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Methotrexate Detection Based On The Optical Properties Of Carbon Nanotubes And Silver Nano Particles Nanocomposites

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Abstract
In this experiment, glassy carbon electrode with multi walled carbon nanotubes nanocomposites have been prepared in different concentration in order to see if methotrexate is anticancer drug. For the purpose of characterizing the structures, nanocomposites were analyzed by scanning electron microscope. Optical measurements of different concentrations were conducted by z-scan method and the results show that by rising the concentration, nonlinear refractive index and linear absorption coefficient increases. The values of nonlinear refractive index are in orders of $\mathbf{10^{-8}\frac{cm^2}{w}}$.

Keywords: **nanocomposites of carbon**. **z-scan technique. silver nanoparticles. methotrexate**

Introduction

Methotrexate (MTX) is one of the most important drugs in the treatment of cancer [1]. However, it has many side effects such as decreased brain activity, liver failure, gastrointestinal lesions and impaired kidney function.

Therefore, continuous measurement of MTX is of great importance in medical sciences and pharmacy [2]. Due to the characteristics of the optical method such as sensitivity, high selectivity, accuracy and ability to measure in situ, methods such as spectrophotometry, chemical luminescence and mass spectrometry have been used to detect and evaluate MTX. Also, to improve the results, metal nanoparticles such as gold nanoparticles or conductive carbon materials such as carbon nanotubes (CNTs) have been used. [3] Using the z-axis sweeping technique, first developed by Sheikh Baha'i, the nonlinear properties of materials are investigated by the closed-hole method and their nonlinear refractive index. In this study, the nonlinear optical properties of glass carbon electrodes with functionalized carbon nanotubes and silver nanoparticles (F-MWCNT / Ag) have been reported in various concentrations.

Theory

To measure linear absorption using Beer-Lambert's law, the relationship between the intensity of light entering and absorbed in matter is expressed.

$$\log\frac{I_0}{I} = \alpha L \qquad (1)$$

According to the slope of the diagram in Figure 4, the value $\frac{I_0}{I}$ is obtained and to Specify F-MWCNTs / Ag from its logarithm the value of the absorption coefficient α is obtained.

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In the nonlinear mode, using the normalized phase change relations and intensity, we obtain the nonlinear refractive index of the sample in the closed aperture mode:

$$n_2 = \frac{\lambda \Delta T_{P-V}}{2\pi I_0 L_{eff}(0.406)(1-S)^{0.25}} \quad (2)$$

In this relation L_{eff} is the effective length, which is calculated from Equation 3:

$$L_{eff} = \frac{1 - e^{-\alpha L}}{\alpha} \quad (3)$$

In Equation 2, I_0 is the maximum intensity at the foci that uses the relation. $I_0 = 2P_0 / \pi W_0^2$ is obtained in which P_0 is the input power, S is the light intensity passing through the aperture, the intensity of the total light reaching the aperture plane, and W_0 is the beam radius (40 micrometers) [4].

Materials and Methods

In this study, functionalized carbon nanotubes (diameter 5-10 nm and approximate length 10 μm) and ethanol with a concentration of 99.8% and also phosphoric acid with a concentration of 80-80% and

Acetone with a concentration of 99% were used. The morphology of the samples was investigated using scanning electron microscopy analysis. The fabrication of nanocomposites of carbon nanotubes and silver nanoparticles has been done in two stages. First, the suspension of functionalized carbon nanotubes in deionized water was subjected to ultrasound for 1 hour and then 0.006 mM solution of AgNO3 was prepared.

Secondly, 5 ml of F-MWCNT solution with a diameter of 5-10 nm and a length of 10 μm with 25 ml of a solution of 0.006 mM AgNO3 with dimensions of 500 nm and using ultrasound waves and silver nanoparticles well in the network Carbon nanotubes were placed. Simultaneously, the pH of the nanocomposite was increased to 5.5 using a 0.1 M NaOH solution. This process was performed for 0.012, 0.018, 0.024 and 0.03 mM AgNO3 solutions and values were obtained in different concentrations. Finally, we examine the resulting material using the z axial sweeping technique. The layout of Figure 2 is used to measure linear absorption. It should be noted that in order to minimize the dispersion, the detector should be located at the shortest distance to the sample. As shown in Figure 4, as the input power increases, the output power increases linearly, and according to the slope of the graph, the linear absorption of the sample is measured by Beer-Lambert law. The Nd: YAG laser light source (532 nm and a maximum power of 50 mW) is used to measure the nonlinear refractive index at various concentrations. The distance from the focal point to the aperture is 81 cm. Also, a converging lens with a focal length of 8 cm is used and light is reflected in the direction of the rail axis to the sample. In the axial sweeping technique using a closed hole, the diameter of the hole opening is 5 mm.

According to the diagram in Figure 5, due to the peak at the beginning of the diagram, the sign of nonlinear refractive index is always negative and considering the linear absorption coefficient for each concentration, the values of n_2 that are seen in Table 1 are different [5].

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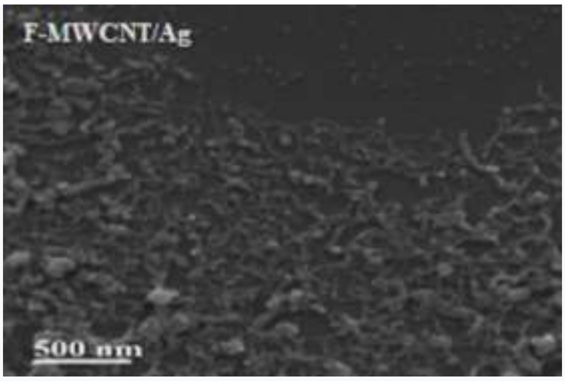

Figure 1. SEM image of the electrode surface
F-MWCNTs / Ag contains 0.006 mM AgNO3

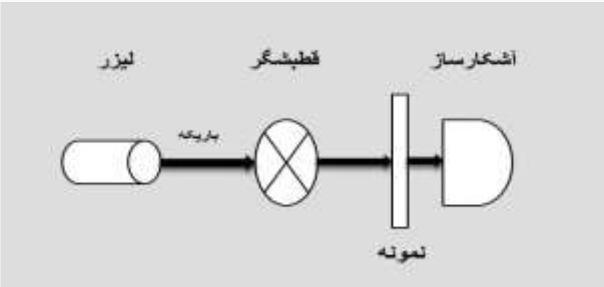

Figure 2. Optical arrangement for linear absorption coefficient measurement

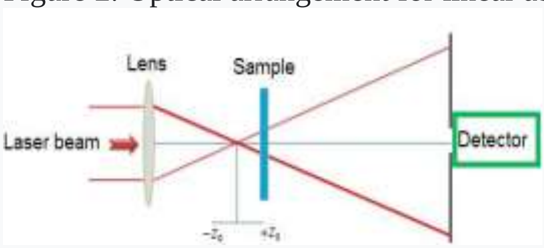

Figure 3. Axial broom arrangement

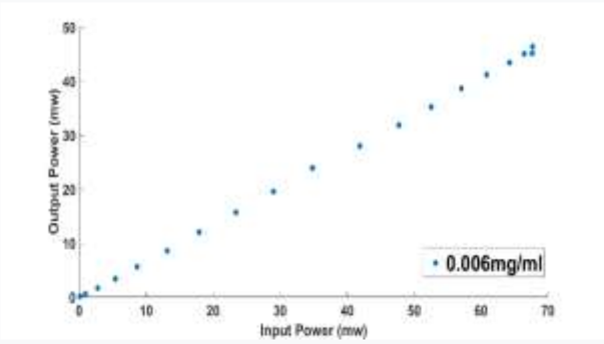

Figure 4. Linear diagram of output power in terms of input power
F-MWCNTs / Ag

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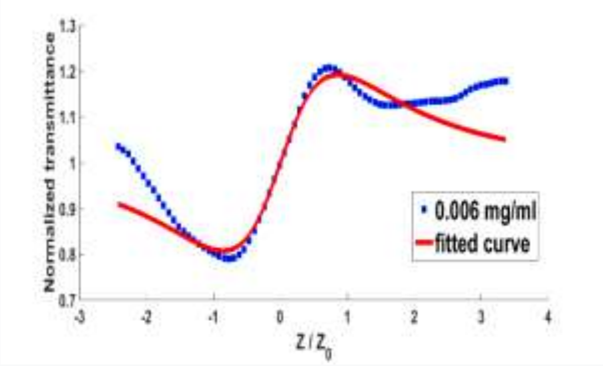

Figure 5. The normalized passing intensity diagram shows the nonlinear behavior F-MWCNTs / Ag

	غلظت AgNO3 $\frac{mg}{ml}$)(	n_2 ($\times 10^{-8} \frac{cm^2}{w}$) $\pm 3.1 \times 10^{-9}$	$\alpha(m^{-1})$ ± 0.06
F-MWCNTs/Ag	0/006	-2/5260	0.913
F-MWCNTs/Ag	0/012	-1/6026	1.077
F-MWCNTs/Ag	0/018	-0/7406	1.160
F-MWCNTs/Ag	0/024	-0/5320	1.409
F-MWCNTs/Ag	0/03	-0/3189	1.877

Table 1

Results and Discussion

Nanocomposite Morphology

F-MWCNT / Ag was evaluated by SEM analysis. As shown in Figure 1, the presence of carbon nanotubes in the F-MWCNT / Ag nanocomposite is visible. Also in this study it is shown that F-MWCNT / Ag with different concentrations has nonlinear properties and the values of linear absorption coefficient and nonlinear refractive index are different for each concentration. The nonlinear refractive index is negative and is of the order of 10^{-8} $\frac{cm^2}{W}$and the refractive index decreases with increasing concentration. This property can be used to detect MTX samples in pharmacy and medical sciences.

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