

Spectroscopic Properties of Sm₂O₃-V₂O₅ Co-Doped Pbo-As₂O₃ Glasses

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Abstract : The Glasses Of The Composition (39-X) Pbo - 60 As₂O₃ -1Sm₂O₃ - Xv₂O₅ (Where X = 0.2, 0.4, 0.6, 0.8 And 1.0%) Have Been Prepared By Conventional Melt Quench Technique And Their Detailed Spectroscopic Studies Has Been Done. The Structural Analysis Analyzes By Using FT-IR Studies, The Optical Absorption Spectra Exhibit Several Transitions, And The Judd-Ofelt Parameters Ω_2 , Ω_4 And Ω_6 Have Been Evaluated. The Judd-Ofelt Theory Could Successfully Be Applied To Characterize The Absorption And Luminescence Spectra Of These Glasses. From This Theory Various Radiative Properties Like Radiative Transition Probability (A), Branching Ratio (B) And Total Radiative Transition Probability (A_T). The Energy Transfer From Samarium To Vanadium.

Keywords - Pbo-As₂O₃ Glasses, FT-IR, Optical Absorption, J-O Theory, Luminescence Spectra

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I. Introduction

The Investigation Of Rare Earth Ions Doped With Different Oxide Glasses Are Mostly Used In The Fields Of Solid State Lighting Devices, Lasers And Display Devices. Sm³⁺ In The Glass Network May Change The Chemical Environment [1-5]. Oxide Glasses Are Chemically Durability, Thermally; Optically Transparent At The Excitation And Lasing Wavelengths [6]. The Presence Of Lead Monoxide (Pbo) Acts As Modifier And Glass Former. In The Content Pb-O Is Ionic – Glass Modifier And Pb-O Is Covalent-Glass Former [7]. The Presence Of As₂O₃ Is Strong Network Former, It's Exhibit High Raman Scattering Coefficients And Low Loss Materials For Long Distance Optical Transmission [8-10]. Different Semiconducting Oxides Doped With As₂O₃ Glasses Available Literature [11-13]. V₂O₅ Have Very High Potentiality In The Application Use Like Optoelectronic Devices And Electro Chromic Display Devices [14]. V₂O₅ Is An Important Semiconductor Whose Electrical Conductivity Is Due To The Electron Hopping Between V⁵⁺ And V⁴⁺ Ions [15]. The Semiconducting Nature Of V₂O₅ Is Due To Two Valence States V⁵⁺ And V⁴⁺ Of Vanadium [16]. This Oxide Is Classified As A Conditional Glass-Former And Can Enter The Same Network Either As A Network-Former Or As A Network Modifier Depending On Its Concentration. Vanadium Ions Are Very Interesting Ions To Probe In The Glass Network Because Their Outer D-Electron Orbital Functions Have Preferably Wide Radial Dispersal And Their Responses To Surrounding Actions Are Very Sensitive ; As A Result These Ions Influence The Physical Properties Of The Glasses To Long-Lasting Scope. The V₂O₅ Can Be Integrate In The Rare Earth Glasses It Undergoes Radiative And Non Radiative Transitions Are Takes Place In The Glass Matrix, Because The Energy Transfer Process More Significant For Laser Materials [17].

In The Present Study The Spectroscopic Properties Of Pbo-As₂O₃-Sm₂O₃-V₂O₅ Glasses Using FT-IR, Optical Absorption And Luminescence Studies Are Recorded.

II. EXPERIMENTAL METHODS

2.1 Glass Preparation

A Series Of Pbo-As₂O₃- Sm₂O₃ Glasses Doped With V₂O₅ Were Prepared By Conventional Melt Quenching Technique In The Compositions Of (39-X) Pbo - 60 As₂O₃ -1Sm₂O₃ - Xv₂O₅ (Where X = 0.2, 0.4, 0.6, 0.8 And 1.0%) Are Listed Table 1. The Raw Materials Of Lead Oxide (Pbo), Arsenic Trioxide (As₂O₃), Samarium Oxide (Sm₂O₃) And V₂O₅ Of Appropriate Amounts Are Mixed Together And Melted In Silica Crucible At A Temperature Of 600-650°C For 10 To 15 Min Until A Bubble Free Liquid Has Been Formed. The Resultant Melt Was Then Poured In A Brass Mould And Subsequently Annealed From 200°C With A Cooling Rate 1 °C/Min .Then The Samples Are Finely Polished To Final Dimensions 1 Cm X 1 Cm X 0.2 Cm For The Measurements.

Table 1: Different Glass Composition Of (39-X) Pbo – (60) As_2O_3 – (1) Sm_2O_3 – Xv_2o_5

Glass Code	Pbo (%)	As_2O_3 (%)	Sm_2O_3 (%)	V_2O_5 (%)
Smv 0.2	38.8	60	1	0.2
Smv 0.4	38.6	60	1	0.4
Smv 0.6	38.4	60	1	0.6
Smv 0.8	38.2	60	1	0.8
Smv 1.0	38	60	1	1.0

2.2 Characterization

The Refractive Index Of The Glasses Is Measured By Using Abbe's Refractometer And The Density Of The Glasses Calculated By Means Of Archimedes's Principle. The Fourier Transform Infrared Analysis Is Carried Out Using SHIMADZU-Iraffinity-1S FT-IR Spectrophotometer With The Resolution Of 0.1cm^{-1} In The Spectral Range $400\text{--}4000\text{ cm}^{-1}$ Using Kbr Pellets (300 Mg) Containing A Pulverized Sample (1.5 Mg). The Optical Absorption (UV-VIS) Spectra Are Recorded On JASCO, V-570 Spectrophotometer From 200 To 2400 Nm With Spectral Resolution Of 0.1 Nm. The Excitation And Emission Were Carried Out By Using FLS-980 Fluorescence Spectrometer At Room Temperature By Using Xenon Flash Lamp As An Excitation Source Having Excited And Emission Wavelengths As 400 Nm And 600 Nm Respectively.

III. Results

3.1 Physical Parameters

From The Measured Values Of Density D And Calculated Average Molecular Weight , Various Physical Parameters Such As Ion Concentration N_i And Ion Separation R_i And Other Physical Parameters Also Calculated Are Presented In Table 2.

Table 2 : Various Physical Properties Of PbO - As_2O_3 : Sm_2O_3 : V_2O_5 Co Doped Glasses

Glass	0.2	0.4	0.6	0.8	1.0
Density D (G/ Cm^3)	5.447	5.501	5.515	5.530	5.5852
Avg.Mol. Weight(\overline{M})	209.15	209.077	208.99	208.90	208.82
Conc.Of Sm^{3+} Ions N_i ($10^{21}/\text{Cm}^3$)	3.1372	6.339	9.536	12.754	16.108
Inter Ionic Distance R_i (A°)	6.831	5.403	4.735	4.715	3.959
Polaron Radius R_p (A°)	2.752	2.177	1.907	1.724	1.595
Field Strength F , ($\text{X}10^{15}\text{ Cm}^{-2}$)	3.96	6.33	8.31	10.09	117.79
Refractive Index(N)	1.682	1.686	1.678	1.676	1.670
Reflection Loss	0.378	0.380	0.377	0.376	0.371
Molar Volume (V_m)	38.39	38.00	37.89	37.77	37.38
Molar Refraction(R_m)	14.54	14.45	14.28	14.20	13.96
Molar Electronic Polarizability(A_m) (A°) ³	5.767	5.733	5.663	5.634	5.537
Metallization Factor(M)	0.621	0.619	0.6231	0.6239	0.626
Optical Band Gap(Ev)	2.43	2.38	2.29	2.14	2.10

Density (D) And Molar Volume (V_m)

It Has Been Observed That The Concentration Of Vanadium Increases The Value Of Density Increased From 5.447 To 5.585. The Molar Volume Decrease From 38.39 To 37.38. The Density Decreases And The Molar Volume Decrease The Compaction Of Structure Of Glass Of Increasing Vanadium Contents. The Variation In The Density, Molar Volume And Refractive Index With Vanadium Contents Is Shown In Fig. 1 & Fig. 2.

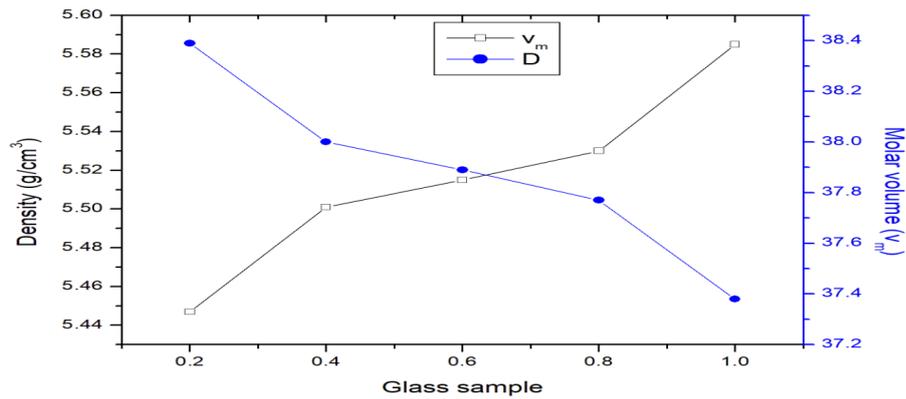


Fig.1. Glass Sample Vs Density & Molar Volume

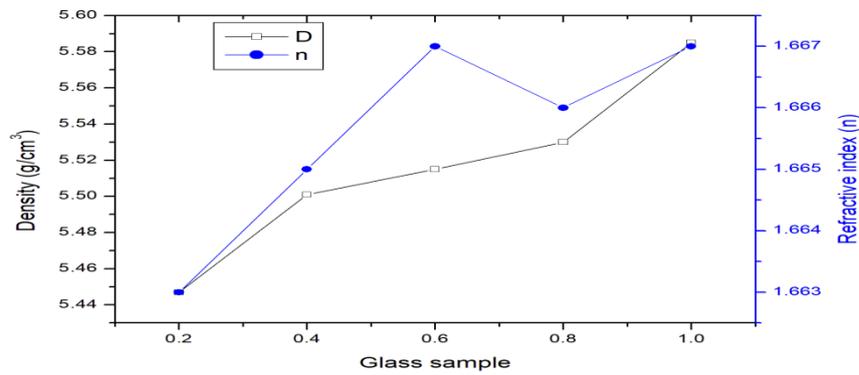


Fig.2. Glass Sample Vs Density & Refractive Index

Polaron Radius (R_p) And Field Strength(F)

The Variation Of Estimated Values Of R_p And Field Strength For Different Concentrations Is Shown In Fig.3. From The Figure, It Is Clear That The Estimated Values Of R_p Decreases With Increase Of V_2O_5 content In The Glass Composition. This May Be Attributed To The Enhanced Compactness Observed With Sm_2O_3 Addition And Due To The Decreases Of The Average Rare-Earth Oxygen Distance. As A Result Of That, The Sm-O Bond Strength Increases, Producing Stronger Field Strength Around Sm^{3+} Ions As Seen From Fig . 3.

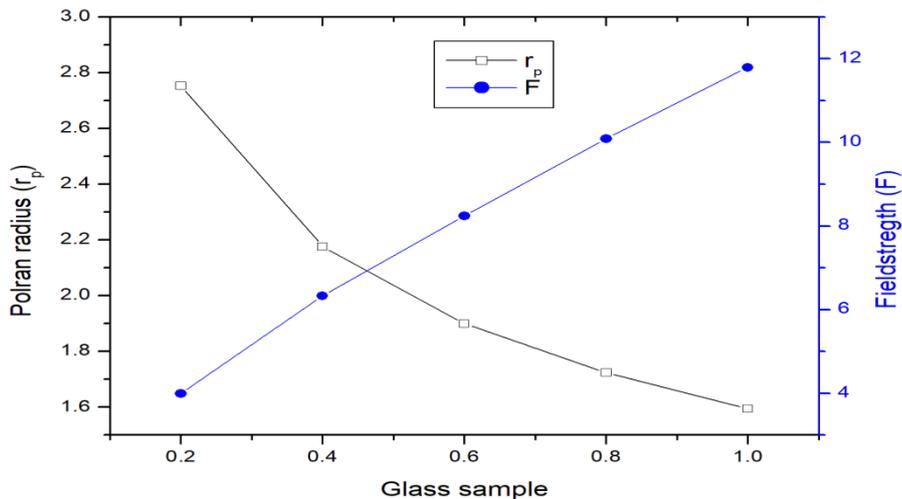


Fig.3. Glass Sample Vs Polaron Radius & Refractive Index

Molar Electronic Polarizability And Metallization Parameter

The Relationship Between The Molar Electronic Polarizability (A_m) Of The Material And Its Molar Refraction (R_m) Is Given By

$$A_m = (3/4\pi n_a) \times R_m$$

Where N_A Is The Avogadro Number. The A_m Values Listed In Table 2 Indicate The Increase Of R_m Values As Well As The Increase In Polarizabilities. For Metals $R_m/V_m > 1$, And Non Metals $R_m/V_m < 1$ [18].

$$\text{Formula For Metallization (M)} = 1 - \frac{R_m}{V_m}$$

The Magnitude Of Metallization Values Are Decreased From 0.582 To 0.598 Listed Table 2. Earlier Reported The SiO_2 And B_2O_3 Glasses Containing Fluorides, Alkali Metals Alkali Earth Oxides Small Metallization Factors Ranging From 0.5 To 0.7 [19], But Present Investigation The Values Are Also Ranging 0.61 To 0.62.

3.2 FTIR Spectral Analysis

Fig. 4 Shows Infrared Transmission Spectra Of $\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Glasses. Within The Glass Region, Rare-Earth Ion Sm_2O_3 Content Is Present, Due To This There Is No Significant Difference Is Observed. FT-IR Spectrum Of Crystalline As_2O_3 Is Expected To Exhibit 4 Fundamental Absorption Bands ν_1 (1050 cm^{-1}), ν_2 (618 cm^{-1}), ν_3 (795 cm^{-1}) And ν_4 (505 cm^{-1}) Which Can Be Attributed To Symmetric Stretching Vibrations, Symmetric Bending Vibrations, Doubly Degenerate Stretching Vibrations And Doubly Degenerate Bending Vibrations Respectively [20]. The Spectrum Of Crystalline V_2O_5 Is Expected To Exhibit Band At 1020 cm^{-1} Due To The Vibrations Of Isolated V=O Groups In VO_5 Polyhedral, Participating In The Formation Of Layered Structure, Another Absorption Band With A Meta Center At 815 cm^{-1} Related To V-O-V Chains And A Weak Shoulder At About 600 cm^{-1} Corresponding To Bending Vibrations Of V-O-V Chains [21].

With The Introduction Of V_2O_5 Into The Glass Network, A New Band At 815 cm^{-1} Related To V-O-V Chains Is Observed. In The Region Of N_1 Vibrations Of As_2O_3 Structural Groups Band Due To Isolated V=O Groups Of VO_5 Structural Groups Is Also Expected.

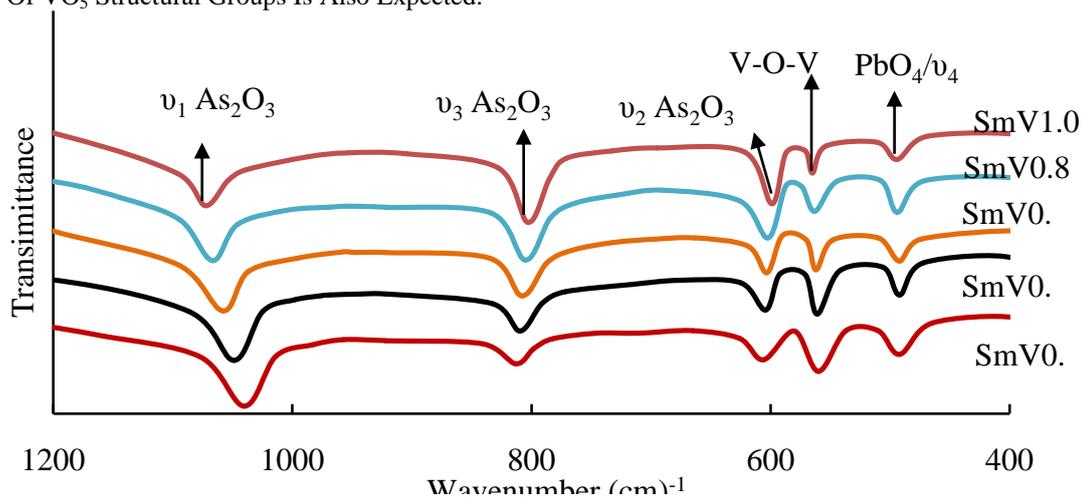


Fig. 4. FT-IR Spectra Of $\text{PbO-As}_2\text{O}_3\text{:Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Co Doped Glasses

Hence The Band Observed At About 1040 cm^{-1} May Be Considered As The Band Due To Common As-O-V Vibrations. With Increase In The Concentration Of V_2O_5 In The Glass Network, The Vibration Bands ν_2 And N_3 Are Observed To Shift Gradually Towards Lower Wave Number With Increasing Intensity. The Intensity Of The Band Due To As-O-V Vibration Band Shows A Gradual Decrease In The Intensity In The Composition Range. In The Region Of N_4 Vibrations Of As_2O_3 Structural Groups It Is Also Quite Likely That The Vibrations Due To PbO_4 Structural Groups Are Also Present; In Fact Earlier It Was Reported That The Vibration Band Due To PbO_4 Units Lies At Around 470 cm^{-1} [22, 23].

3.3 Optical Absorption Spectra

The Optical Absorption Spectra Of $\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Glasses Fig. 5 Measured At Room Temperature In The Spectral Wavelength Range 200-1600 nm With Spectral Resolution Of 0.1 nm, Have Exhibited 8 Absorption Bands Corresponding To Following Transitions [24] And Additionally 2 Absorption Bands Are Observed

${}^6\text{H}_{5/2} \rightarrow {}^4\text{I}_{13/2} + {}^4\text{I}_{11/2} + {}^4\text{M}_{17/2}$ Samarium Absorption Bands (UV-Visible Region), (477 nm)

${}^2\text{B}_2 \rightarrow {}^2\text{B}_g$ Vanadium Absorption Bands (UV-Visible Region), (608 nm)

${}^6H_{5/2} \rightarrow {}^6F_{11/2}, {}^6F_{9/2}, {}^6F_{7/2}, {}^6F_{5/2}, {}^6F_{3/2}, {}^6F_{1/2}, {}^6H_{15/2}$ Samarium Absorption Bands (NIR Region), (938nm), (1077nm), (1227nm), (1378nm), (1412nm), (1493nm), (1534nm).
 ${}^2B_2 \rightarrow {}^2E_g$ Vanadium Absorption Bands (NIR Region) (1077nm)
 Generally Sm^{3+} Ions Exhibit Several Bands In The UV-Region But We Can Found Only One Transition Depending Up On Host Materials.

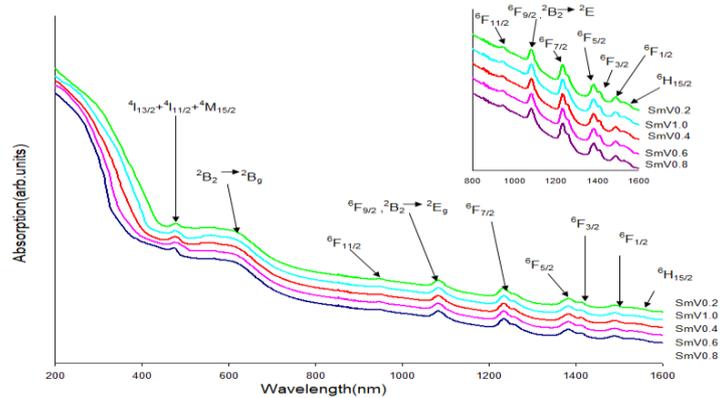


Fig. 5. Optical Absorption Spectra Of PbO - As_2O_3 : Sm_2O_3 : V_2O_5 Co Doped Glasses

From Absorption Edges, We Have Estimate The Optical Band Gaps (E_0) Of These Glasses By Drawing Tauc Plot Fig. 6 Between $(A\hbar\omega)^{1/2}$ And $\hbar\omega$ As Per The Equation:
 $A(\Omega)\hbar\omega = C(\hbar\omega - E_0)^2$

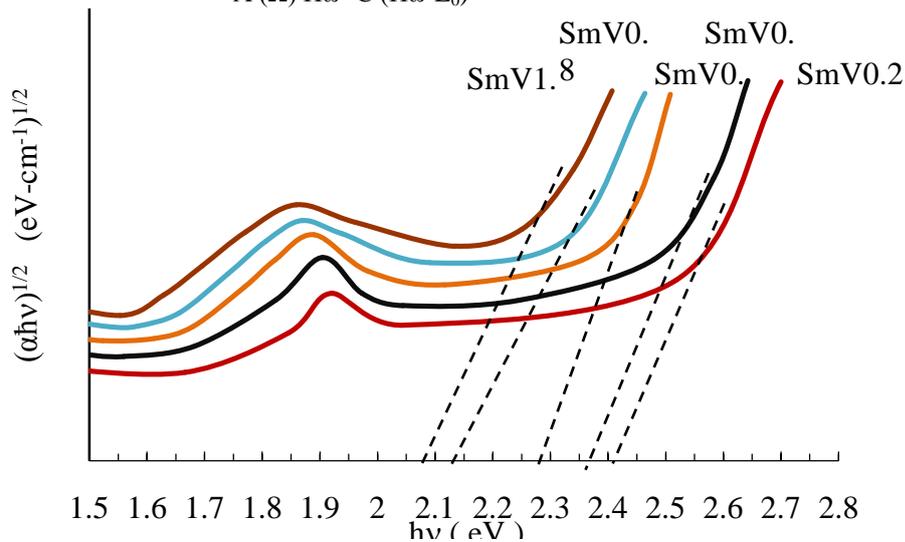


Fig.6. Optical Band Gap For The PbO - As_2O_3 : Sm_2O_3 : V_2O_5 Co Doped Glasses

The Optical Band Gap Has Been Found To Decline Moderately With Enlarge In The Concentration Vanadium In The Glass Matrix. The Data Related To Optical Absorption Spectra Of These Glasses Band Gap (E_0) Are Presented In Table 2. The Importance Of Rare Earth Spectra Earlier Reported By Wybourne's Book [25]. Conventional Judd-Ofelt (J-O Theory) Parameter Has Been Calculated From The Absorption Spectra Of Sm^{3+} Ions. The Intensity Of The Absorption Bands Can Be Estimated By Using Oscillator Strength F_{exp} , Which Is Calculated From The Absorption Spectra By Using Following Equation

$$F_{exp} = 4.318 \times 10^{-9} \int \epsilon(\nu) d\nu \quad \text{----- (1)}$$

Where $E(N)$ Denotes The Molar Extinction Coefficient At Average Energy N In Cm^{-1} . According To The F-F Intensity Model Of The J-O Theory [26], The Calculated Oscillator Strength From Initial State To An Excited State For Electric Dipole Transitions Is Determined By The J-O Theory.

$$F(\Psi_j; \Psi'J) = \frac{8\pi^2 m c v}{3h(2J+1)} \left[\frac{(n^2+2)^2}{9n} \right] \times \sum_{\lambda=2,4,6} \Omega_{\lambda} (\Psi_j | U^{\lambda} | \Psi'J)^2 \dots\dots (2)$$

Where M Refer To The Mass Of The Electron, C Is The Velocity Of Light In Vacuum, H Is The Plank’s Constant, N Is The Refractive Index Of Refraction Of The Glass, N Is The Frequency Of The Transition. (N² + 2) /9n Is The Refractive Index. Ψ_j→Ψ’J, Ω_λ (λ=2, 4 And 6) Are The J-O Intensity Parameters And |U^λ| Are The Doubly Reduced Matrix Elements Of The Unit Tensor Operators Are Available In The Literature [27]. Unit Tensor Operators Of The Rank λ=2, 4 And 6 Which Are Evaluated From The Intermediate Coupling Approximation For A Transition Ψ_j→Ψ’J. The Experimental Oscillator Strengths Of Absorption Bands Of Sm³⁺ Doped Glass Are Determined From The Known Values Of Sm³⁺ Concentration, Sample Thickness, Peak Position And Peak Areas By Using The Equation 1. By Applying Least Square Fitting Procedure To Determine The J-O Intensity Parameters Ω₂, Ω₄ And Ω₆ Using Experimentally Measured Oscillator Strength, Rms Deviation Values Are Presented In Table 3&4.

Table 3: Theoretical And Experimental Oscillator Strength Of Pbo-As₂O₃: Sm₂O₃: V₂O₅ Co Doped Glasses

Glass Samples	Smv 0.2		Smv 0.4		Smv 0.6		Smv 0.8		Smv 1.0	
	F _{exp}	F _{cal}								
⁴ I _{13/2} + ⁴ I _{11/2} + ⁴ M _{15/2}	0.449	0.798	0.469	0.631	0.419	0.660	0.439	0.541	0.349	0.401
⁶ F _{11/2}	0.441	0.436	0.248	0.345	0.299	0.354	0.279	0.294	0.224	0.229
⁶ F _{9/2}	2.458	2.661	2.222	2.139	2.028	2.201	1.841	1.839	1.359	1.391
⁶ F _{7/2}	3.968	3.814	3.171	3.244	3.450	3.301	2.807	2.819	2.387	2.329
⁶ F _{5/2}	1.698	1.890	1.794	1.920	1.859	1.901	1.741	1.770	1.657	1.671
⁶ F _{3/2}	0.687	0.879	0.704	0.954	0.698	0.945	0.714	0.884	0.478	0.747
⁶ F _{1/2} + ⁶ H _{5/2}	0.307	0.088	0.312	0.171	0.360	0.157	0.271	0.141	0.251	0.031
R.M.S. Deviation	0.206		0.2814		0.1435		0.0692		0.2074	

Table 4: J-O Intensity Parameters Of Pbo-As₂O₃: Sm₂O₃: V₂O₅ Co Doped Glasses

Glass	Ω ₂ (x10 ⁻²⁰ cm ²)	Ω ₄ (x10 ⁻²⁰ cm ²)	Ω ₆ (x10 ⁻²⁰ cm ²)	Trend
Smv 0.2	0.18	3.17	2.99	Ω ₄ > Ω ₆ > Ω ₂
Smv 0.4	0.423	3.23	2.29	Ω ₄ > Ω ₆ > Ω ₂
Smv 0.6	0.324	3.03	2.21	Ω ₄ > Ω ₆ > Ω ₂
Smv 0.8	0.345	2.87	1.76	Ω ₄ > Ω ₆ > Ω ₂
Smv 1.0	0.048	2.71	1.29	Ω ₄ > Ω ₆ > Ω ₂
Tellurite (34)	0.006	0.339	0.243	Ω ₄ > Ω ₆ > Ω ₂
Pbo-Pbf ₂ (35)	1.160	2.600	1.400	Ω ₄ > Ω ₆ > Ω ₂
Pbo-Pbf ₂ -B ₂ O (36)	1.280	2.780	1.970	Ω ₄ > Ω ₆ > Ω ₂

3.4 Emission Spectra And Radiative Properties

Temperature With Excited Wavelength 400 Nm In Region 500-900 Nm. When Sm³⁺ Ions Are Excited The Initial Population Relaxes Finally To The ⁴G_{5/2} Level, There Are Several Intermediate Levels With Smaller Energy Difference, Which Encourage Their Efficient Non-Radiative Relaxation There By Leading To The Population At The ⁴G_{5/2} State. This State Is Distinct From The Intermediate Lower State I.E. ⁶F_{11/2}. It Could Be Stated That Radiative Transitions And Relaxations By Non-Radiative Energy Transfer Are The Two Main Processes, Which Could Finally Depopulate The ⁴G_{5/2} State. The Emission Spectra Of The Pbo-As₂O₃-Sm₂O₃:V₂O₅ Glasses Containing Sm³⁺ Ions Exhibit Four Emission Transitions, Which Are Assigned To ⁴G_{5/2}→⁶F_{5/2} (565 Nm), ⁴G_{5/2}→⁶F_{7/2} (600 Nm), ⁴G_{5/2}→⁶F_{9/2} (648 Nm) And ⁴G_{5/2}→⁶F_{11/2} (710 Nm) [28-29]. By The Addition Of V₂O₅ Another Band Is Observed At Round 782.5nm With The Transition ²E→²T₂ [30-31]. The Fig. 7.Shows The Luminescence Spectra Of Pbo-As₂O₃-Sm₂O₃: V₂O₅ Glasses.

Table 5: Various Radiative Properties Of Pbo-As₂O₃: Sm₂O₃: V₂O₅ Co Doped Glasses

GLASS	Smv 0.2		Smv 0.4		Smv 0.6		Smv 0.8		Smv 1.0	
	A(S ⁻¹)	B (%)								
⁶ H _{5/2}	19.97	9.25	20.73	9.1	23.84	9.7	24.04	10.87	28.36	11.35
⁶ H _{7/2}	116.54	54.02	120.98	53.63	131.24	53.65	121.28	54.87	126.48	50.64
⁶ H _{9/2}	52.21	24.2	54.96	24.36	57.87	23.63	45.93	20.77	64.80	25.94
⁶ H _{11/2}	27.01	12.5	28.90	12.1	31.64	12.93	29.78	11.47	30.09	12.04
A _T	215.73		225.57		244.59		221.03		249.73	

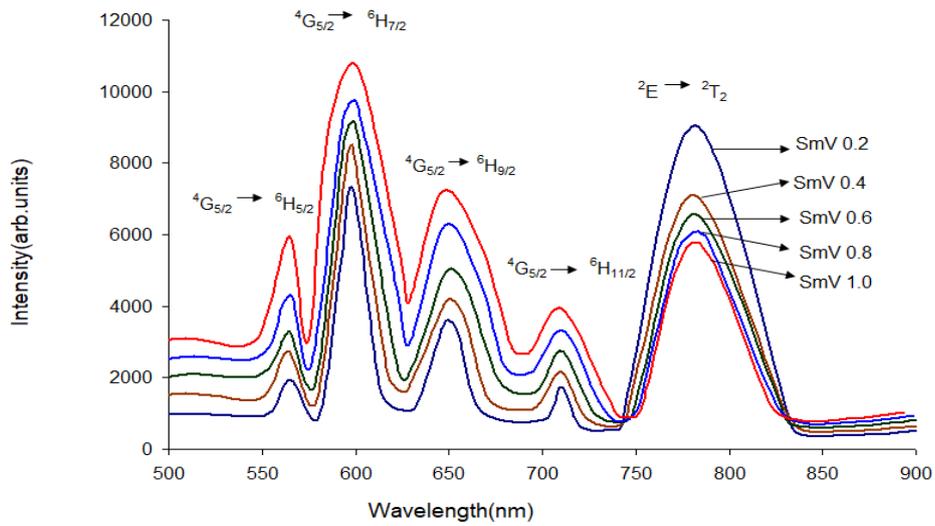


Fig.7.Emission Spectra Of PbO - As_2O_3 : Sm_2O_3 : V_2O_5 Co Doped Glasses

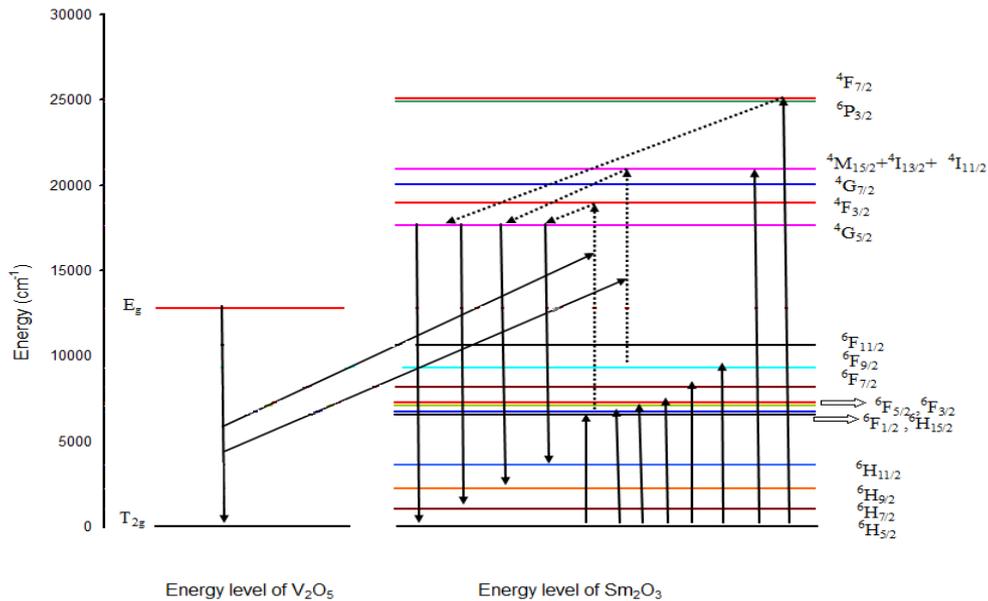


Fig.8.Energy Level Diagram Of PbO - As_2O_3 : Sm_2O_3 : V_2O_5 Co Doped Glasses

3.5 CIE Color Coordinates

The Tunability Of Color Emitted By The Glass Samples, The Variation In The Relative Intensities Of The Emission Bands Has Been Analyzed In The CIE Diagram [32].The Diagram Exhibits All The Chromaticity Visible To The Human Eye.Fig.8 Shows The CIE (1931) Chromaticity Co-Ordinates Of PbO - As_2O_3 - Sm_2O_3 : V_2O_5 Glasses Under 400 Nm Excitations. The Evaluated Chromaticity Coordinates (X,Y) Are (0.212,0.83), (0.223,0.9), (0.262,0.1), (0.29,0.159), (0.313,0.165) For PbO - As_2O_3 - Sm_2O_3 : V_2O_5 Glasses (Smv0.2,Smv0.4,Smv0.6,Smv0.8,Smv1.0) Respectively. These Coordinates Are Very Useful In Determining The Exact Color Of The Samples. Fig.9 Represents CIE Diagram Of PbO - As_2O_3 - Sm_2O_3 : V_2O_5 .

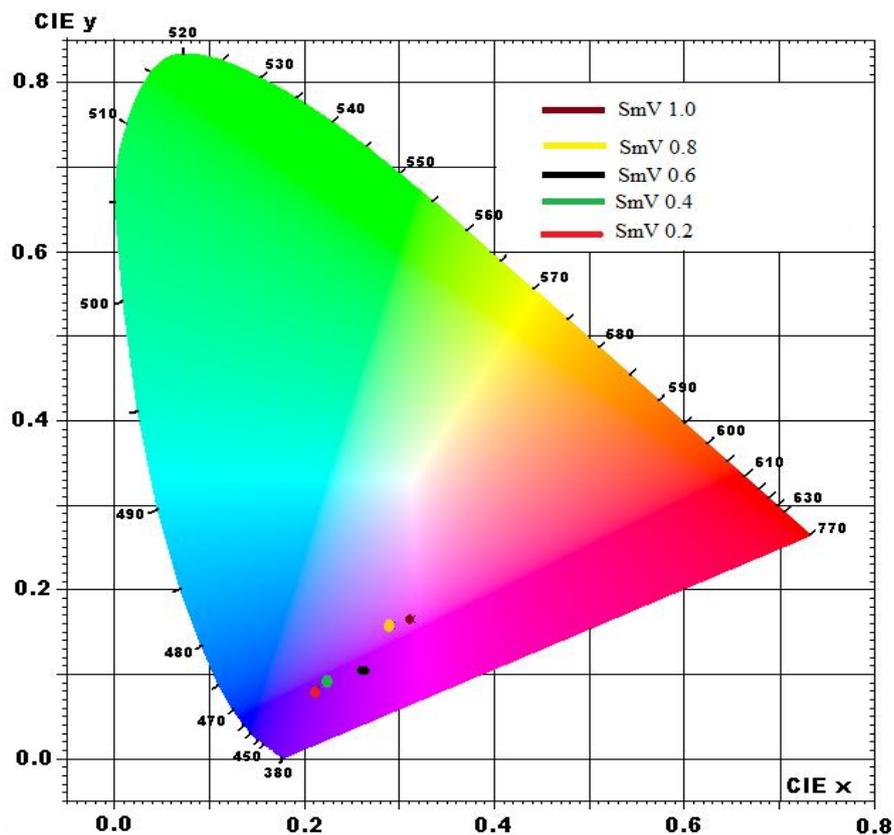


Fig.9. The CIE Chromaticity Diagram Of $\text{PbO-As}_2\text{O}_3\text{: Sm}_2\text{O}_3\text{: V}_2\text{O}_5$ Co Doped Glasses

IV. Discussion

In The Present Paper Physical Properties And Density Main Tool To The Analyze The Degree Of Structural Compactness Of The Glasses, Increasing The V_2O_5 Concentration Simultaneously Density Also Increased. V_2O_5 Acts As Dual Role, At Low Content-Network Modifier, At High Content-Network Former Because Non Bridging Oxygen Content Is Increases. The Refractive Index Varies With Non Linearity With Increasing Concentration Of V_2O_5 . Interionic Distance, Polaron Radius, Field Strength, Reflection Loss, Molar Refraction And Electronic Polarizability Values Are Decreased And Metallization Factor Values Are Small Variation With Increasing Concentration Of V_2O_5 . The Infrared Transmission Spectra Of $\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Glasses Contain Different Structural Units. Within The Glass Region, Rare-Earth Ion Sm_2O_3 Content Is Present, Due To This There Is No Significant Difference Is Observed, But May Be Shifted To Lower Frequency. Arsenate Vibrations, Pbo Vibration And V-O-V Chains Is Observed.

The Absorption Spectrum Of $\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{: V}_2\text{O}_5$ Glasses, The Transitions Observed In The Absorption Spectrum With (F-F) Transition Are Almost Overlapping With The Surrounding Ions. The Spectrum Consists Of V^{4+} An Ion Belongs To D^1 Configuration. The Optical Band Gap Of The Sample Is Found To Decrease With An Increasing The Concentration Of Dopant V_2O_5 In The Glass Matrix Due To Increase Of Non-Bridging Oxygen Ions. The JO Intensity Parameters Are Host Dependent And Are Important In Exploring The Glass Structure And Transition Rate Of The Rare Earth Ion Energy Levels. The Trends Of The JO Parameters Are Found To Be Order Of $\Omega_4 > \Omega_6 > \Omega_2$ For The Prepared Sm^{3+} Glasses. The Ω_2 , JO Intensity Parameter Of The Sm^{3+} Doped Glasses Are Found To Be Associated With The Covalency, Structural Change And Symmetry Of The Ligand Field Around Sm^{3+} Site [33]. Theoretical And Experimental Oscillator Strength Of $\text{PbO-As}_2\text{O}_3\text{: Sm}_2\text{O}_3\text{: V}_2\text{O}_5$ Co Doped Glasses Are Listed Table 3. J-O Intensity Parameters Of $\text{PbO-As}_2\text{O}_3\text{: Sm}_2\text{O}_3\text{: V}_2\text{O}_5$ Co Doped Glasses Are Listed Table 4, The Trend Of $\Omega_4 > \Omega_6 > \Omega_2$ Is Follow Previous Literature [34-36]. The JO Intensity Parameters Ω_4 And Ω_6 Refer To The Viscosity Of The Glass Matrix And Dielectric Of The Media, Which Are Affected By The Vibronic Transitions Of The RE Ions Bound To The Ligand Atoms $\Omega_4 > \Omega_6 > \Omega_2$ [37,38].

The Photoluminescence Spectra Of $\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Glass System Exhibit Four Emission Transitions Due To Sm^{3+} Ions In Which Transition ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{7/2}$ (604 Nm) Has A Most Intense. ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{7/2}$ Transition Is Magnetic Dipole Allowed But Electrical Dipole Dominated With $\Delta J = \pm 1$, And The ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{9/2}$ Band Is Purely An Electric Dipole Transition. The Intensity Ratio Of Electric Dipole To Magnetic Dipole Transition Has Been Used To Measure The Symmetry Of The Local Environment Of The Trivalent RE Ions

[39]. In This ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{9/2}$ Transition Is More Intense Than ${}^6\text{H}_{5/2}$ Deciding The Asymmetric Nature Of The Glass Host. In The Present Composition The Concentration Of Sm_2O_3 Was Fixed At 1 Mol%. Increasing Vanadium Concentration In Steps Of 0.2 To 1.0 Mol%, Possible Energy Transfer From V_2O_5 To Sm_2O_3 . Concentration Quenching Between The Vanadium To Samarium [40]. Dipole-Dipole Interaction Is Possible By Variation In Concentration In Prepared Glass Samples. Samarium To Vanadium Level Energy Separation Is Small Multiphonon Relaxation Is Possible.

Fig. 8 Represents The Energy Level Scheme For $\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Glasses [33, 41]. The Energy Transfer From ${}^2\text{E} \rightarrow {}^2\text{T}_2$ Level [42-43] To ${}^6\text{F}_{1/2}$ And ${}^6\text{F}_{9/2}$ Of Sm^{3+} Ions, Due To This Reason Samarium Ion Gets Excited From ${}^6\text{F}_{1/2}$ To ${}^4\text{F}_{3/2}$ And ${}^6\text{F}_{9/2}$ To ${}^4\text{M}_{15/2}$ And Diexcited To ${}^4\text{G}_{5/2}$ Through Non Radiative Decay From ${}^4\text{G}_{5/2}$ Of Samarium Ions. The Intensity Of Samarium Ions Increases Comparing To Vanadium Ions. Various Radiative Properties Are Calculated Like Radiative Transition Probability (A), Branching Ratio (B) And Total Radiative Transition Probability (A_T). We Observed Branching Ratio Values > 50 For All Glasses, The Transition From ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{7/2}$. In The CIE Diagram Two Color Coordinates (0.313,0.165) Nearly Equal To White Light Due To This Reason This Material Is Used For Optical Devices.

V. Conclusions

$\text{PbO-As}_2\text{O}_3\text{-Sm}_2\text{O}_3\text{:V}_2\text{O}_5$ Glasses At Different Concentrations Were Prepared Via Conventional Melt Quenching Technique. FT-IR Spectra Revealed The Structure And Vibrational Modes For Prepared Glasses. The Optical Spectra Exhibit Several Bands; The Judd-Ofelt Theory Could Successfully Be Applied To Characterize The Optical Absorption Spectra Of These Glasses. The Radiative Transition Probabilities And Branching Ratios Evaluated For Various Luminescent Transitions Observed In The Luminescence Spectra, Suggested The Highest Value For ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{7/2}$. The Comparison Of B_r Values Of These Transitions ${}^4\text{G}_{5/2} \rightarrow {}^6\text{H}_{7/2}$ Is High For Better Lasing Action. From The Results Of These Investigations, It Is Concluded That The Title Glasses Are Promising Materials For Development Of Optical Devices.

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