

MEASUREMENT OF REFRACTIVE INDEX AND ABSORPTION SPECTRUM OF OLIVE OIL

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Abstract

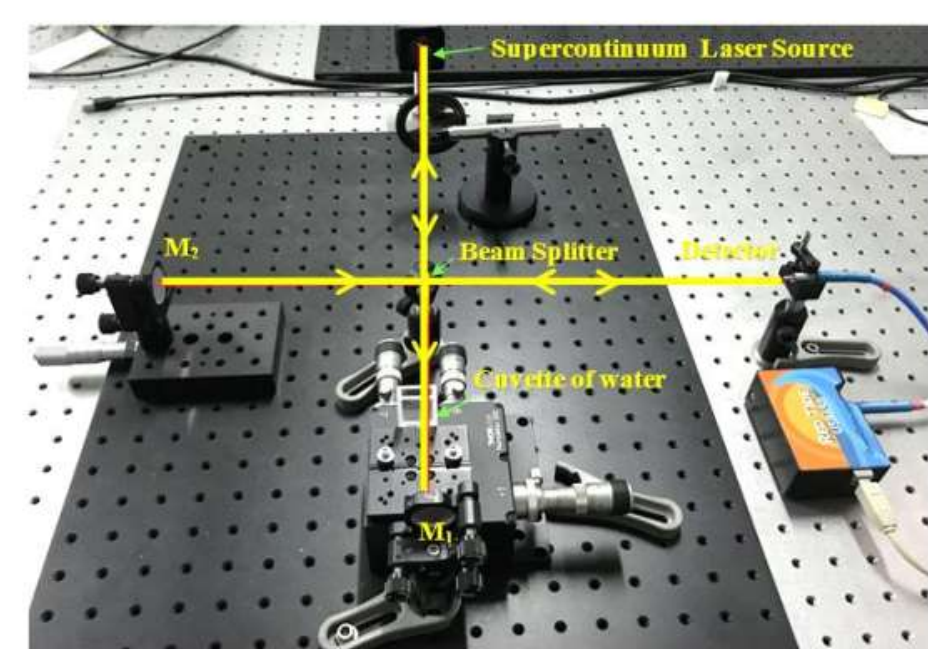
In this work, we present the results of refractive index measurements of olive oil. From the experimental data, we processed the results and derived the Sellmeier coefficients for the refractive index function as a function of wavelength for olive oil. Additionally, we measured the absorption and transmission spectra of olive oil in the infrared region from a wavelength of 900 nm to 2400 nm.

Introduction

As is well known, liquids provide remarkable capabilities in the field of optics. Recent developments in optical devices have opened a new area: liquid photonics, which combines liquids and photonics. This field has garnered increasing attention recently due to new flexible concepts. Liquids are particularly suitable for supercontinuum generation because of their relatively high nonlinear refractive index n_2 compared to solids. Examples of applications include selectively liquid-filled photonic crystal fibers (PCFs) [3–6] and liquid-core optical fibers, where the dispersion properties can be tailored suitably to form supercontinuum. Liquid-filled samples in such fibers enable directional couplers, all-optical switching, and discrete spatial liquid optical solitons in waveguide arrays. Moreover, stimulated Brillouin scattering and self-phase modulation can be studied in these systems. Furthermore, pulse propagation in tapered fibers immersed in liquids can be adjusted. Additionally, the transparency in the visible and near-infrared range plays an important role in unobstructed light transmission in these configurations.

Theory

To investigate the refractive index of olive oil as a function of wavelength, we used a Michelson interferometer system as shown in Figure 1.



Experimental setup diagram using a Michelson interferometer to investigate the refractive index of olive oil at different concentrations.

Spectrophotometer is used to measure the absorption spectrum of olive oil.

At that time, the variation of the difference of optical path can be rewritten as follows:

$$\Delta'_M(\lambda) = 2(L - l) - 2t[N(\lambda) - 1] - 2d[N_l(\lambda) - 1] \quad (4)$$

At the equilibrium wavelength, the optical signal is zero. Therefore, the position of the mirror M_1 is determined by the following equation:

$$L'(\lambda_0) = l + t[N(\lambda_0) - 1] + d[N_l(\lambda_0) - 1] \quad (5)$$

If $\Delta L'(\lambda_0) = L'(\lambda_0) - L_0 = L'(\lambda_0) - l$ is the distance between the mirror M_1 and its initial position, the function of the group refractive index of soybean oil at the equilibrium wavelength λ_0 is calculated by:

$$N_l(\lambda_0) = 1 + \frac{\Delta L'(\lambda_0) - t[N(\lambda_0) - 1]}{d} \quad (6)$$

Finally, the phase refractive index of soybean oil is determined by the following equation: $N(\lambda) = n(\lambda) - \lambda \frac{dn}{d\lambda}$ (7)

The principle of spectrophotometric analysis is to show the substances absorb phenomenon on different wavelengths and do qualitative and quantitative analysis of the substances.

This instrument is measuring base on relative measurement. Choose a certain substance (Distilled water, air or the sample) as reference solution, set its transmittance to 100%. The transmittance of the sample being tested is relative to the reference solution. The transmittance and concentration of the test substance is related. Within a certain range, it is consistent with Lambert - Beer law.

$$T = I/I_0 \quad A = KCL = -\log I/I_0$$

T : Transmittance A: Absorbance C: Concentration

K: Absorption coefficient of the solution

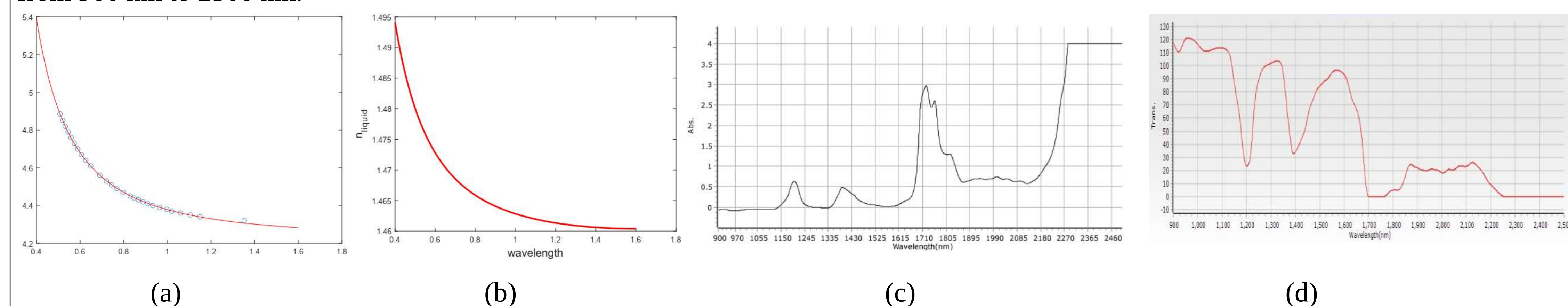
L: Length of the liquid layer in the optical path

I: Intensity of light transmitted through the test sample on the photoelectric converter

I_0 : Intensity of light transmitted through the reference sample on the photoelectric converter

Results

Figure (a) shows the experimental results of the relationship between the optical path difference and the wavelength at which the interference fringe reaches its maximum. From these results, we fitted the refractive index of olive oil as a function of wavelength, as shown in Figure (b). Figure (c) shows the absorption spectrum and Figure (d) shows the transmission spectrum of olive oil in the wavelength range from 900 nm to 2500 nm.



Conclusions

In this work, we measured the refractive index, absorption spectrum, and transmission spectrum of olive oil. The results show that the refractive index of olive oil was obtained over the wavelength range from 450 nm to 1600 nm, while the absorption and transmission spectra were measured in the wavelength range from 900 nm to 2500 nm.

Acknowledgments

- [1]. Gunter Gauglitz and David S. Moore, Handbook of Spectroscopy, Wiley-VCH, 2014.
- [2]. Krzysztof Wójcicki, Application of NIR spectroscopy for whisky identification and determination the content of ethanol, Poznań University, Poland, 2018.
- [3]. Shanghai Drawell Scientific Instrument Co., Ltd Spectrumbab 410 NIR Spectrophotometer User Manual.