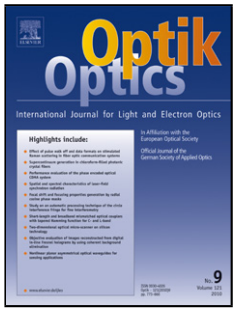

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Investigation of nonlinear optical behavior of creatinine for measuring its concentration in blood plasma

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Abstract

Since creatinine reflects the Kidneys function in the human body, the accurate measuring methods to assess the concentration of creatinine in blood plasma are important. Colorimetric method is usually used to measure the concentration of creatinine in blood plasma. In this paper, we have applied Z-scan technique to investigate the nonlinear behavior of creatinine of blood plasma. The samples include different concentrations of creatinine. The concentration of creatinine directly changes the nonlinear refractive index of samples. As a result, this method can be used to measure the creatinine concentration of blood plasma.

Keywords: Creatinine, Z-scan technique, nonlinear refractive index

1. Introduction

Creatinine is a waste chemical, which achieves from muscles metabolism. Approximately 2% of the body's daily creatine converts to creatinine and then it goes to the kidneys in the blood flow[1,2]. Kidneys filter creatinine and excrete it through urine. Since muscle mass is usually fixed, excretion level of creatinine is in a clear range[3,4]. Kidneys hold the blood creatinine levels constant within the normal range, so the amount of creatinine excretion is a good indicator to assess renal function [2]. Due to more muscle mass in men than women, the normal range of this chemical in men is 0.6-1.2 mg/dL and in women is 0.4-0.9 mg/dL [2]. Typically, Jaffe method and enzymatic methods are used to the creatinine concentration [5] in the labratory [6]. If the kidneys fail for any reason the creatinine level in the blood rises, since the kidneys are not able to properly cleansing action. So if creatinine increases, the risk of renal complications should be considered; that is why the standard tests always evaluate creatinine levels in the blood [7]. In the present investigation, we have tried to calculate the creatinine concentration of human plasma using Z-scan technique via calculation of the nonlinear refractive index ($n_2<0$), for the first time. Z-scan method is a simple method and a sensitive one for measuring non-linear refractive index. Sheik-Bahae et al introduced this method [8] and because of its simplicity in both procedure and interpretation of data quickly become papular. This method have been also used to estimate nonlinear characteristics of urea and uric acid [9], total protein and albumin [10], Plasma glucose [11], bovine serum albumin [12], lipid peroxidation [12,13] for the quantification of total cholesterol [13] and triglycerides [13]. In this method Gaussian laser beam is used with small focus regarding geometry and a non-linear material would be moved in a defined distance around focus, then with a simple analysis, we get magnitude and sign of the nonlinear refractive index [14,15]. By starting scan from a distance of focus, the beam intensity that reached the detector was nearly constant but when became close to the focus beam, the intensity increased and led to self-focusing effect. The Self-focusing before focus leads to the parallel beam that increases transmittance. With Scan the sample along the Z axis and