GRAPHENE NANOPARTICLES ON REFRACTIVE INDEX OF CANCEROUS BREAST TISSUES: SPECTRAL APPROACH

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The study of the refractive index (RI) in biological tissues is of great importance due to its numerous applications in medical optics. This physical quantity provides information on the interactions between light and tissue, and its quantification is essential and necessary for the identification and diagnosis of different pathologies and their respective therapies. Biological tissues show a structural complexity in response to the light beam, as their structures (cells, membranes and macromolecules) are integrated into a heterogeneous network of fibres. The scattering of the optical field that occurs in these structures is a complex phenomenon that is closely related to both the spatial variations of the RI and the morphological parameters of the scattering centres, such as the size, number density and shape of the particles. Therefore, any change in these parameters is reflected in the light scattering patterns [1].

This analysis is a very useful tool in the detection and characterization of tumours, as cancerous tissues have significant variations in their cell structures that lead to changes in light scattering. In addition to these variations, the absorption of light by endogenous tissue chromophores, such as melanin (RI =1.70) is also a feature that can be used to classify a tissue as pathological. These biomolecules, with their high light absorption efficiency, especially in the ultraviolet range (high RI values), are essential for the light protection of the body against ionising radiation [1].

It is also possible to relate the RI value to various parameters, such as dehydration, protein concentration, infections, elasticity, conductivity, cell division, oxygen saturation and metabolic rate, to name but a few. Another example is the optical mapping of RI in breast tissue, which makes it possible to recognise differences in cancerous tissue, as this has a higher RI value compared to healthy breast tissue.

Recent studies have shown important and significant differences in RI between healthy adipose tissue (which makes up the majority of the breast) and epithelial and tumour tissue [2].

This article presents the study of a nanofluid with graphene nanoparticles to be applied to breast tissue to improve its UV-Vis spectral analysis. Graphene, which consists of a single layer of carbon atoms arranged in a hexagonal structure, has unique and extremely important physical and chemical properties, it is an excellent electrical and thermal conductor, very resistant, impermeable to gases but permeable to water, has good elastic properties and exhibits excellent optical transparency [3].

This poster presents the preliminary study carried out to select the ideal concentration to achieve the proposed goal. For this purpose, we used glycerol and water in different concentrations as base liquid, x C3H8O3 + (1 - x) H2O and different concentrations of nanoparticles.

Five samples were prepared with different volumetric concentrations of graphene nanoparticles, 0.01%, 0.025%, 0.05%, 0.075% and 0.1%, for the different glycerol-water based liquids, with a volumetric ratio of 100:0, 80:20, 60:40, 50: 50, 40:60 and 20:80. The nanofluids were prepared by the two-step method [4], using graphene nanoparticles with CAS 7782-42, size 11-15 nm, from *MK-nano*, and a glycerol solution from the commercial supplier *labKem*, with CAS 56- 81-5, together with distilled water obtained on the same day in the laboratory. A *Bandelin Sonopuls* HD 2200 ultrasonic homogenizer with a titanium tip (M72) was used to homogenise the solution. A *Kern* analytical balance with a resolution of 0.0001 g was used for mass measurements. The RI was measured with a *Kern* ORT-1 *Abbe* refractometer with a resolution of 0.0005. The FLEX STD UV-VIS spectrometer T24402 from Sarspec was used for spectra acquisition, together with the *Avantes* CUV-ALL-UV/VIS SF210125 sample holder and 10x10 mm quartz cuvettes from *PG Instruments*. A T17805 deuterium-tungsten lamp from *Sarspec* was used as the light source. The fibre optic cables used were UV/VIS with a diameter of 200 nm (T15717) and 600 nm (T05512), both 50 cm long. This configuration, as shown in Figure 1, was set up during spectra acquisition, with the dilution of the nanofluid used being 0.1 cc in 3 cc of base fluid.

The refractive index results for the different glycerol-water base liquids are shown in Table 1, where it can be seen that the index decreases with increasing water content.

Table 1 – Liquid Base refractive index

x $C_3H_8O_3$ + (1 - x) H_2O	RI
20:80	1,3675 ± 0.00003
40:60	1,3944 ± 0.00003
50:50	1,4085 ± 0.00003
60:40	1,4235 ± 0.00003
80:20	1,4475 ± 0.00003
100:0	1,4745 ± 0.00003

Table 2 – Refractive index (RI) of nanofluids with different concentration of graphene[1]

x % (V/V) graphene	RI
0.011%	1.4056 ± 0.00003
0.024%	1.4055 ± 0.00003
0.048%	1.4056 ± 0.00053
0.064%	1.4056 ± 0.00003
0.082%	1.4056 ± 0.00005

(1) Recalculation of the volume concentration after production of the nanofluids

It was found that the RI did not change significantly at low concentrations of graphene nanoparticles between the prepared samples. However, the RI decreased compared to the base fluid used in these samples (50:50).

Figure 2 shows the UV-Vis absorption spectra. It can be observed that at concentrations of 0.075% and 0.1% in the 190 to 200 nm range, the reader is saturated and reaches its maximum resolution. However, at lower concentrations, the peak around 200 nm can be seen, which is due to graphene.

The aim is to further investigate the study on nanofluids with graphene nanoparticles in both UV-Vis absorption and transmission and to apply a different method to measure the refractive index in order to quantify the RI of biological tissue immersed in the nanofluid. So, the next step is to apply these nanofluids to breast tissue samples to analyse the influence of graphene on the interaction of light with the tissue and evaluate possible differences in light scattering.

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References

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Figures

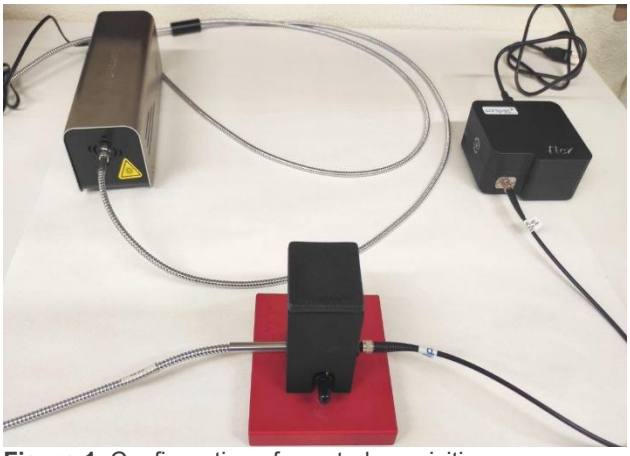

Figure 1. Configuration of spectral acquisition

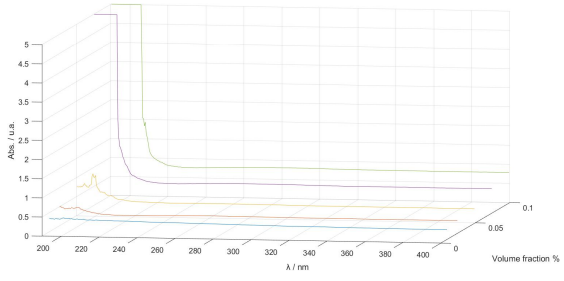

Figure 2. UV-Vis absorption spectra of nanofluids diluted in the base liquid with 0.01%, 0.025%, 0.05%, 0.075% and 0.1% graphene volume fraction