ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

X -Ray Crystallography investigations of DCM laser dye doped Silica based solid state dye laser material

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Abstract

Polymerization of silica-gel matrix has been carried out by capturing of the laser dye DCM . Solid state materials are prepared with

the different concentration of dye. There diffraction patterns are recorded by using X- ray diffraction method. This X-ray diffraction design obtained from this technique gave a remarkable information about the nature and structure of the sample. The diffraction pattern of these synthesized silica material can be done by the help of XRD method

Keywords: Dye laser, Solid state dye laser materials, sol-gel method and x-ray diffraction.

1. Introduction

In dye laser materials, organic dyes plays an interesting and beneficial role for many applications, generally a liquid solution of dye is used as a gain medium for dye laser. Sorokin observed the radiation from these organic lasers that was obtained in form of broadband emission. Broadband emission is mainly consists of several transverse modes and multitude of longitudinal modes in each transverse modes [1,2]. As compare to other multiwavelength sources of laser organic dyes are more advantageous because they are cheaper in cost as compare to other and the another property which make them advantageous is its spectral coverage from UV region to near IR. Also, they have a high conversion efficiency for beams.
Paterson et al. in 1970 gave a outstanding approach about the emission control with the innovation of continuous wave dye laser in areas of high power pulsed dye laser .

The laser cavity initiate by Hansch who take advantage of the principles of wavelength tunings and frequency tapping that is required for practical of tunable lasers. However liquid dye have many advantageous point but still it cannot reach to our commercial market broadly because unfortunately liquid dyes have some inherent defects such as tangled dye circulatory system [3]. With retainment of all the advantageous properties of liquid dye a new research is come with the name of solid state dye laser materials [4].
Solid state dye laser remains a energetic area because innovation in technology and capabilities present with no other type of laser have opened the fruitful new areas for solid state laser research [5,6]. All properties of liquid dyes are retained in this with extra feature of clean and toxicity free .Many research have been done in regular pattern with long run of time duration to assimilate the dye molecule into form of solid matrix that is having a proper chemical and physical properties [7,8].

Over the past time, many progress has been made for development and preparation of efficient solid state active media for tunable lasers based on organic dyes embedded in to different matrix [9]. The sol gel technology has achieved a much more attention in this solid state laser materials or we can say in field of material science [10,11]. Among all the processes, the sol-gel method has an important part in the production of smart materials [12]. Resfield, had synthesized the smart optical materials with the sol gel method and also studied spectroscopic and ultra structural properties of optical materials [13].

In this method a technique is required that is low–temperature technique, this technique permits the superior control on by product chemical configurations, when the amount of dopants such as organic laser dyes, transition metals, rare earths and metal salts nano particles in the sol is small [14]. By the help of this method we get finely spreaded products. They are helpful in ceramics production process. Materials that are formed with sol–gel procedure, have numerous advantages in physics, chemistry, astronomical science, medical field (e.g. controlled drug release) & also used in partition (e.g. chromatography) technology. So by doing various improvements in the field of material with the help of this process, we can generate the more beneficial materials [15].

Among all the host matrix, polymethylmethacrylate and silica gel plays a vital role to fabricate the solid state dye laser materials. PMMA is a clear and capable of softening on fusing when heated and of hardening again when cooled. it is used as a lightweight or break-resistant best replacement to glass and occasionally it is called as acrylic glass. It has moderate properties, easy to handle, and processing at low cost. It offers various optical properties such as it is transparent in visible region, compatibility with the selected dyes and a moderate laser damage threshold. It has a superior exterior polish, good outside weather-beaten properties and rigidity [16]. It has superior electrical shockproof quality at low frequency and unaffected to alkali.

Silica gel is an indefinite, extremely permeable, powdered and partially hydrated appearance of silica. Its occurrence as element silicon, that is a natural material which can be made synthetically from sodium silicate so it is able to convert in to xerogel that have a superior role in fabrications of smart materials. Silica gel is tough and hard than common household gel likes gelatin or agar. It is used as drying agent because it has high surface area due to which it absorbs water readily. The silica gel can be revitalize with heating it to the temperature of 120°c (250°f) for one hundred twenty minutes [17]. But in addition ,by doping process using attractive and new dopants we can easily modify the properties of these types of materials which can further explore to pay crucial role to developed advanced smart materials.

Solid-state dye laser technology is at full bloom and have reached a platform where these lasers can be used for various applications, they are used in commercial industries, and they have many applications in spectroscopic investigation and analysis as well. This technology provides direct approach to visible spectrum at low expenditure. They are extra compressed, relatively steady and easy to handle. Due to past few years of success in latest and advanced host materials, there is a new resolution has comes in the field of these materials, furthermore the achievement of latest idea to add the organic molecules into the solid host matrices, because of this it has form a extraordinary contract in this field [18].

Further research work was focused on doping with nanometer sized particles of CdS, CdSe, CdTe and PbS, that have been doped by using chemical methods in silica glass films. These films were prepared either of pure silica or silica zirconia or combined zirconia with ormosils [19]. In this paper, we made a effort by a simple synthetic pathway for the preparation as well as incorporation of organic dyes molecules in the silica gel rod shaped materials. The characterization of prepared sample is under taken with the help of XRD .

2. Experimental Section

2.1 Chemicals

Chemicals that were used in this experimental work for the synthesization of silica gel based solid state dye laser material; tetraethylorthosilicate (TEOS) (Sigma Aldrich), DCM (SigmaAldrich), N,Ndimethylformamide(GC Grade, fisher scientific International Inc), ethanol(AR Grade, Changshu Honhsheng Fine Chemicals Co., Ltd), hydrochloric acid (AR Grade, Rankem), ethylene glycol(AR Grade, Fisher scientific International Inc), acetonitrile(AR Grade, CDH fine chemicals).

Methodology and chemical doping

The solid state silica gel based materials have been produced by using sol-gel route. The reaction mixture is stirred for 3 hours and then transferred into a different shape of culture glass tubes and put into oven for about 60 hours at 70ºC. After 36 h temperature down to 40ºC for about 15 days. The temperature variate slowly and slowly upto 99ºC for 58 hours for concluding the last step which is required for silica gel based solid state dye laser materials . Finally we obtain silica gel materials with definite shape and size. The prepared samples of silica gel are doped and 2, 5-diphenyloxazol with different concentration such such as $0.98x10^{-6}$, $3.99x10^{-6}$ and $5.98x10^{-6}$ mol/L.

3. Results and discussion 1 . XRD study

The X-ray diffraction patterns of undoped and DCM doped silica based material are shown in Fig.1. The concentration of dopant varies as $0.98x10^{-6}$, $3.99x10^{-6}$ and $5.98x10^{-6}$ mol/L. The X-ray diffraction pattern tells significant information about the nature and structure of the sample. XRD pattern of silica generally differs and depend on the synthesis route, solvent and ionized state. Broad diffraction peaks are observed, which is a typical feature of the amorphous nature. In other way we can say that the samples are amorphous because no sharp peak has been observed in X-ray diffraction patterns

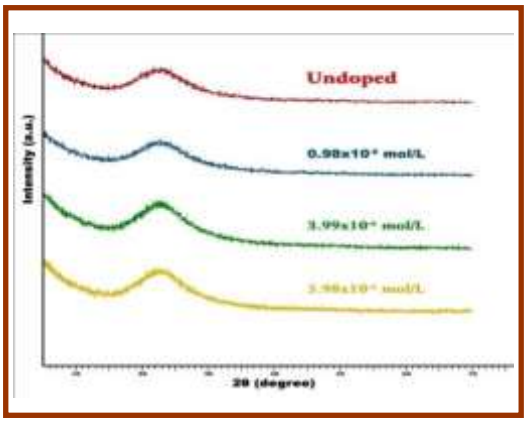

Fig.1: XRD spectra of undoped and DCM dye doped silica based material.

Conclusions

The silica gel samples were prepared with embedded different concentration of DCM and characterize by x-ray diffraction technique. Here the technological interest is focused on the investigation of sol-gel processed silica gel derived transparent materials in desired shape at room temperature. An X-ray diffraction study shows that the synthesized material is amorphous in nature.

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