmed the presence of two melting points at 80^{0}C and 110^{0}C and further showed that coconut oil had liquid crystalline properties. In view of this, we have investigated the coconut oil at various temperatures using the spectrophotometer and compared the results obtained with standard liquid crystals.

II. Theory

The transmitted light through a sample or solution can be affected by the analye in the solution. The more the analyte is found in the solution, the more the light is absorbed by it and the lower is the transmission through the solution. The absorbance A ca be expressed in terms of the transmission T of a material as

$$A = \log_{10} \frac{I}{I_o} = -\log_{10} T \tag{1}$$

where I_o is the light transmitted by that material and I is the light received by the material.
The optical depth is the measure of the extinction coefficient or absorptivity up to a specific depth. It describes how much absorption occurs when light travels through an absorbing medium. The optical depth, denoted by β, is expressed as

$$B = A \ln 10 \tag{2}$$

According to the Beer-Lambert law, we can express the absorbance A as

$$A = cd\varepsilon \tag{3}$$

where c is concentration, d is the path length and ε is the extinction coefficient

III. Results and Discussion

The coconut oil was heated from a temperature of 40^0C to 80^0C and various measurements of transmittance and absorbance were carried out using a UV 1650PC UV – VIS spectrophotometer. At a temperature of 40^0C, we obtained the absorbance. Likewise for temperatures of 50^0C, 60^0C, 70^0C and 80^0C, we obtained their respective absorbance as shown in figure 1.

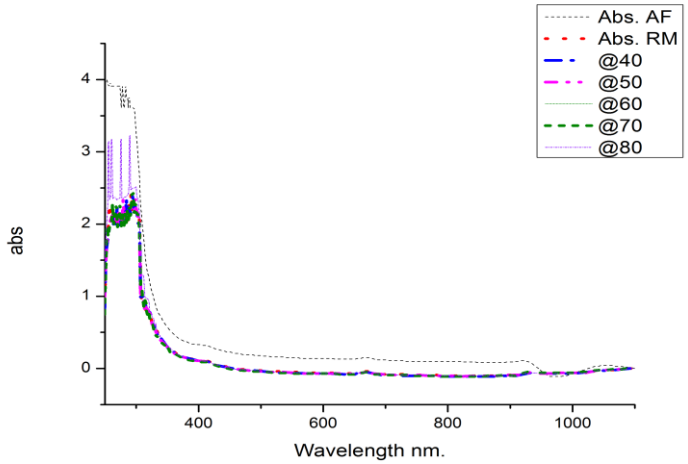

Figure 1: Absorbance of coconut oil at different temperature ranges from 40^0C, 50^0C, 60^0C, 70^0C and 80^0C respectively.

From the absorbance measurements of figure 1, we have extracted figure 2 below for a clearer comparison with figure 3 below.

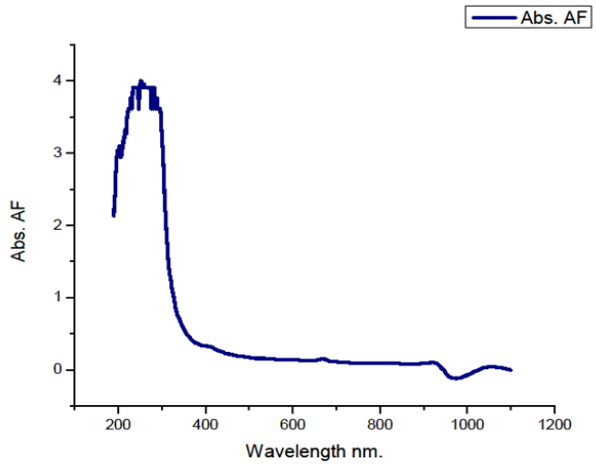

Figure 2: Absorbance of coconut oil after heating.

From figure 2, a high absorbance region was observed between 200nm to 300nm for the heated coconut oil while for wavelengths greater than 350nm the coconut oil appeared to be transparent at the different temperatures of 40^oC to 80^oC. According to R. Ramos-Garcia Et.al[9], Azobenzene dyes of MY and MR, were doped in 5CB liquid crystal and the absorbance over a wavelength range of 400nm to 1000nm was obtained as shown in figure 3 below.

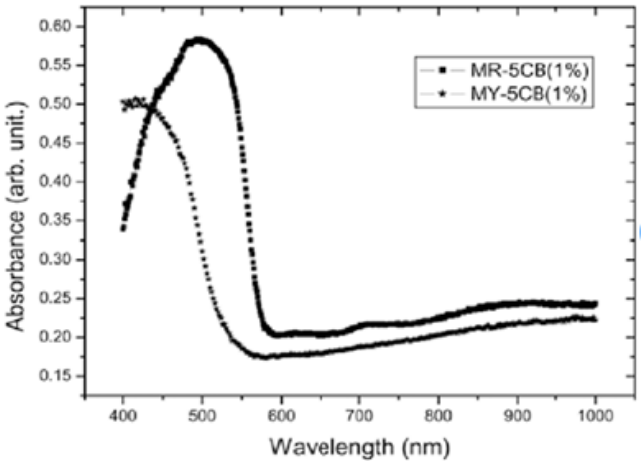

Figure 3: Absorbance spectral of MY and MR in 5CB liquid crystal at 1% wt (R. Ramos et.al 2015).

From fig 3, there was a high absorbance between 400nm and 550nm in the 5CB doped with MR (methyl red) and MY(methyl yellow) [9]. This behavior is comparable to the results obtained in figure 2 for the coconut oil after heating from 40^{o}C to 80^{o}C.

Figure 4(a) presents transmittance measurements of pure 5CB, 5CB + SWCNT (single wall carbon nanotube) suspension (0.02 wt%) measured in the isotropic (T = 310K) and nematic (T = 301K) phases over the wavelength range of 200nm to 800nm[10]. Also presented in figure 4(b) is the measurement from our experiment for the transmittance for the coconut oil over the wavelength range of 200nm to 800nm.

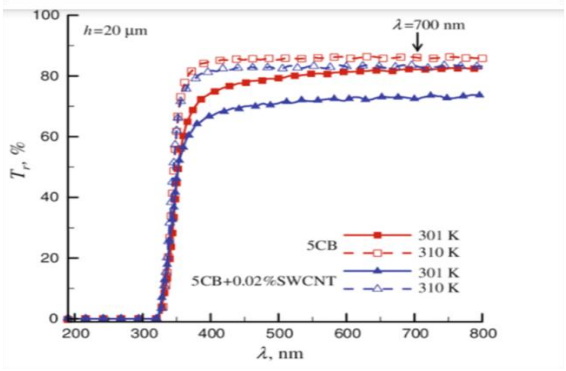

Figure 4(a)

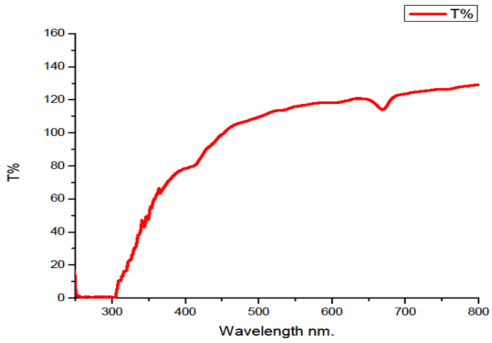

Figure 4(b)

Transmittance of 5CB with other impurities over the wavelength range of 200nm to800nm(fig. 4(a)) and for cocnut oil(fig4(b)) at 50^{0}C over the wavelength range of 200nm to 800nm.

The transmittance measurements for 5CB with impurities (figure 4(a)) and the heated coconut oil at 50^{0}C from our experiment (figure 4(b)) show interesting similar behaviors. From both figures 4(a) and 4(b), we observe that transmittance was about zero for wavelengths below 300nm and a high transmittance was observed for wavelengths over 300nm for both 5CB with impurities and the heated coconut oil.

IV. Conclusion

From our results we have shown the coconut oil has some optical characteristics which can be likened to that of a synthetic liquid crystal such as 5CB due to the presence of cholesterol in the coconut oil. With proper synthesizing of these oils, they can act as a possible substitute to certain liquid crystals for some specific applications. From our experiment with the coconut oil, it was observed that after heating to 80^{0}C and allowing it to cool down to 40^{0}C, a similar absorbance behavior was observed when compared to MY(methyl yellow) and MR(methyl red) in 5CB liquid crystal at 1% wt. Also at 50^{0}C, the coconut oil showed a similar transmittance behavior compared with 5CB liquid crystal. This research shows that coconut oil at certain temperatures can have similar properties with some known liquid crystals like 5CB dopped with MY and MR. A consequence of this is that coconut oil can serve as an alternative to 5CB and other liquid crystals for certain specific applications, thereby cutting down production cost compared to the standard liquid crystals.

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N.E.J. Omaghali, et. al. "Coconut Oil as a Substitute for 5cb Liquid Crystal in Certain Applications." *IOSR Journal of Applied Physics (IOSR-JAP)*, 14(01), 2022, pp. 01-04.