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ABSTRACT BOOK

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Board of Research in
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In Collaboration with

Indian Laser Association

Laser Optogalvanic Spectroscopy

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A see-through, dual anode, iron hollow-cathode discharge tube (HCDT) is designed and developed for laser optogalvanic spectroscopy. The optogalvanic signals, detected in the HCDT, will be used for precise and absolute wavelength calibration of indigenously developed tunable narrow-linewidth dye lasers. This HCDT has provision for filling the buffer gas at a desired pressure and this is advantageous over commercial HCDT, which are sealed and have buffer gas at a fixed pressure. The main focus of the paper is on the design details, method of fabrication and development of the indigenously developed iron HCDT.

CP-03-34

UV-Absorption Studies of Dye and Metal Doped Sol-Gel Silica Glasses and Estimated Oscillator Strengths for Superior Transition Probability of Metal Doped Glasses

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In this work, comparision of oscillator strengths of fluorescent dye and metal doped silica glasses for superior transition probability is presented. The silica glasses were prepared by sol gel route by varying the molar concentration of dye and metal to get a uniform dye and metal doped clusters in solid silica matrices. The UV- absorption spectras were recorded and analysed. The dye doped silica glasses exhibited absorption spectra at 400-600nm and the metal doped silica glasses exhibited absorption spectra at 250-500nm. Oscillator strengths of dye doped and metal doped glasses were calculated and compared. Rh6G dye showed higher transition probability. Silver showed superior transition probability amongst the metals.

CP-03-35

Development and Application of Dual-Wavelength Interferometric Diagnostic to Simultaneously Quantify Thermal and Concentration Driving Forces during TGS Crystal Growth from Solution

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UV-absorption studies of dye and metal doped Sol-Gel silica glasses and estimated oscillator strengths for superior transition probability of metal doped glasses

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Abstract

In this work, comparison of oscillator strengths of fluorescent dye and metal doped silica glasses for superior optical property is presented. The silica glasses were prepared through sol gel route by varying the molar concentration of dye and metal to get a uniform dye and metal doped clusters in solid silica matrices. The UV-absorption spectra were recorded and analyzed. The dye doped silica glasses exhibit absorption band at around 400-600nm and the metal doped silica glasses exhibit absorption band at around 250-500nm. Oscillator strengths of dye doped and metal doped glasses were calculated and compared. Rh6G dye showed superior oscillator strength while Silver showed superior oscillator strength amongst the metals.

1. Introduction

Synthesis of sol-gel derived glasses doped with transition metals as well as organic-inorganic dyes for better optical properties have been in the spotlight of research study since last several decades[1]. Introducing organic–inorganic guest materials (dopants) in the host inorganic porous silica matrix it is possible to produce organic –inorganic hybrids with prospects of huge applications in photonics, active laser material synthesis and many more[2]. However, co-doping effect of fluorescent dye with transition metals in mesoporous silica is yet to be investigated analytically except a few with energy transfer mechanism[3]. The search of suitable co-dopants with favorable relationship for enhanced properties of luminescence, quantum yield, life-time etc. is a subject of active research at present time. The systematic introduction of different metals and highly fluorescent dye in silica matrices is being considered to investigate with a prospect of suitable dye-metal cluster formation to exhibit material properties of above interest. The sol gel process allows the dye molecules and the metal ions to be trapped in inorganic matrices which shows significant optical properties. Synthesis of novel materials plays a major role in the development of modern technology for the production of new optical materials. Further exploration is required for the development of new materials in the field of photonics. The dopants and the co-dopants used in the silica glasses has the ability to modify the material properties such as band gap tuning in solar cell materials, enhanced luminescence etc [4-6].

2. Materials and Methods

Chemicals used for the preparation of the doped glasses by sol gel route are as follows, Tetraethylorthosilicate (TEOS), and Rhodamine 6G dye from Merck and methanol, doubly distilled water, nitric acid, $AgNO_3$, from Rankem, Iron filings from Fisher scientific and Cupric nitrate from Sigma Aldrich were used in preparation of dye Rh-6G / metal (Ag/Fe/Cu) doped SiO2 glasses by varying the concentration of constituents. Requisite amount of Rh 6G or Ag/Fe/Cu alone was dissolved in 10.5ml of mixture of methanol(8.75ml), distilled water (1.25ml), dil nitric acid taken in proportion of 70(Methanol): 10(H2O):4(HNO3) parts by stirring continuously in a magnetic stirrer for 15 mins. 2ml of TEOS which is the remaining 16 parts of the total mixture of 12.5ml solvent was added and further stirred for an hour. When the formation of gel began, it was transferred to plastic shell and left to dry and solidify at room temperature (25-27^{0}C). With progress in hydrolysis the gel solidified to form coloured stiff hard mass pellet in 48-72 hours and left for ageing for 22 days. Composition of sol gel glasses prepared for the analysis is as given below:

Samples	Conc. (M)x10^{-4}	Methanol(ml)	H_2O(ml)	HNO_3(ml)	TEOS(ml)
Rh6G /01	1	8.75	1.25	0.5	2
Rh6G /02	0.1	8.75	1.25	0.5	2
Ag/01	1.	8.75	1.25	0.5	2
Ag02	0.1	8.75	1.25	0.5	2
Cu/01	10	8.75	1.25	0.5	2
Cu/02	1	8.75	1.25	0.5	2
Fe/01	10	8.75	1.25	0.5	2
Fe/02	1	8.75	1.25	0.5	2

Table1: Composition of doped silica glasses

3. Result and Discussion 3.1 **Structural analysis**: The SEM micrographs recorded in a HR-SEM JEOL JSM-IT 300 of Glasses with dye (Rh6G/02) and glasses with metal (Ag/02) along with EDAX are shown in Fig 1. They reveal an inhomogeneous surface morphology of the matrices with particles of size ~ 10-50 μm. The EDAX spectra alongside each of micrographs indicate a large presence of Si and O in the matrix which forms Si-O-Si and Si-O groups along with other elements of dopant compounds.

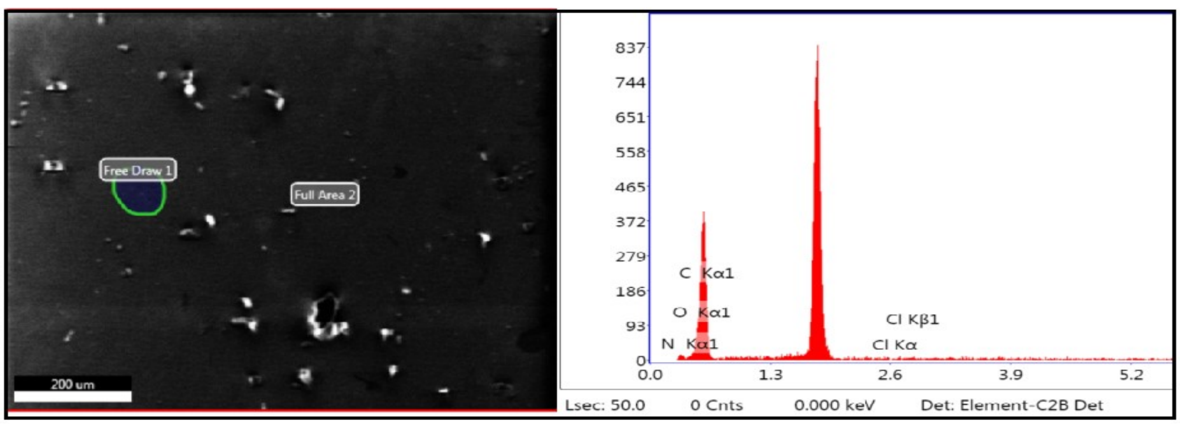

Fig.1 (a) – SEM-EDAX of Rh6G/02 glass

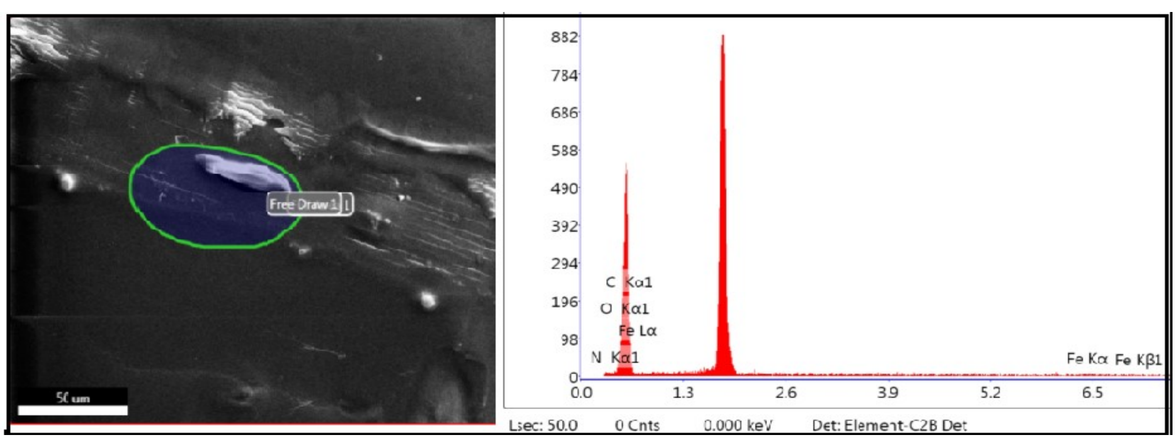

Fig.1(b) – SEM-EDAX of Fe/01 glass

The XRD patterns of the dye doped (Rh6G/02) and metal doped (Fe/02) glasses recorded in a Rigaku Ultima-IV are shown in Fig - 2. The XRD spectra presented are without any features to support crystalline nature and confirm the amorphous nature of Si-O-Si silica matrices.

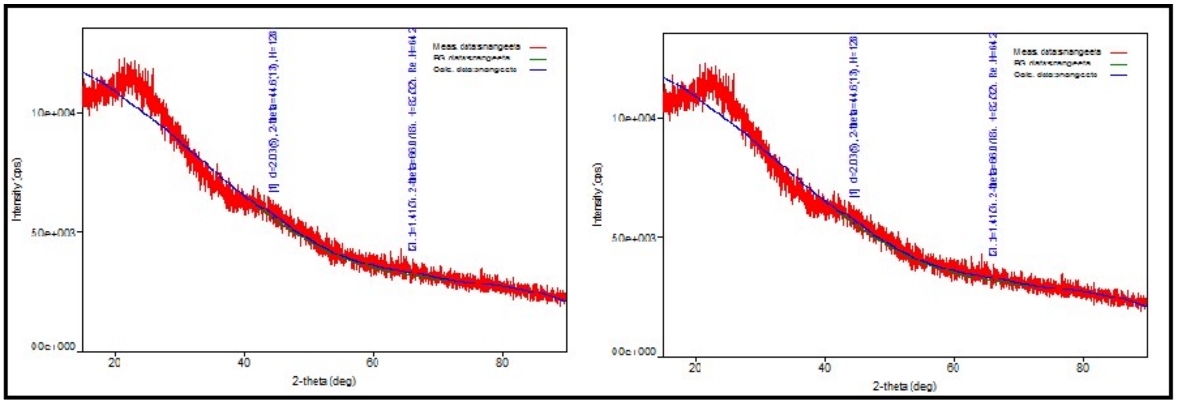

Fig.2 – XRD spectra ofRh6G/02 and Fe/01 glasses respectively

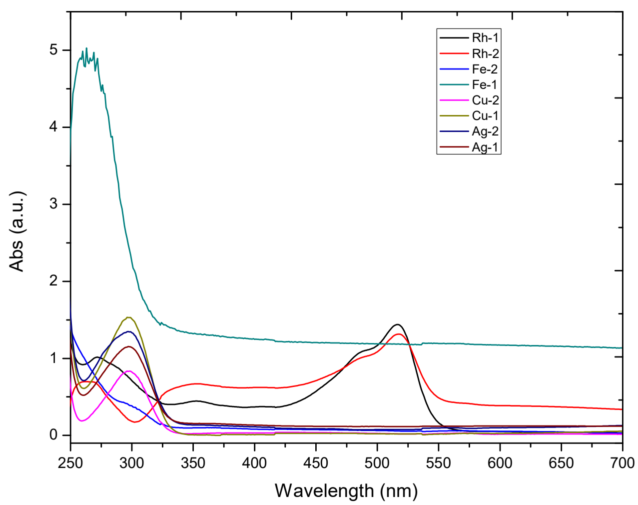

Fig3: Absorption spectra of Rh6G dye and metals (Ag/Fe/Cu) doped in silica glasses

3.2 Absorption spectra Analysis: Vis absorption spectra of the glasses were recorded in UV-Vis spectrophotometer (SHIMADZU). The absorption spectra of the doped glasses are found within the range (250-700) nm. The UV-Visible spectra of the doped silica glasses with Rhodamine6G and transition metals Ag/Cu/Fe are shown in figure 3.The maximum absorption for fluorescent dye Rhodamine 6G of molar concentration $1x10^{-4}$M and $0.1x10^{-4}$M doped in silica glass was found at 516 nm and 517 nm. The maximum absorption for Cu of molar concentration $1x10^{-4}$ and $10x10^{-4}$ doped in silica glass was found at 296 nm. Similarly, the maximum absorption for silver ($1x10^{-4}$M,$0.1x10^{4}$M) and iron ($1X10^{-4}$, $10X10^{-4}$) doped glasses were found at 298nm & 299nm and 246nm & 263nm.Oscillator strength of the glasses were analysed using the formula $f = 4.32 \times 10^{-9} \int \varepsilon(\upsilon) d\upsilon$, where $\int \varepsilon(\upsilon) d\upsilon \approx \varepsilon(\upsilon) \times \Delta\upsilon$ and $\varepsilon(\upsilon)$ is the molar absorption coefficient at frequency υ(cm^{-1}) and $\Delta\upsilon$ is the band width at $1/2\varepsilon(\upsilon)$ measured directly from absorption spectra (FWHM) using"Origin-8.5" software.

Sample glass	Abs. Max (nm)	Oscillator strength (f)	FWHM ($\Delta\nu$) nm	Abs. Coefficient $M^{-1}cm^{-1}$
Rh6G/01	516	0.0247	79.5508	71950
Rh6G/02	517	0.2446	86.06485	658000
Ag1/01	298	0.0199	79.95391	57600
Ag2/02	299	0.2354	81.0266	672500
Cu1/01	296	0.0025	76.59004	7665
Cu2/02	296	0.0077	42.66298	41800
Fe1/01	263	0.0041	38.59953	25145
Fe2/02	246	0.0175	52.09294	78200

Table 2: Oscillator strength of doped silica glasses

Conclusion : The oscillator strengths of Rhodamine 6G (Rh6G) and transition metal (Ag/Cu/Fe) doped silica glasses are being calculated and compared. The silica glass doped with Rhodamine 6G with $0.1x10^{-4}$ M exhibits higher oscillator strength amongst all the other doped glasses. Materials having high oscillator strength have high transition probability and often have the capability to enhance or develop new optical materials. Amongst the metals, silver is seen to exhibit superior oscillator strength. Henceforth, silver has superior transition probability among the metals.

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