Research Centre 4

Subject : Material Science

Centre for Novel Dye-doped Metal-Polymer Nanocomposites films for Third Harmonic Nonlinear Optical and Photonic Switching Applications

Co-ordinator : Dr. Shubhrajyotsna Aithal

Description :

Nonlinear optics plays an important role in the realization and development of many photon technologies, and it can be used to generate, process, detect, and store the optical signal information at enhanced speed. Novel nonlinear optical materials with exceptional nonlinear susceptibility, ultrafast response time, high resistance to bulk and surface laser damage, and low two-photon absorption with large optical nonlinearities are critical for their implementation in many device applications. The rapid development of nanoscience and nanotechnology has provided a number of new opportunities for nonlinear optics especially to improve novel properties of the nonlinear optical materials and systems. A growing number of nanomaterials have been shown to possess remarkable nonlinear optical properties which promote the design and fabrication of nano and nano-scale optoelectronic and photonic devices. Nonlinear optics is widely used in many fields such as in laser technology, light aspects of communication, information and image processing and storage, and optical computing and has a great value and far-reaching scientific significance.

Objectives :

(a) To Design the model of an ideal optical switch and ideal optical logic gate by predicting the required input, process and output characteristics.
(b) To design nonlinear nanocomposites by means of organic and inorganic nanomaterials using well known theoretical postulates and preparation of such material formulations using suitable methods.
(c) To prepare thin films of nonlinear dye doped nanocomposite films.
(d) To study of physical parameters metal-polymer nanocomposites in the films.
(e) To study the mechanical properties, dielectric properties, and linear optical properties of these films.
(f) To study nonlinear optical properties including nonlinear absorption, nonlinear refraction and third harmonic susceptibility of these sample films.

(g) To study various design possibilities of nonlinear optical switches using two and three-wave mixing, stimulated scattering, self- and cross-phase modulation, and/or optical limiting principles.
(h) To identify suitable working design for optimum structure/composition for optimum optical switch.
(i) To design optical logic gate configurations using developed models of optical switch.
(j) To compare the properties of developed nonlinear optical switch and nonlinear optical logic gates with that of ideal optical switch model and ideal optical logic gates models respectively.
(k) Finally, to discuss &suggest the possible use of these switches and logic gates in optical computer design in integrated circuit format.

Novelty :

In this proposal, Some Novel Dye-doped Metal-Polymer Nanocomposites will be prepared using chemical in situ technique. Spin coating technique will used to obtain thin films of required thickness. Characterization of nanocomposite films using X-Ray diffraction, Transmission electron microscopy, Linear Absorption Spectroscopy, third-order nonlinear optical properties using open- and closed-aperture Z-scan technique, self-focusing behaviour is due to the combined effect of quantum confinement and thermo-optical effects. The increased NLO effect is based on surface plasmon resonance, which enhances the local electric field near the nanoparticle surface. Thus, metal-polymer nanocomposite has favourable nonlinear optical properties for various optoelectronic applications. The expected outcome is a novel dye-doped metal-polymer nanocomposite film of optimum thickness with enhanced third harmonic susceptibility and a new configuration developed first time for achieving optical switching using such sample for optical switching of continuous wave laser beam in UV, Visible, and near IR region. This also opens a door for the first time the design of an optical logic gate which is a building block to realize the long waiting Optical computers which is considered as a breakthrough of science and technology of 21^{st} century.

Publications / Working Papers :

(1) Study on various design possibilities of nonlinear optical switches using two and three-wave mixing, stimulated scattering, self- and cross-phase modulation, and/or optical limiting principles.
(2) Design models of optical logic gate configurations using dye doped nanocompositesfor optical switch.
(3) Comparing the properties of developed nonlinear optical switch and nonlinear optical logic gates with that of ideal optical switch model and ideal optical logic gates models.