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Nonlinear Optical Response of byosintethized Gold Nanoparticles

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Abstract. In this work nonlinear index refraction of colloidal biosynthesized gold nanoparticles with latex of *Jatropha curcas* is investigated. Z-scan curves were obtained using a CW Argon ion laser, with an incident power of 20 mW and wavelength of 514 nm, for samples synthesized at different temperatures and latex concentrations. Experimental results are compared with a phenomenological model.
Keywords: nanoparticles, nonlinear optics, z-scan.

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1. Introduction.

As building blocks in nanotechnology, various methods have been developed to fabricate nanostructures of well defined compositions. However, conventional physical and chemical methods either are energy intensive or impose environmental hazards due to toxic solvents or additives as well as hazardous by products. Biosynthesis of nanoparticles has received considerable attention due to the growing need to develop environmentally benign technologies in material synthesis. The use of parts of whole plants in the biosynthesis of metal nanoparticles is an exciting possibility that is relatively unexplored and under exploited. The plant *Jatropha curcas* is commercially important one as biodiesel is extracted from its seeds on industrial scale. Though the jatropha latex has come ethno medical use like wound healing, coagulant activities of blood, it is acrid and irritable to the skin also.

In this work we characterized the nonlinear optical response of this kind of nanoparticles, which were synthesized with different concentration of gold and jatropha and using different temperatures. Employing the Z-scan technique and a recent theoretical model that takes into account the non local response of the media [2], the nonlinear refractive index of the medium was investigated.

2. Nanoparticle synthesis.

All the aqueous solutions were prepared using deionized water. For sample preparation, crude latex was obtained by cutting the green stem of jatropha curca plants. Milky white latex was stored at −20 ◦C until use. In a typical reaction procedure, crude latex was diluted to 100ml using deionized water to make it 1% in volume of this latex solution, different concentration of this latex solution was used and mixed with 5×10^{-3}M aqueous $AuHCl_4$ solution. All the mixtures were heated at different temperatures with constant stirring for 4 h the gold nanoparticles were obtained gradually. Jatropha plants were obtained from Huitzilan, Puebla, Mexico and the $AuHCl_4$ was purchased from Sigma–Aldrich.

3. Theoretical model.

The model used to characterize the samples is the established in [2], considers a Gaussian beam propagating in the Z direction, at some distance z it illuminates a thin nonlinear sample with a field amplitude $E(r,z)$, then the field at the exit of the medium can be written as;

$$E_{out} = E(r,z)\exp(-i\Delta\phi(r)) \ , \tag{1}$$

where φ(r) is the nonlinear phase change and it is proposed as :

$$\Delta\phi(r) \approx \Delta\phi_0(z,m)\exp\left(-mr^2/w(z)^2\right), \tag{2}$$

and