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Strong Cubic Optical Nonlinearity of Gold Nanoparticles Suspension in Nematic Liquid Crystal

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We report on the observations of extremely strong and fast cubic optical nonlinearity in the suspension of gold nanoparticles in nematic liquid crystal (LC). The nonlinearity was observed by recording dynamic phase sinusoidal holograms with a continuous operating laser. It is caused by changes of the refractive index of a LC due to efficient light-induced heating of the nanoparticles at plasmon resonance excitation and following thermal transport of heat to LC matrix. Large nonlinearity parameter ($n_2 \sim 10^{-2}$ cm^2/kW) and fast characteristic times, together with excellent photo- and thermo-stability of the system make its extremely promising for optical processing applications.

Keywords Cubic nonlinearity; gold nanoparticles; holographic gratings; liquid crystal; plasmon resonance

1. Introduction

Suspensions of nanoparticles (NPs) of different nature in liquid crystals (LCs) are of high interest due to a great science and promising applications. LC nano-suspensions give unique opportunity of modifying and controlling of LC properties by non-chemical way and design of novel smart materials. One of the potential applications of LC nano-suspensions is their use as highly nonlinear optical materials for optoelectronics, various nonlinear optical devices, optical switching, beam coupling, etc. [1]. In particular, embedding of absorbing nanoparicles to a LC matrix results in a strong thermal third-order nonlinearity, which is responsible for the variation of refractive index changes of the media [2]. Each particle "works" as effective nano-heater of a LC matrix causing decrease of the order parameter around the particles. As a result, average order parameter of the LC is lowered and, as a

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