Introduction

From the Middle Ages coloration of glass or solutions containing colloids of noble metals stirred attention of many researches. It's well known that silver particles typically demonstrate yellow color while gold and copper colloids are responsible for the red coloration of stained glass windows. The first explanation of extinction spectra and coloration of metal particles was carried out by Mie in 1908 [1.8]. Since then optical properties of metal nanoparticles have extensively been studied in different fields of science and technology.

The linear and nonlinear optical properties of metallic nanoparticles in dielectrics are dominated by the strong surface plasmon resonances (SPR). Since spectral position and shape of these SPR can be designed within a wide spectral range throughout the visible and near infrared by choice of the metal and the dielectric matrix, or manipulation of size, shape and spatial arrangement of the metal clusters, these composite materials are very promising candidates for a great number of applications in the field of photonics. In this context, laser-based techniques to modify shape and arrangement of the metal clusters are of great interest since they provide a very powerful and flexible tool to control and optimize the linear and nonlinear optical properties of these materials.

Recently, it has been shown [3.14] that the excitation of the single spherical Ag nanoparticles by fs laser pulses near to the SPR evokes a laser induced dichroism in the composite glass indicating shape modification of the metal clusters. However, the mechanism of the shape transformations seems to be very complicated and still needs additional investigations. This thesis considers some aspects of interactions of intense fs laser pulses with silver nanoparticles incorporated in soda-lime glass. Presented hear investigations of the fs laser assisted modifications of Ag nanoparticles in dependence on the laser pulse intensity, excitation wavelength, temperature as well as performed luminescence and relaxation dynamic studies reveal new information concerning the processes arising by excitation of the silver cluster near to the SPR and leading to structural alterations.

Additionally, effects of the fs and ns laser pulses on the system of aggregated Ag nanospheres are shown here. For instance, exposure of the compact packed metal clusters to intense fs laser pulses demonstrates anisotropic structural modifications in the sample, which in turn strongly dependent on excitation wavelength and affected

by collective interactions. On the other hand, the thermal instabilities produced in the samples by ns second laser pulses result in ripening of periodically distributed in the glass chain-like silver structures. The possible mechanisms responsible for the observed effects are discussed.

The last chapter of this thesis refers to the possible applications of the fs laser induced dichroism in the glass containing spherical clusters. In turn, an opportunity of the 3D anisotropic structuring as well as 3D data storage in these materials is demonstrated and discussed. Moreover, proposed technique could find many additional applications in development of different 3D polarization and wavelength selective microdevices such as polarizers, filters, gratings, RGB and DWDM devices, optical and plasmonic embedded circuits.