Microcrystallization and Active Applications of some Novel Glasses

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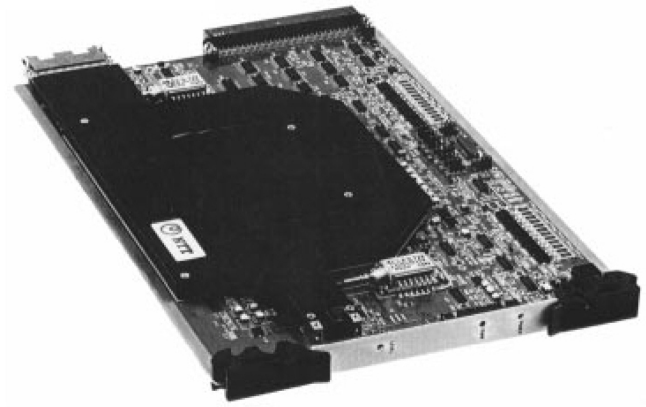
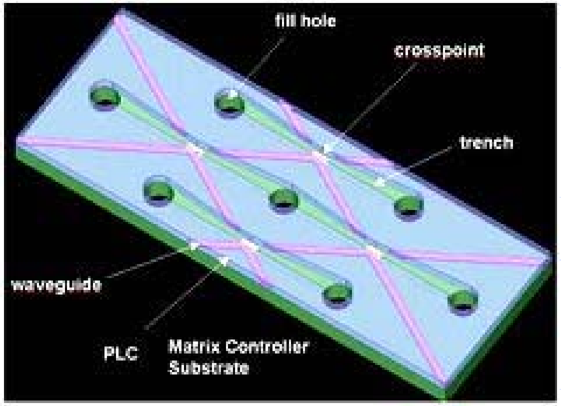
Passive and Active Applications

Passive applications
Without changing the optical properties, other than that due to scattering, absorption and end face reflection losses, etc.

Active applications:
The initial light propagating being modified by a process. Examples include fiber lasers, amplifiers, all-optical devices, etc.

Passive and Active Applications





Shanghai

ECUST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学生公寓
学生公寓落成典礼

華東理工大學
East China University of Science & Technology

3500	employees
1000	professors
15000	undergraduates
4000	graduates

52	B.Sc.
72	M.Sc.
12	Eng. M.
26	Ph. D.
5	Postdoc.

14 Schools

Pharmacy
Biotechnology
Chemical Engineering
Chemistry and Pharmaceuties
Materials Science and Engineering
Resources and Environmental Engineering

Information Science and Engineering
Mechanical and Power Engineering
Science (Maths and Physics)

Culture and Arts
Foreign Languages
Philosophy and Politics
Business and Economics
Public & Social Administration

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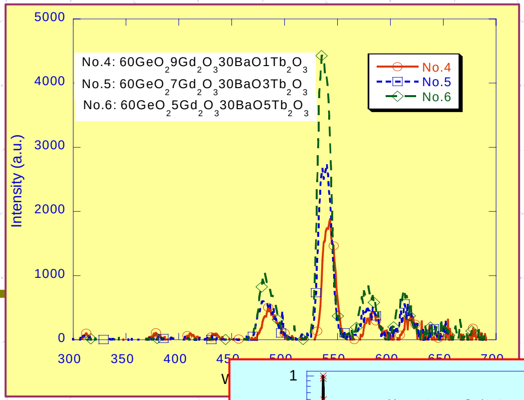
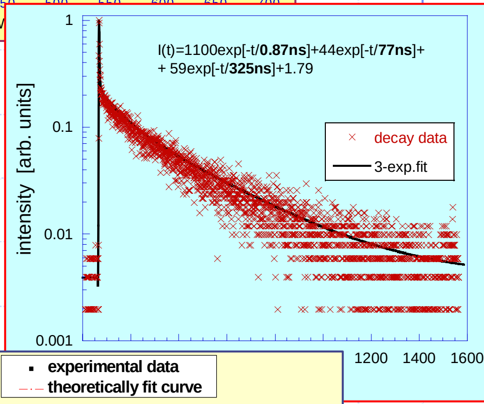
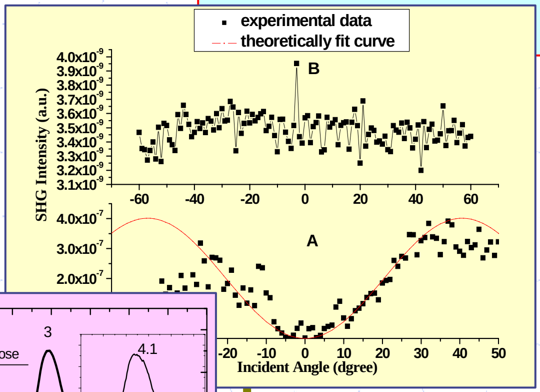
Researches

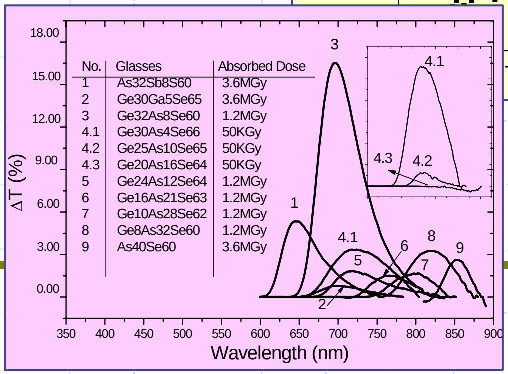
Novel Functional Glasses

- Oxide Glasses
  - Rare earth doped
  - ZnO-activated
- Chalcogenide Glasses
  - Micro-crystallization
  - IR luminescence
  - Non-linearity
  - Irradiation induced effects









Oxide Glasses

Rare earth doping for scintillation and white LED

ZnO activating for fast scintillation

Internationally Collaborated with

ENEA
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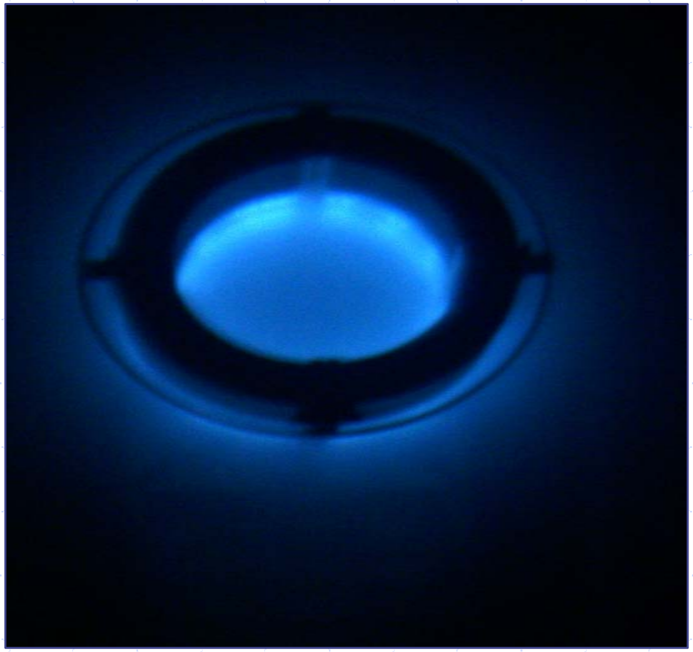
Fyzikální ústav
Akademie věd ČR

Calliope ^{60}Co Source



ENEA-Casaccia Center, Rome, Italy

Background

A good alternative candidate as higher energy irradiation detector for dosimetry system due to:

- A low barrier of information bleaching temperature (<350 ºC)
- The higher energy irradiation detection (> 5MGy)

back

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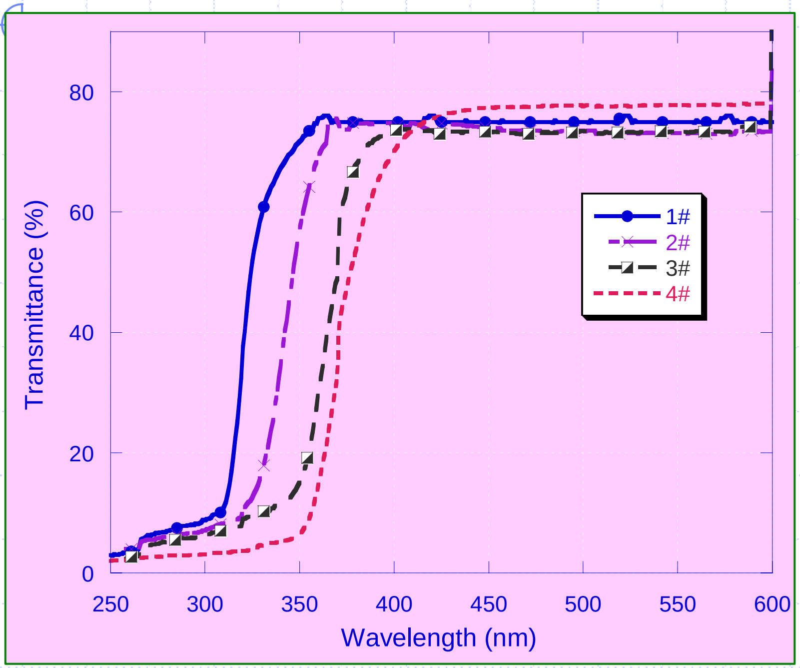
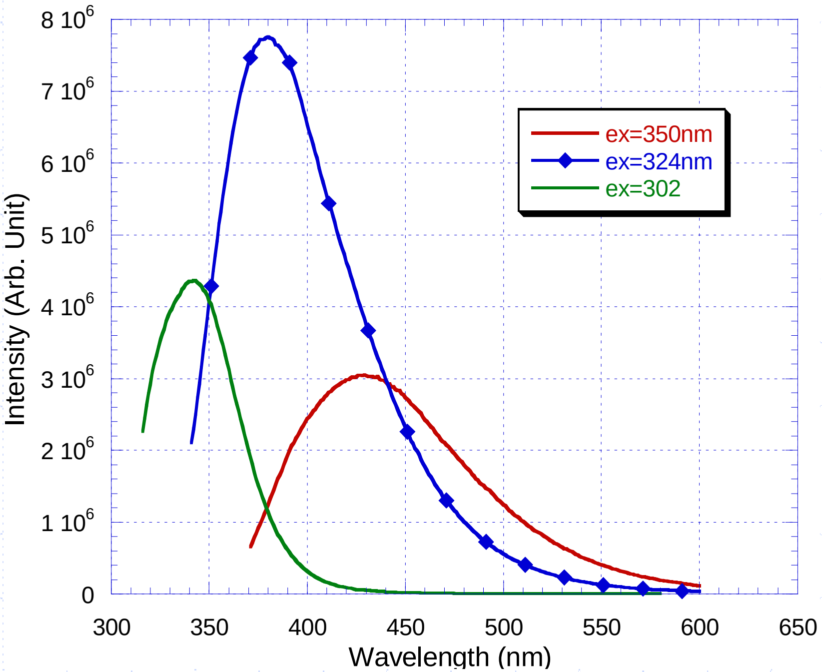
Optical properties of Ce^{3+} doped glasses





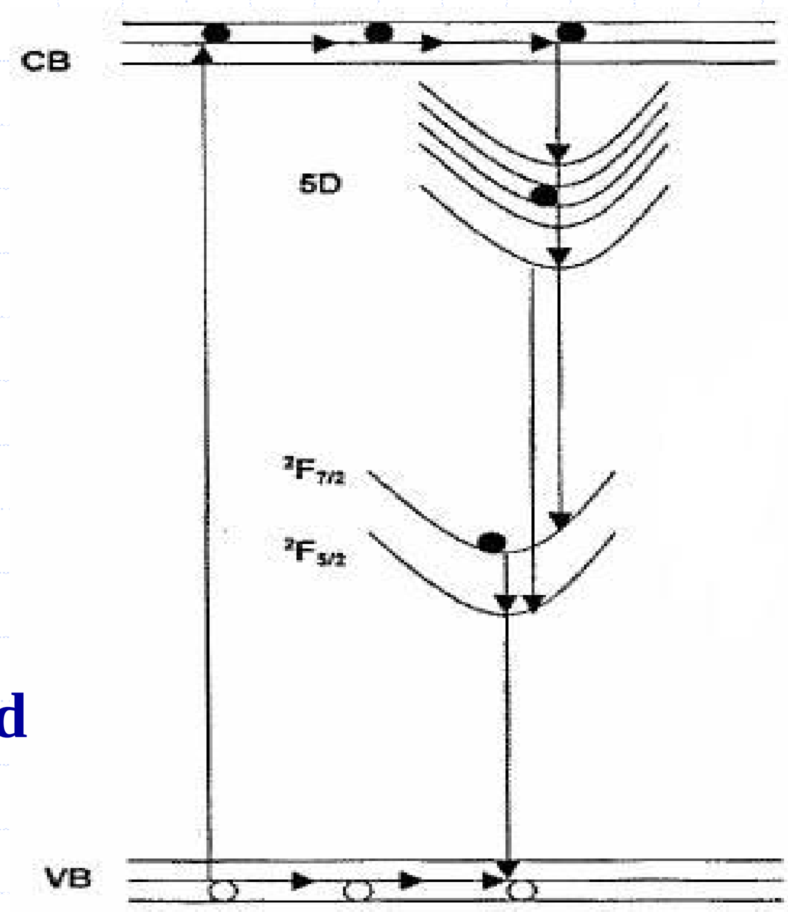
Transmitting and emission spectra of Ce^{3+} doped oxide glasses with different optical basicity - the electron donor power of the oxides

Mater. Res. Bull. **(2006), doi:10.1016/j**

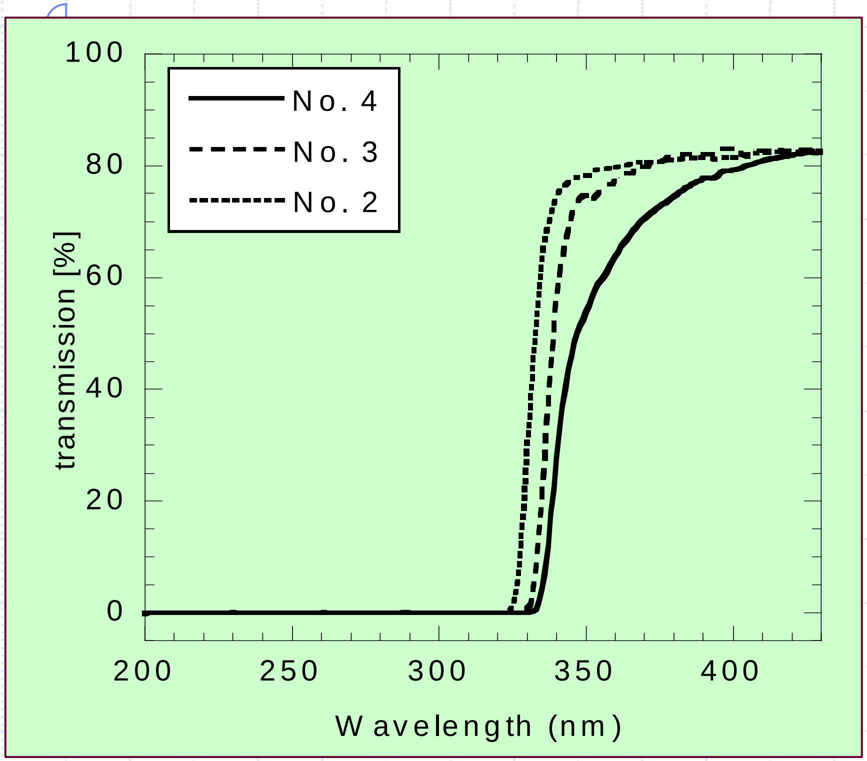
- Fast decay time of 20–50 ns suitable for scintillation

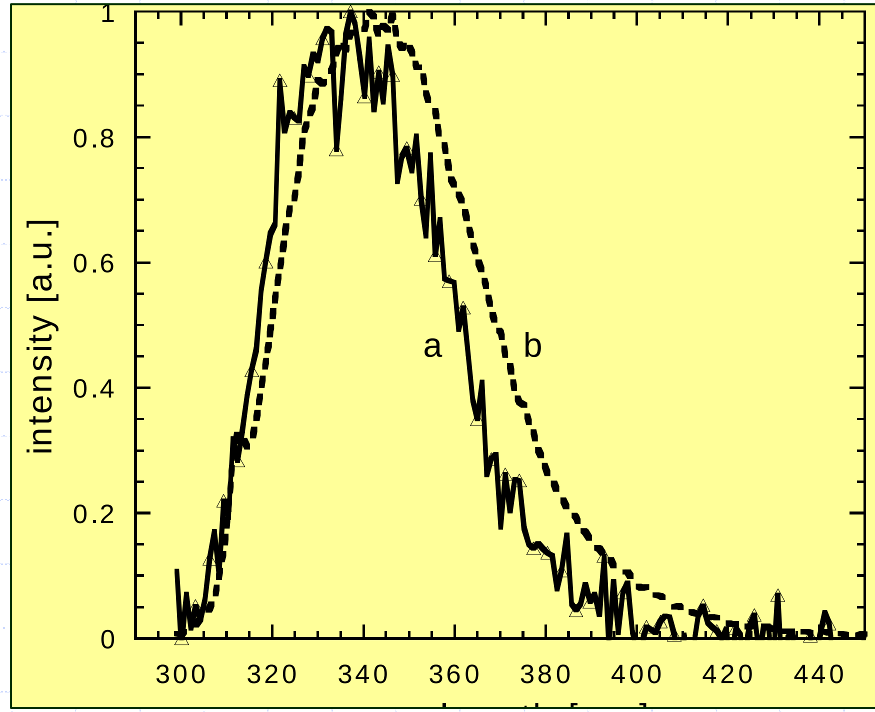
- Advantages of glasses: good matrix for rare earths, lower cost, stable properties etc.

- Disadvantages: Non-shielded 5d orbit sensitive to matrix; lower quantum efficiency



Energy levels diagram of Ce^{3+} 4f-5d electrons transitions



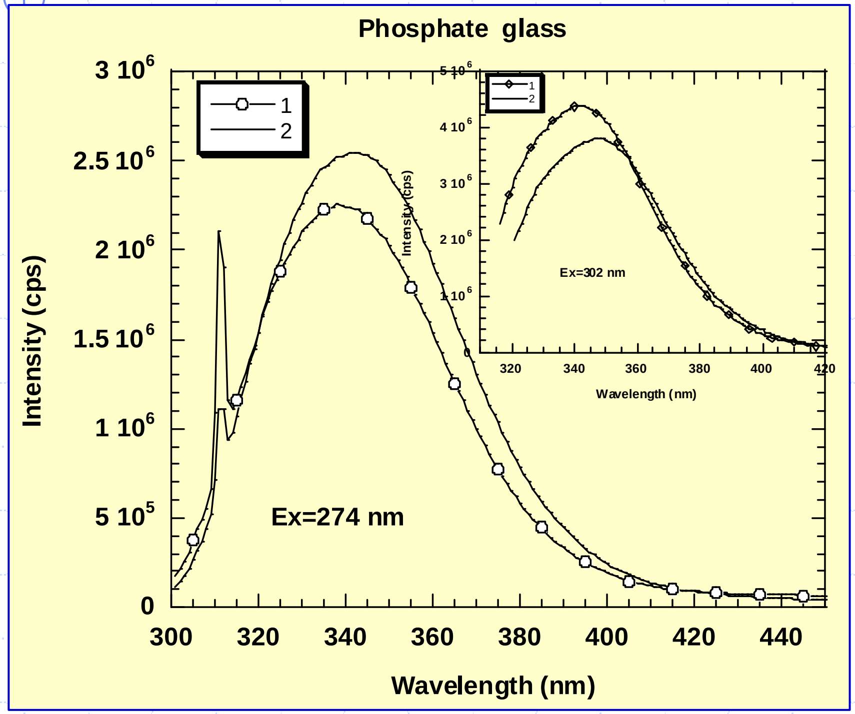


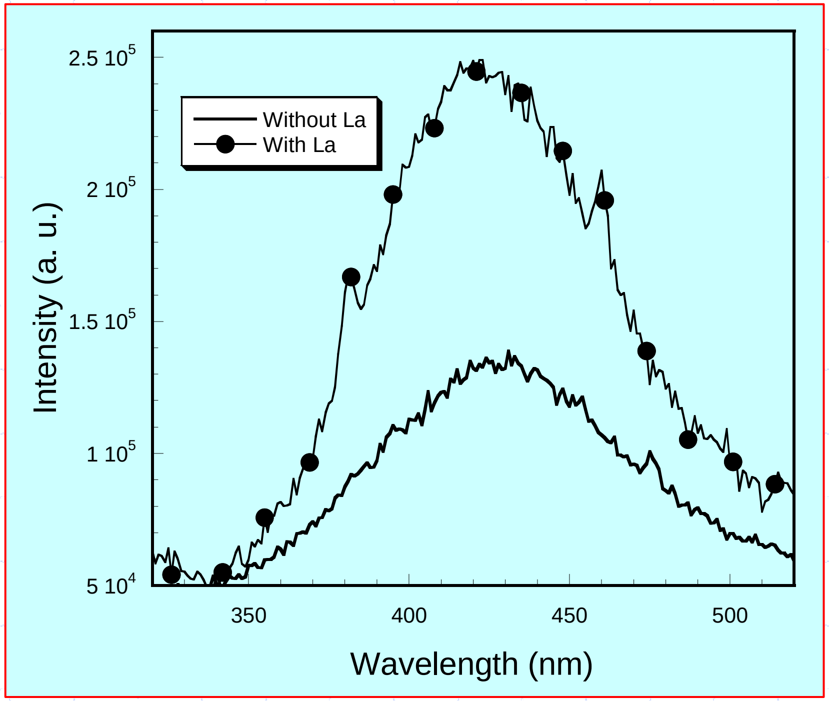
Transmittance and emission spectra of Ce^{3+} doped oxide glasses with different alkali content

***J. Am. Ceram. Soc.*, 87(7) (2004) 1378-1380**

***J. Non-Cryst. Solids*, 326-327(2003)343-347;**

Enhanced emissions due to energy transfer from Gd^{3+} or partitioning role of La^{3+}

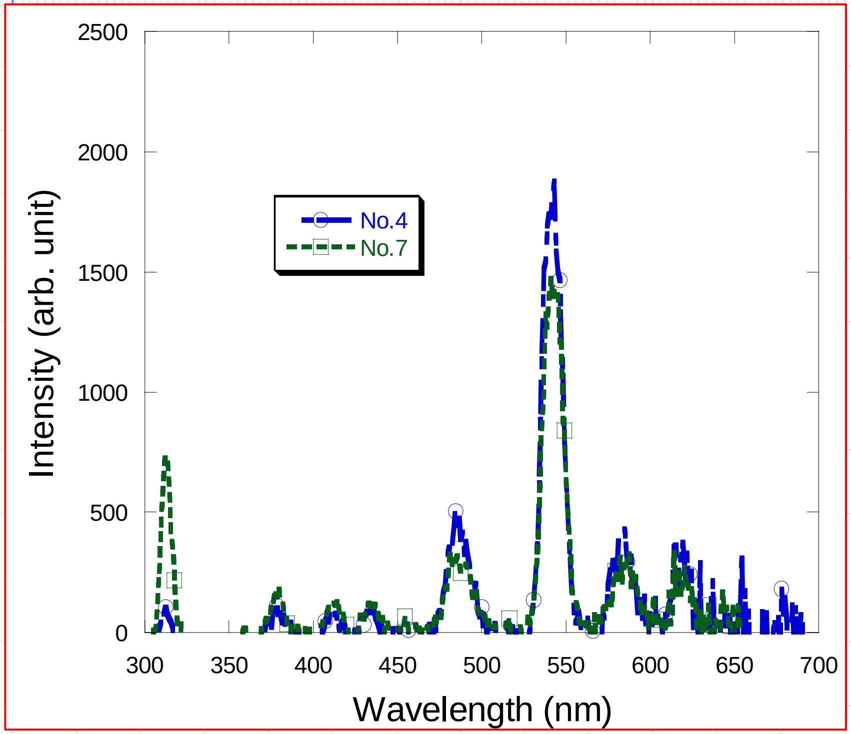


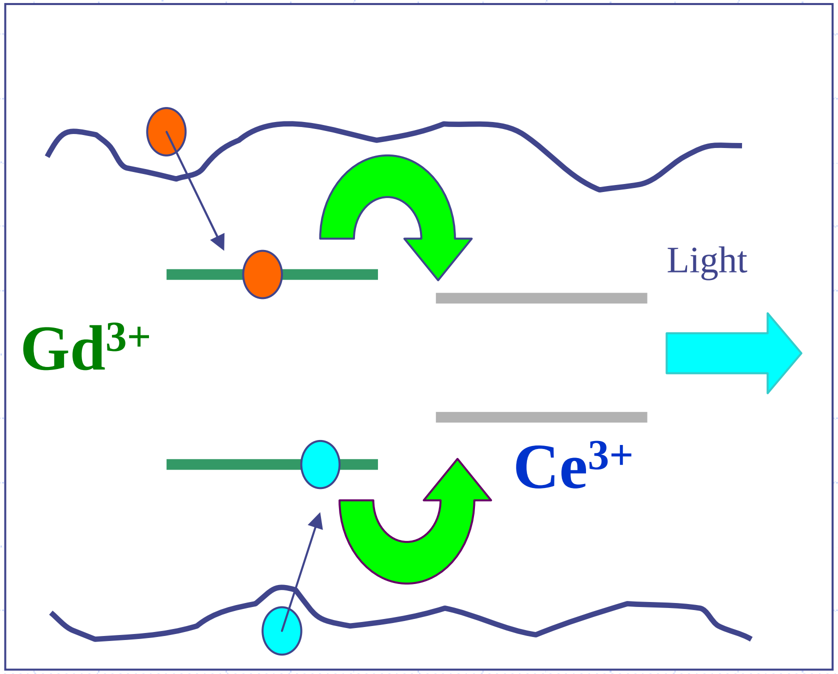


Mater. Res. Bull. (2006), doi:10.1016/j

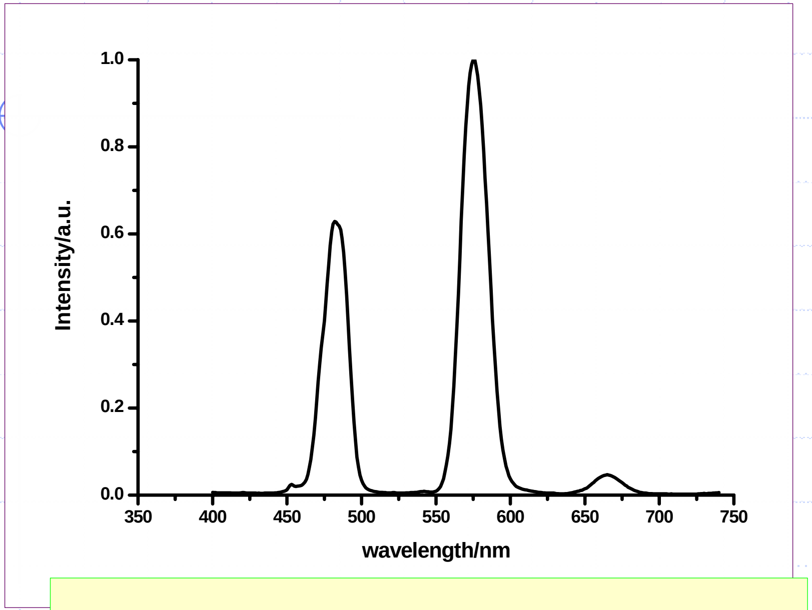
J. Am. Ceram. Soc., 88(2) (2005) 293-296

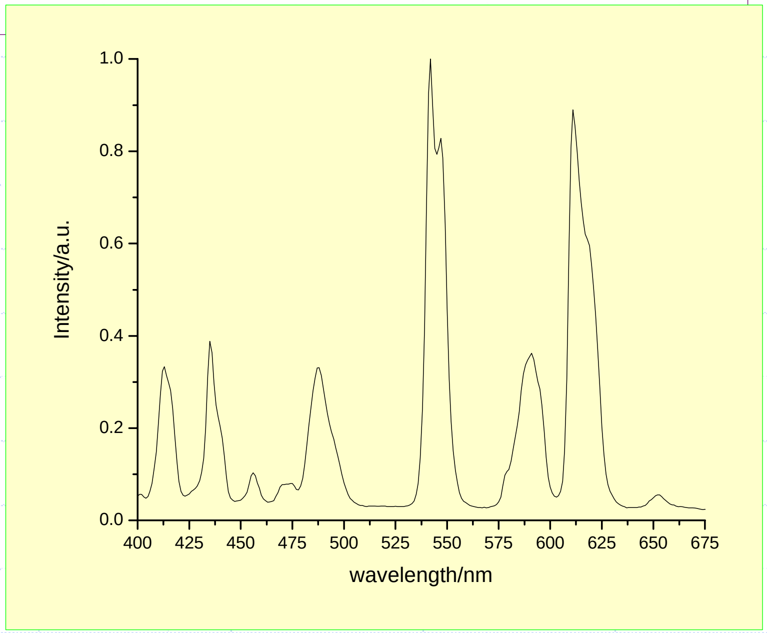
Enhanced emissions due to energy transfer from Gd^{3+} or partitioning role of La^{3+}

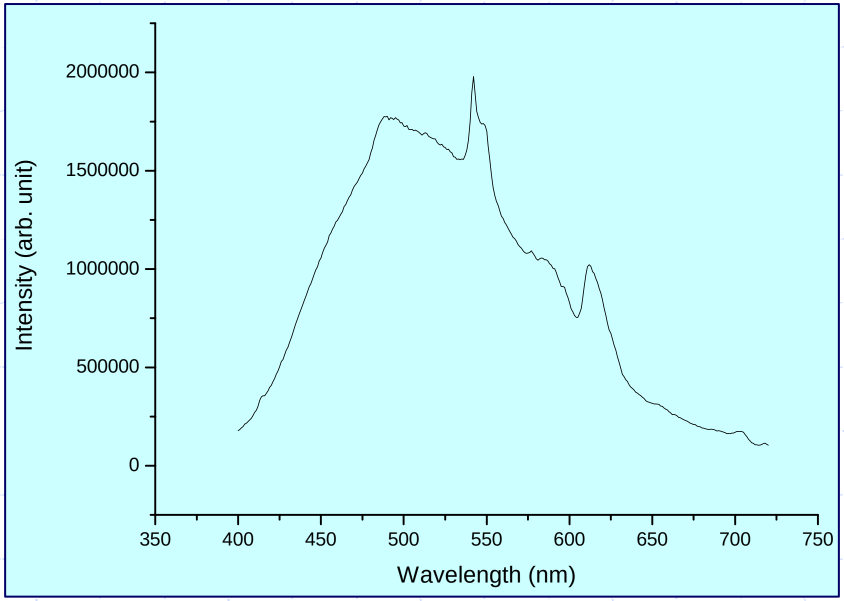




Luminescent Glasses for White LED Lighting







Emission spectra of Dy^{3+} doped (left above), Tb^{3+}/Eu co-doped (left below) and Ce^{3+}/ Tb^{3+}/Eu co-doped glasses excited at UV wavelength

J. Lum. doi:10.1016/j

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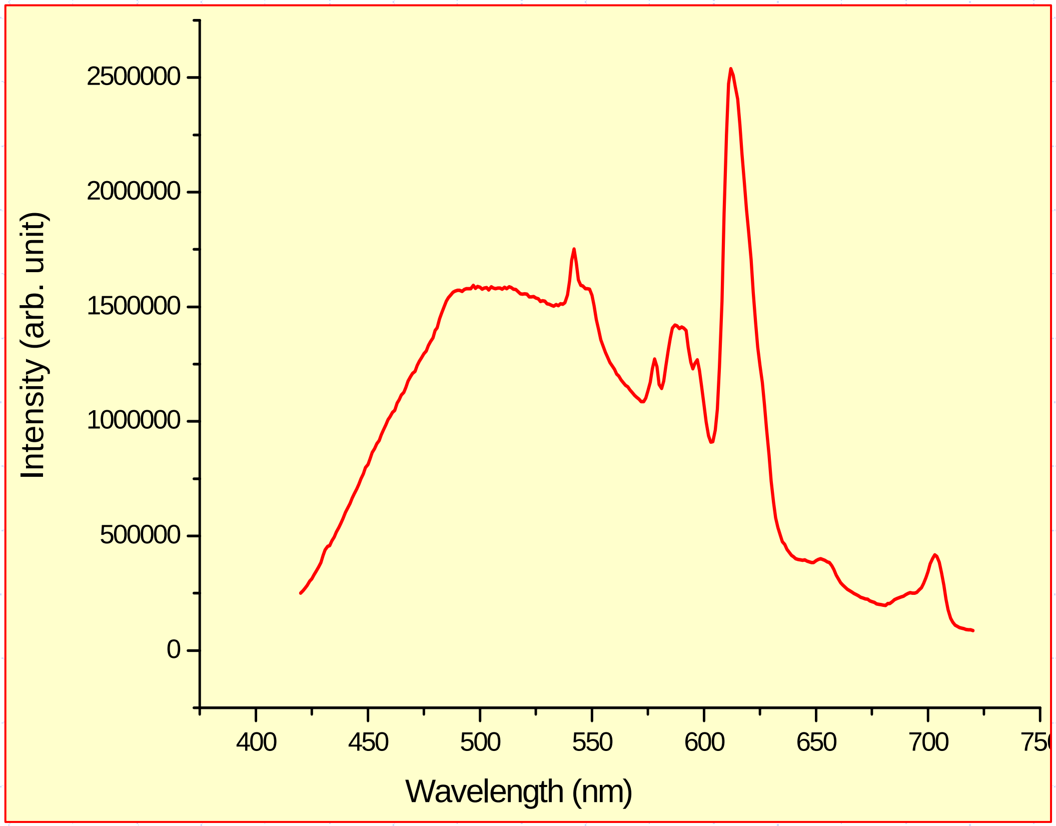
Luminescent Glasses for White LED Lighting



J. Lum. doi:10.1016/j

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White-Light-Emitting diodes (W-LEDs)

An important class of lighting devices for replacement of conventional lighting sources of incandescent and fluorescent lamps

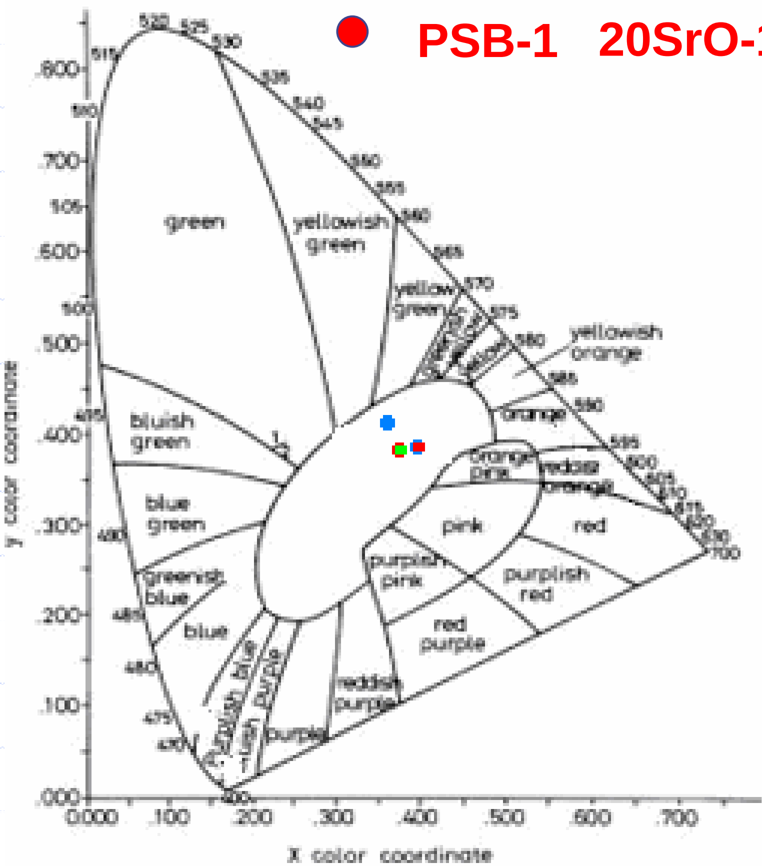
Advantage: long lifetime, lower energy consumption, and environmental-friendly characteristics

Glasses: lower production cost, simpler manufacture procedure, free of halo effect, etc, feasible to replace phosphors for W-LED

● SCB-4 $37CaO\text{-}13BaO\text{-}40SiO_2\text{-}10B_2O_3{:}0.5Ce,0.25Tb,1.5Eu$

● SCB-5 $37CaO\text{-}13BaO\text{-}50SiO_2{:}2Dy$

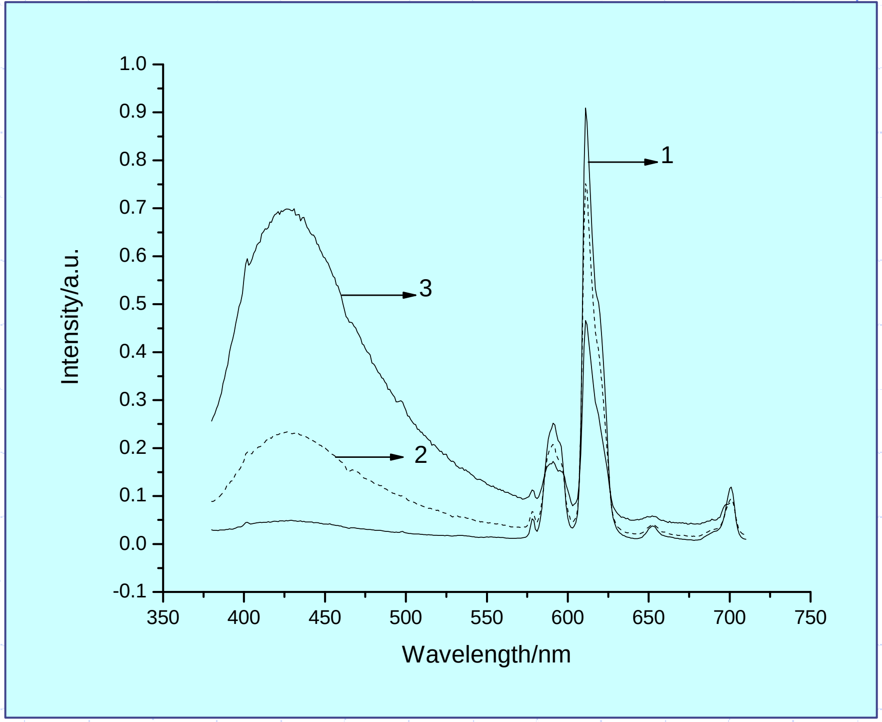
● PSB-1 $20SrO\text{-}15BaO\text{-}5B_2O_3\text{-}60P_2O_5{:}1Eu,1Tb$

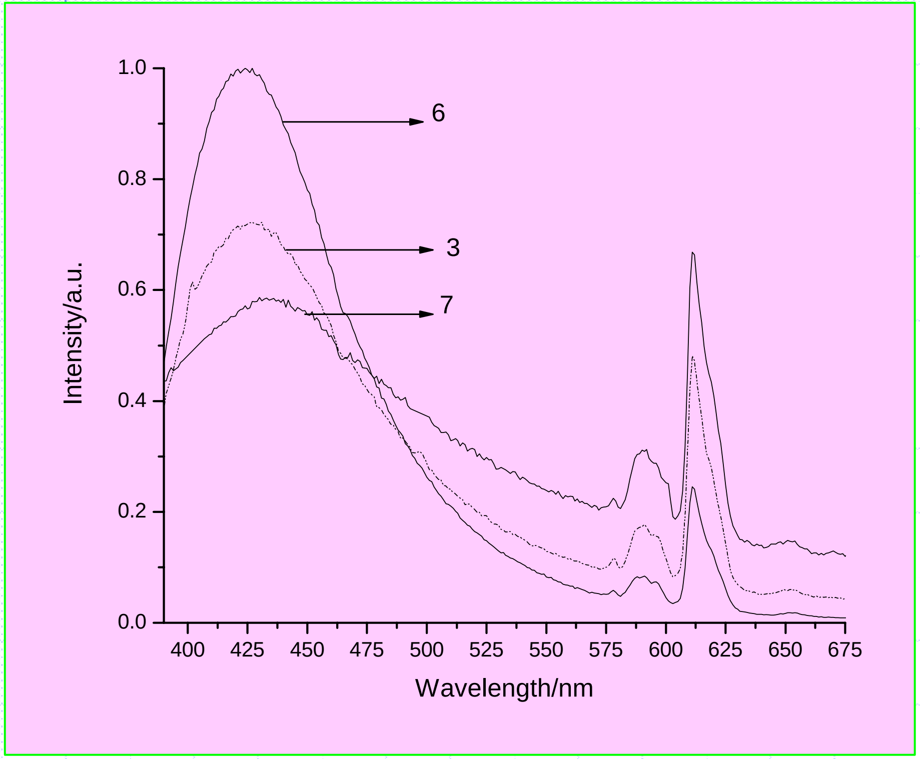


Sample No.	X	Y
SCB-4	0.3731	0.3828
SCB-5	0.4137	0.3684
PSB-1	0.4241	0.3578

Color coordinate diagram of luminescence glasses

J. Lum. doi:10.1016/j

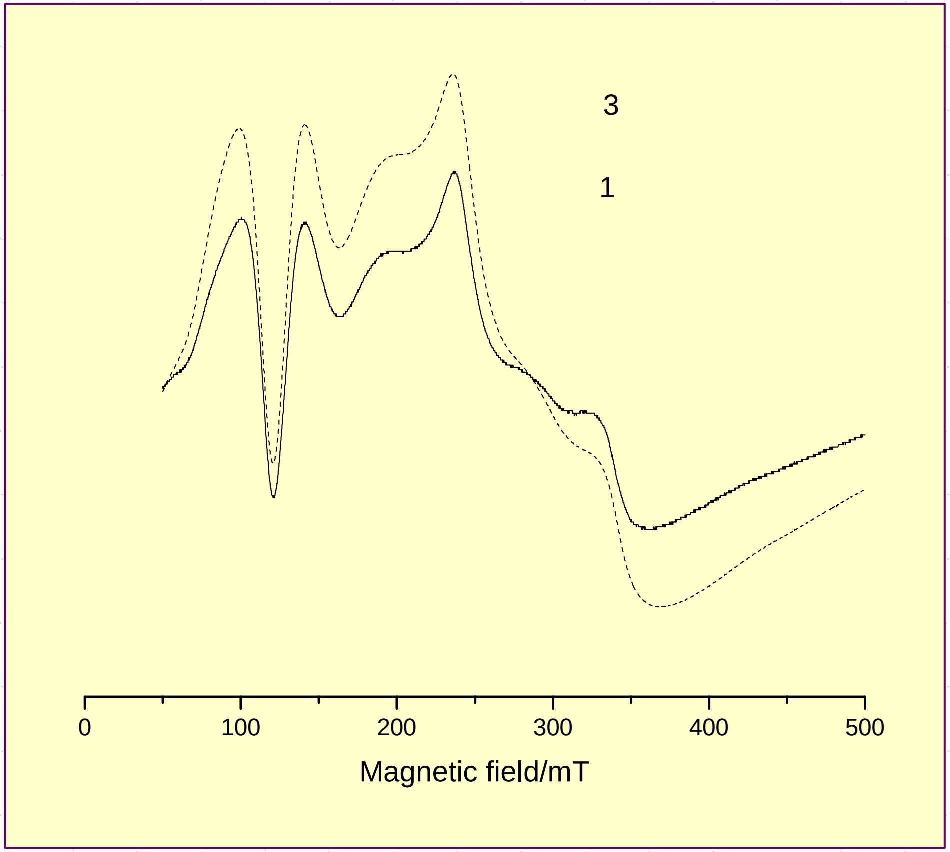




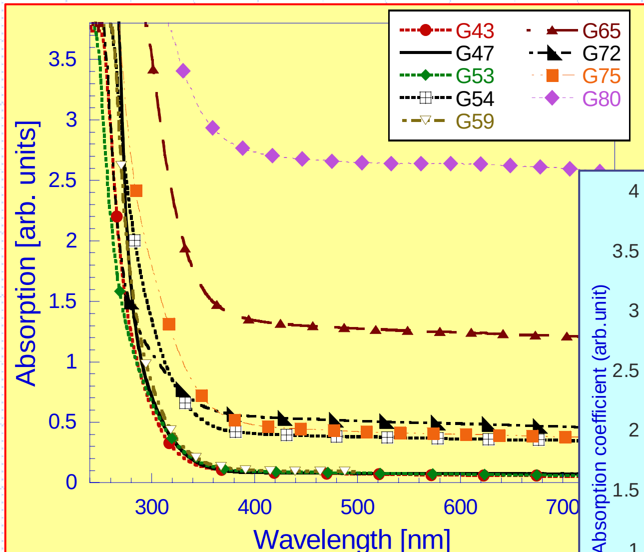
Emission spectra

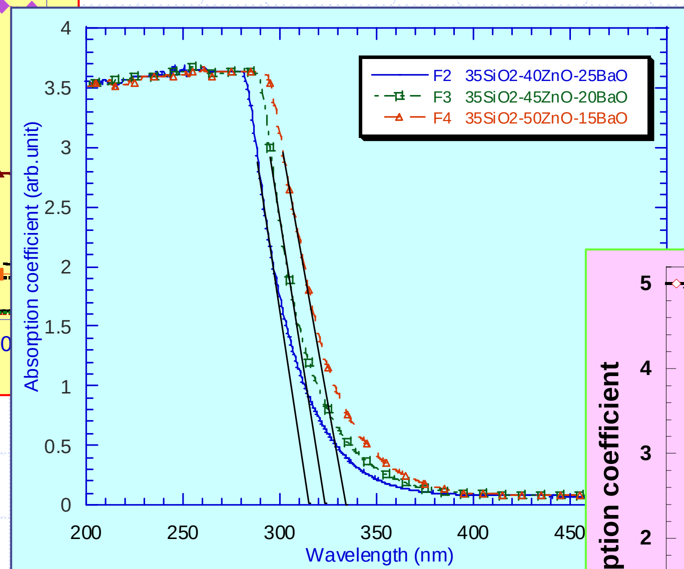
of Eu-doped glasses with different B_2O_3 (above) and different type of alkaline earth oxides

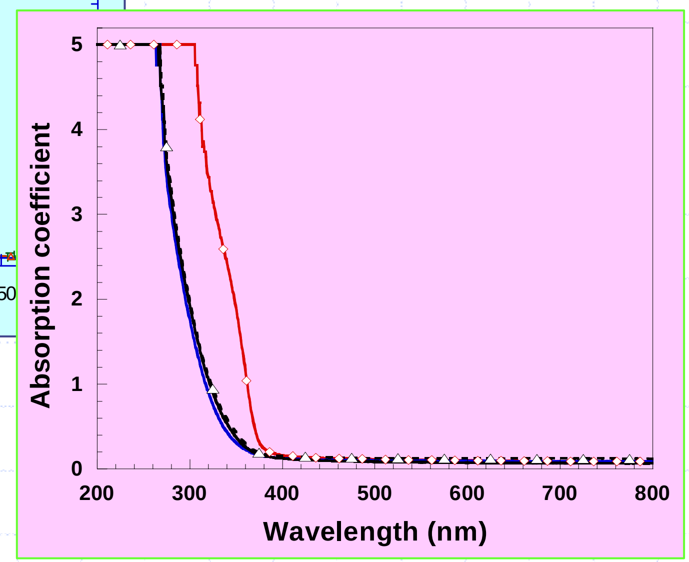
Submit to J. Am. Ceram. Soc.


3
1
0
100
200
300
400
500
Magnetic field/mT

ZnO-Activated Oxide Glasses for Scintillation





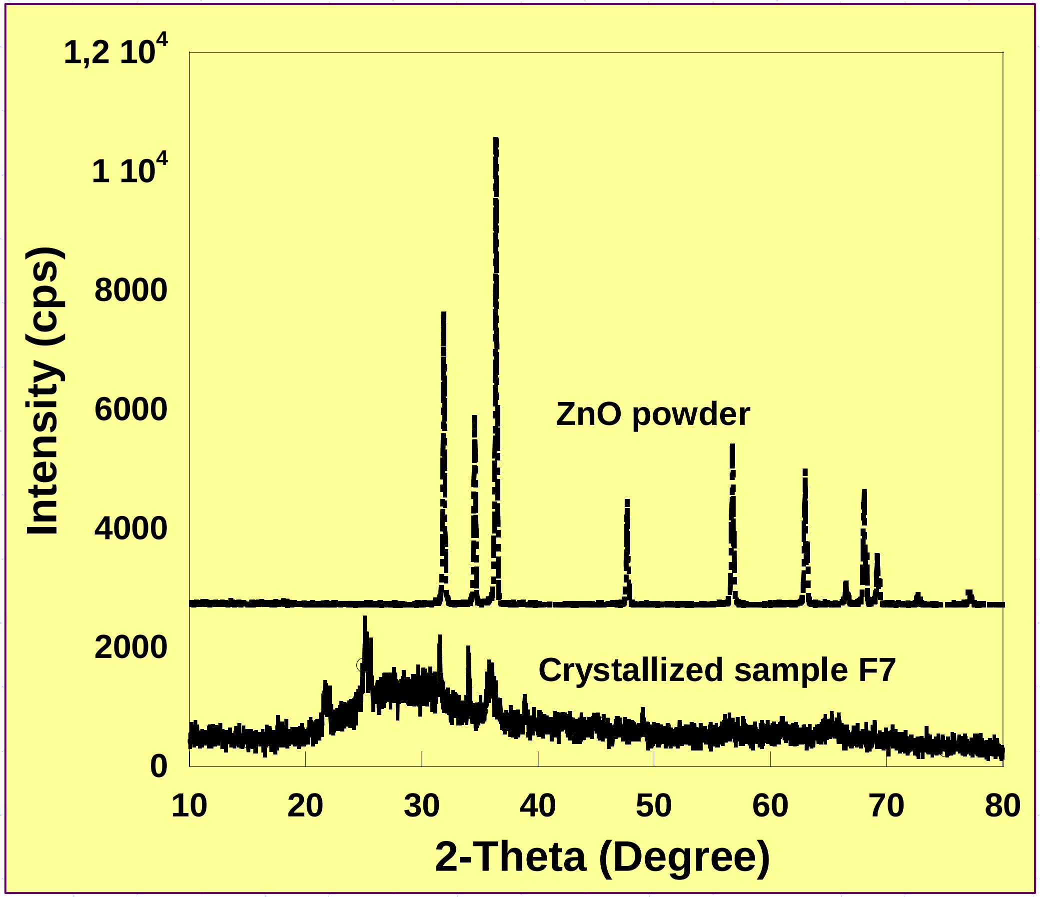


Absorption spectra

of glasses with different compositions (left), different ZnO/BaO ratios (middle) and different thermal treating conditions.

Opt. Mater., 29(2007)552-555
J. Am. Ceram. Soc. (accpeted)

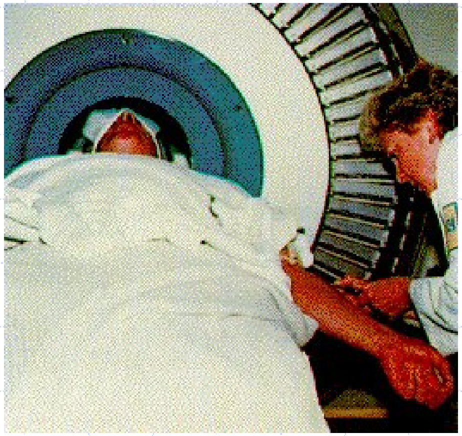
ZnO-Activated Oxide Glasses for Scintillation



Opt. Mater., 29(2007)552-555
J. Am. Ceram. Soc. (accpeted)

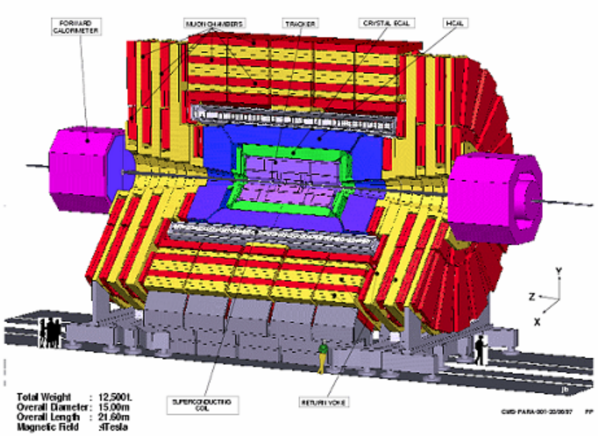
Luminescence ZnO

Applications in optoelectronic devices: vacuum fluorescent and field emission displays, blue and ultraviolet emitters and detectors.

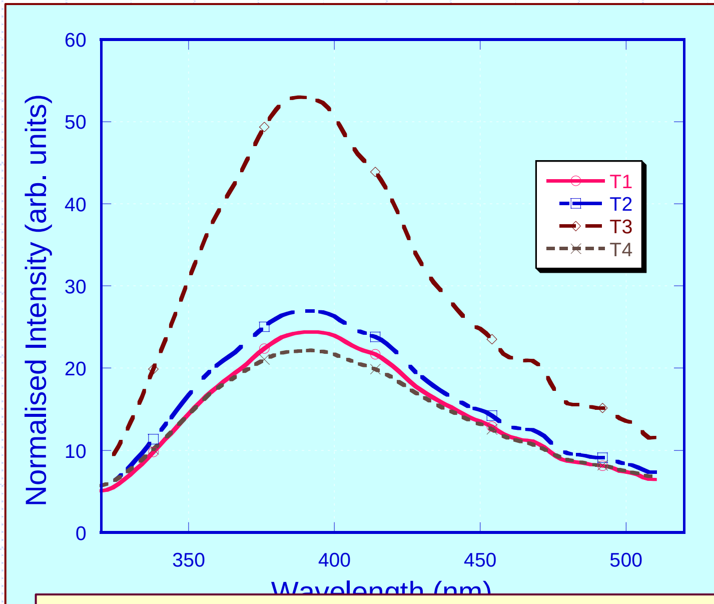


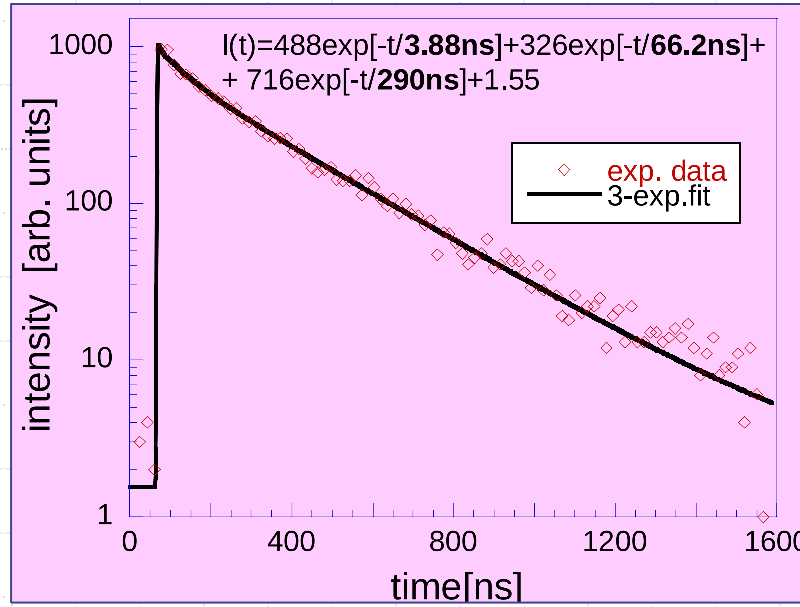
Near band-gap excitonic emission from ZnO at around 380 nm with the subnanosecond lifetime.

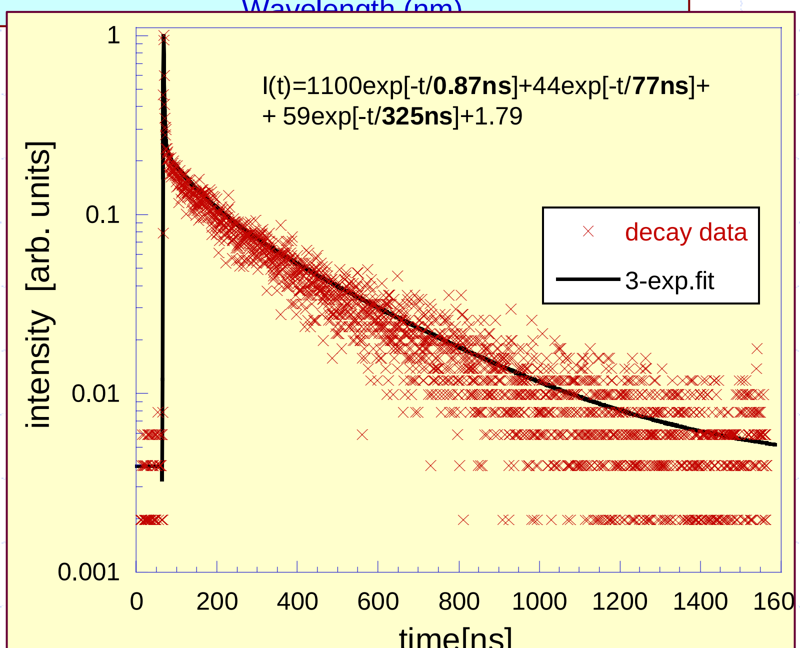
It appears of interest for developing novel superfast scintillating materials with ZnO as activator.



Photoluminescence







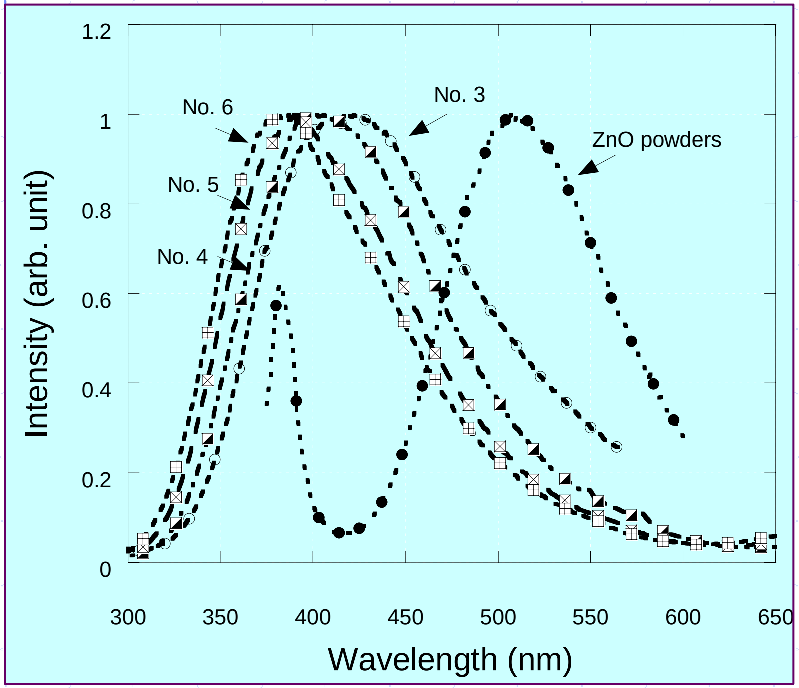
Emission spectra

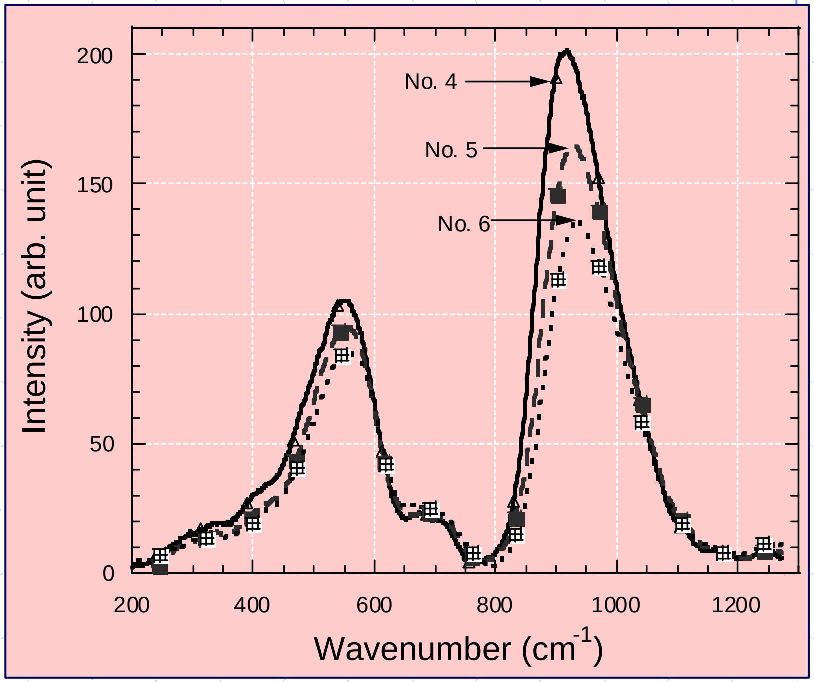
of glasses annealed at different temperatures (left) and decay curve of glasses with different compositions

Rad. Meas., 38(2004) 771-774

Opt. Mater. 29(2007)552-555

Emission spectra (below) and Raman spectra (right) of glasses with and without F^- ions





Si-O-Zn → Si-O-Si

***J. Phys. Chem. Solids*, under review**

Chalcogenide Glasses (ChG)

- Novel systems for crystallization
- IR luminescence
- Second Harmonic Generation (SHG)
- γ-irradiation induced effects

Internationally Collaborated with

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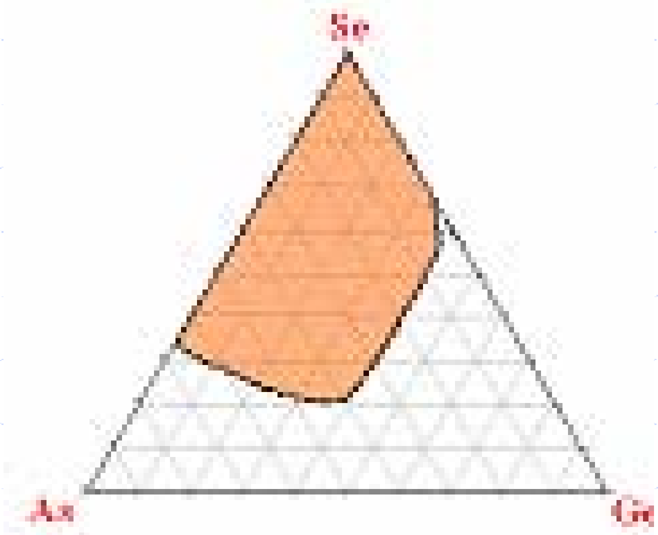
京都大学

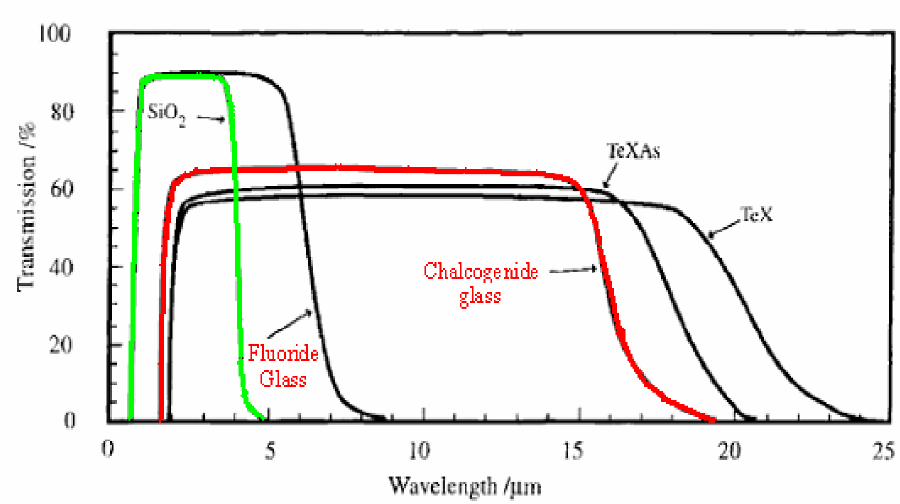
UNIVERSITE DE RENNES I

Typical Chemical Elements used in chalcogenide glass

C	N	O	F
Si	P	S	Cl
Ge	As	Se	Br
Sn	Sb	Te	I
Pb	Bi	Po	At

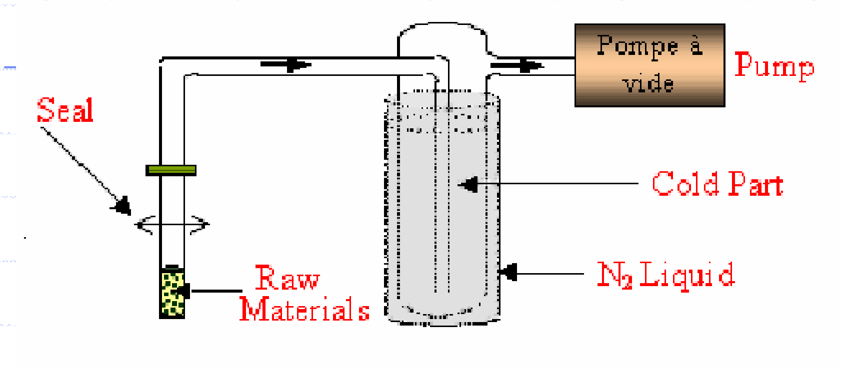


Se-Ge-As chalcogenide glass systems

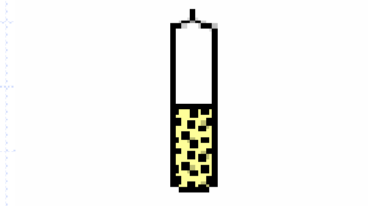


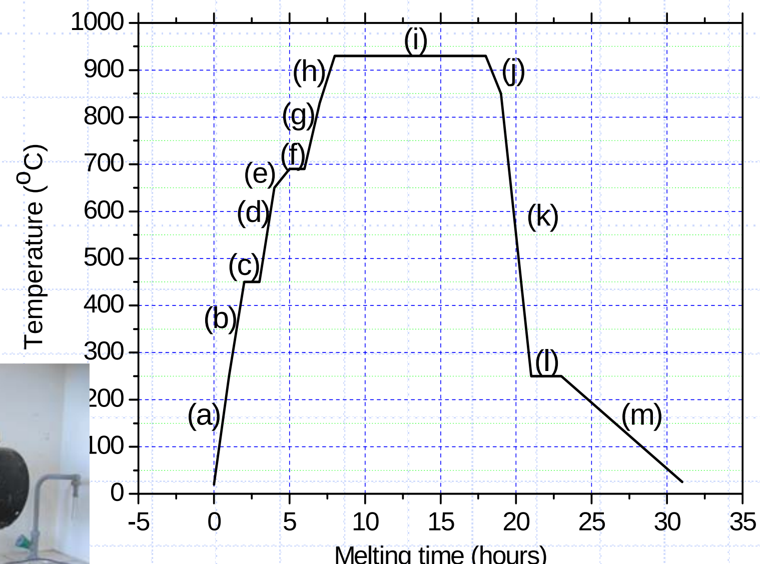
Optical transmission spectra of chalcogenide glasses

Sample Preparation



Vacuum Sealing



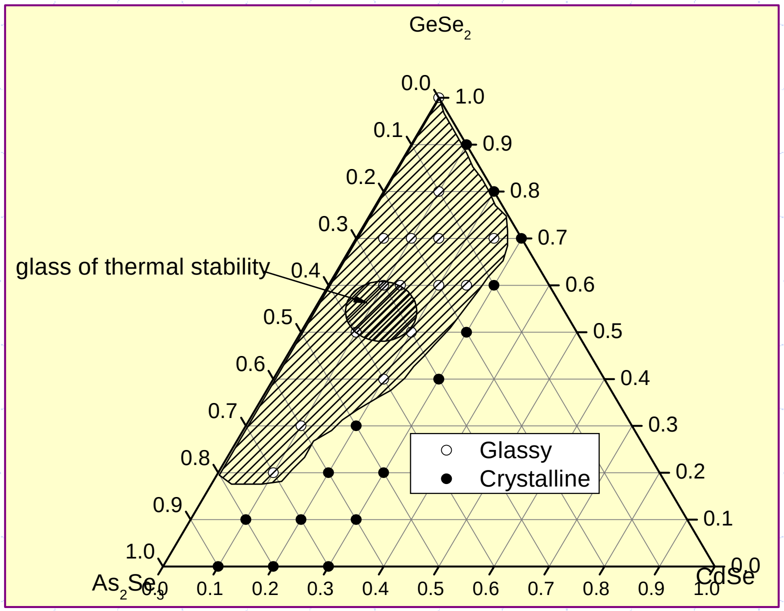


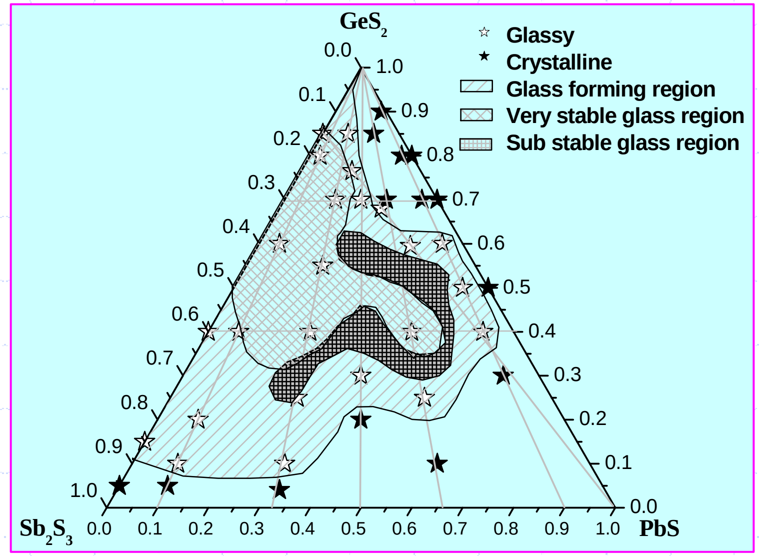
Melting in Rocking Furnace

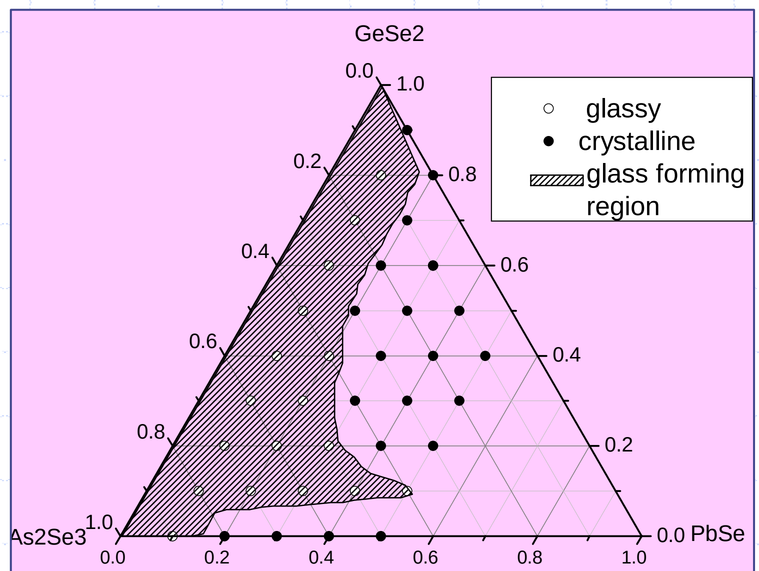
Prepared Samples

Novel Chalcogenide Glass Systems

Novel glass forming regions:
$GeSe_2$-As_2Se_3-CdSe (below), GeS_2-Sb_2S_3-PbS (right above) $GeSe_2$-As_2Se_3-PbSe







J. Am. Ceram. Soc., 88 (2005) 3143-3146

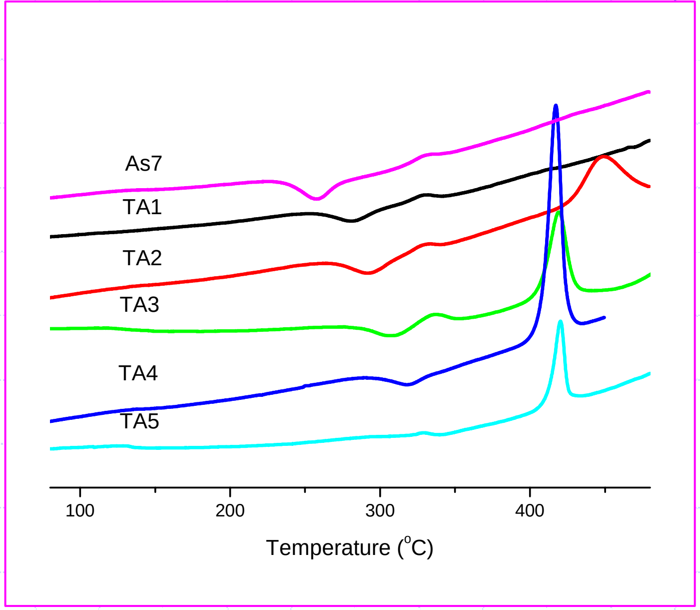
J. Am. Ceram. Soc. 89 (2006) 2154-2158

J. Am. Ceram. Soc. (2007) (accepted)

Crystallization Process

Properties of some glasses in the (1-x)($0.85GeS_2+0.15Sb_2S_3$)-xPbS Group

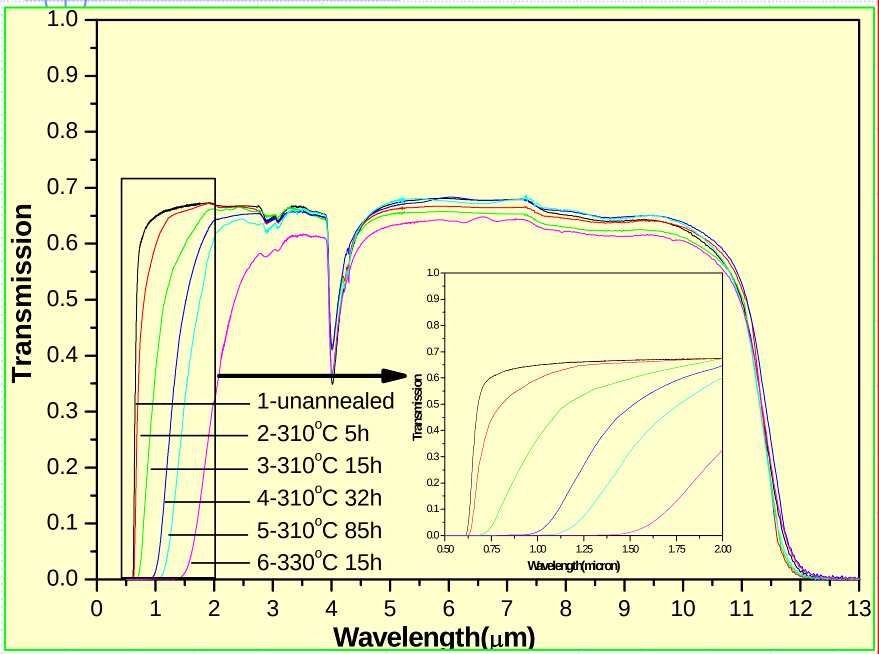
Sample code	ρ (kg/m^3)	Molar Volume (cm^3/mol)	H_v (kg/mm^2)	K_c ($MPa.m^{1/2}$)	T_g (℃)	T_c (℃)	ΔT (℃)
P1	3.1299	53.42	185.2	0.2379	336	537	201
P2	3.6110	48.30	184.2	0.2090	312	505	193
P3	3.8481	47.19	166.6	0.1937	293	467	174
P4	4.2197	44.75	169.6	0.1920	293	458	165
P5	4.4352	44.20	169.6	0.1913	295	437	142



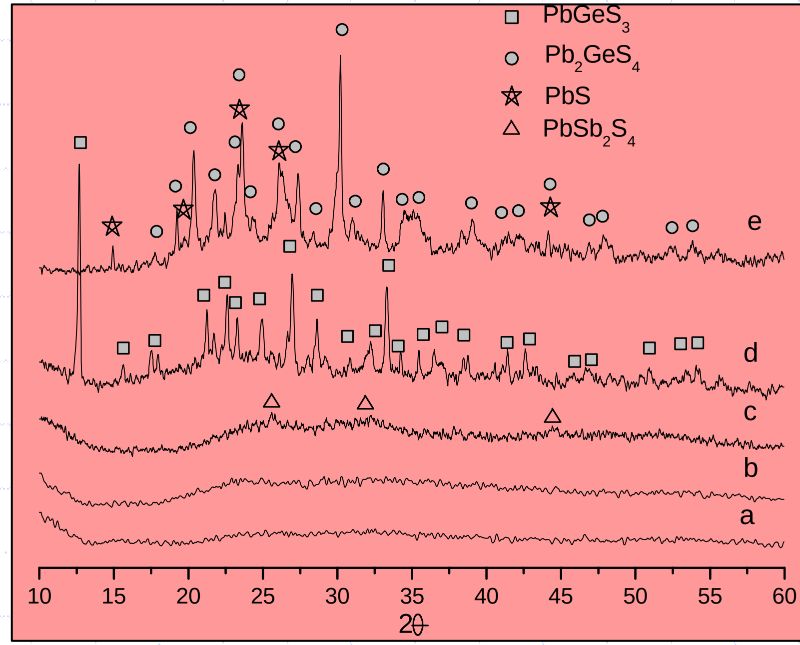
DSC curves of $GeSe_2$-As_2Se_3-CdSe chalcogenide glasses

J. Am. Ceram. Soc. 89 (2006) 2154-2158

J. Cryst. Growth, 285(1-2) (2005) 228-235



IR transmitting spectra of P5 ($51GeS_2$-$9Sb_2S_3$-40PbS) glass



XRD patterns of (a) P5 ; (b) P5 after annealing at 340℃ for 15h; (c) P7 at 300 ℃ for 5h; (d) P5 at 310 ℃ for 85h; (e) P6 at 330 ℃ for 12h

J. Am. Ceram. Soc. 89 (2006) 2154-2158

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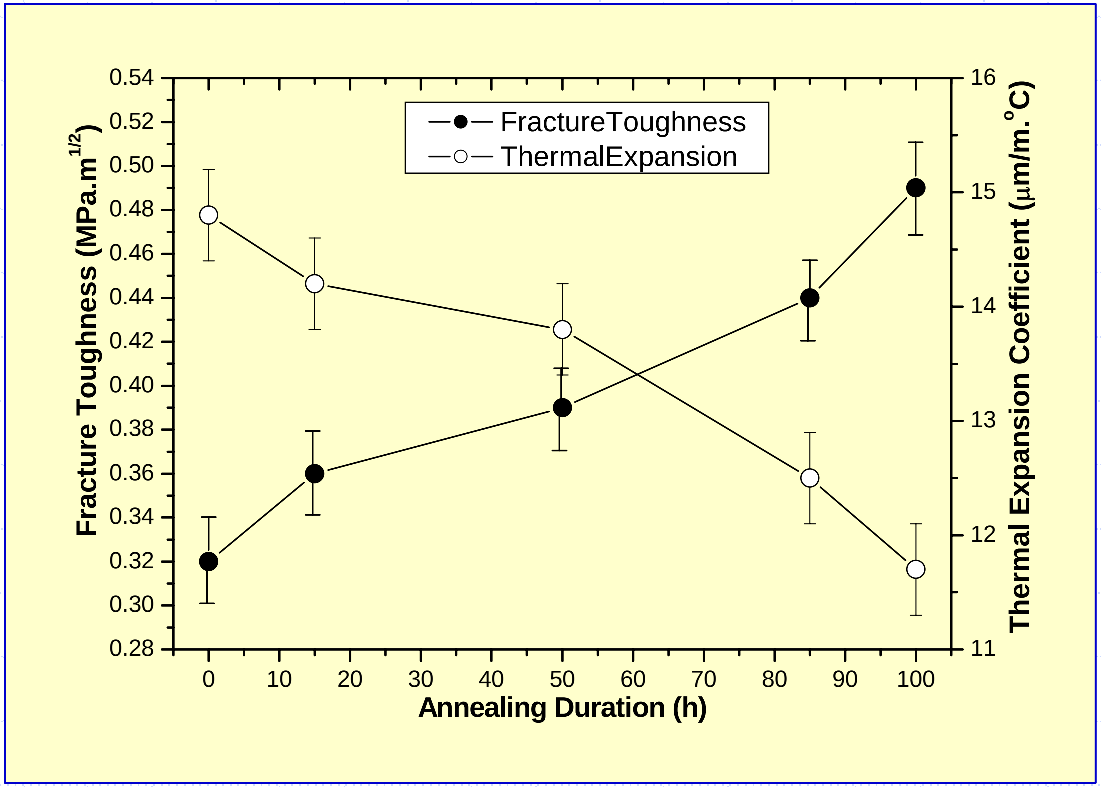


J. Am. Ceram. Soc. **89 (2006) 2154-2158**

SEM Observations:

(a) P9 at 330℃ for 163h,

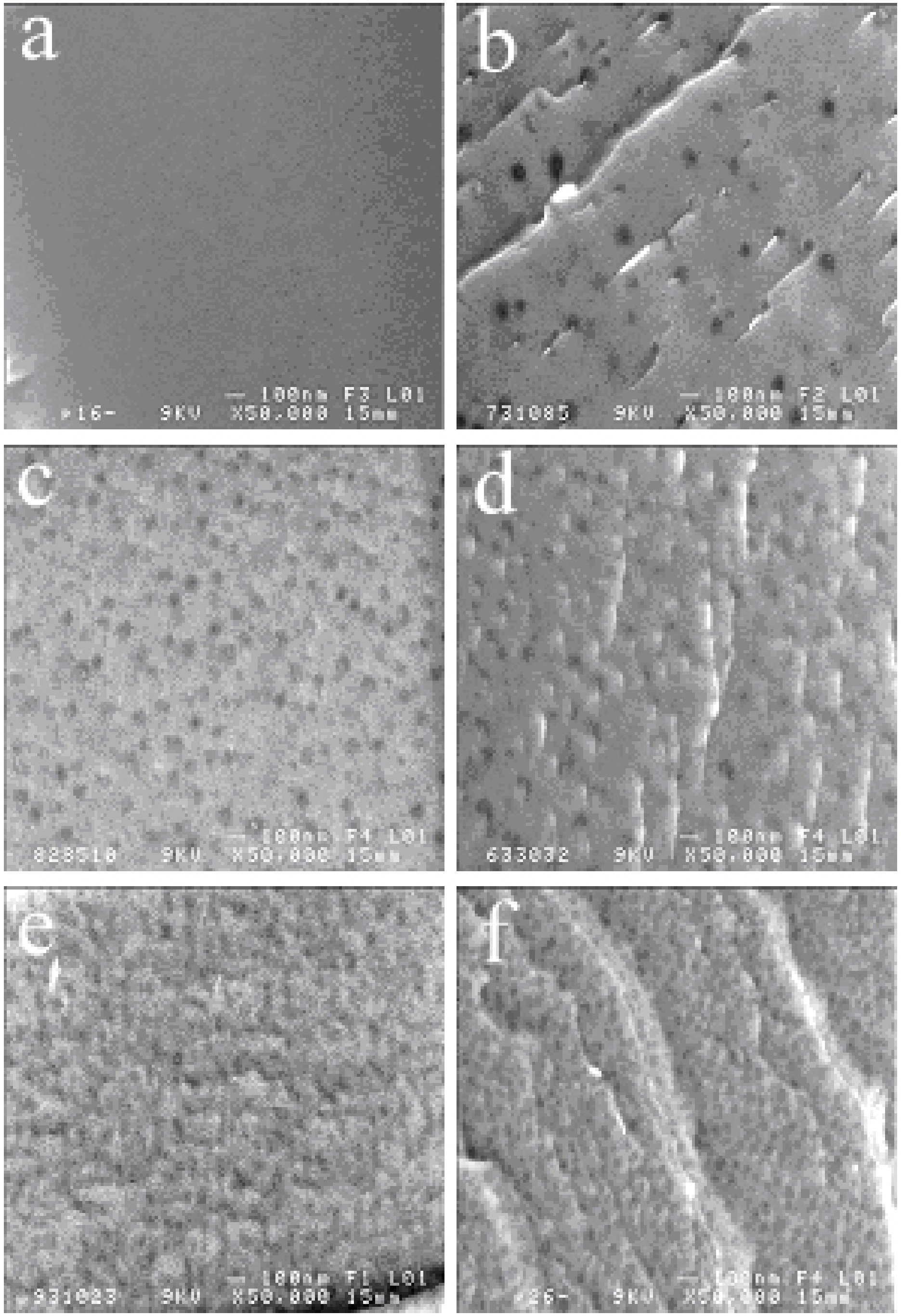
(b) P7 at 300℃ for 5h,

(c) P5 at 340℃ for 15h,

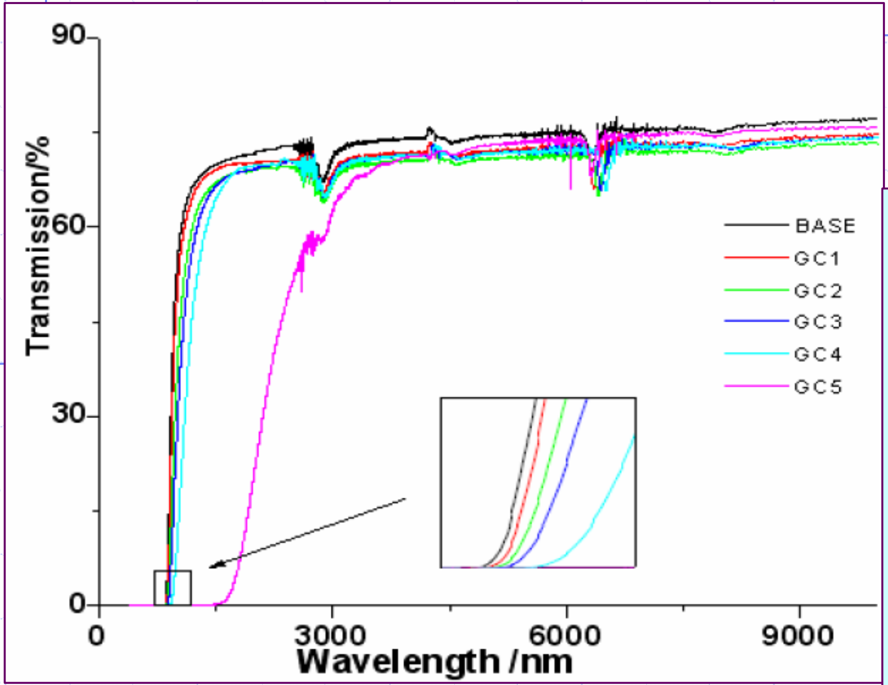
(d) P5 at 310℃ for 15h,

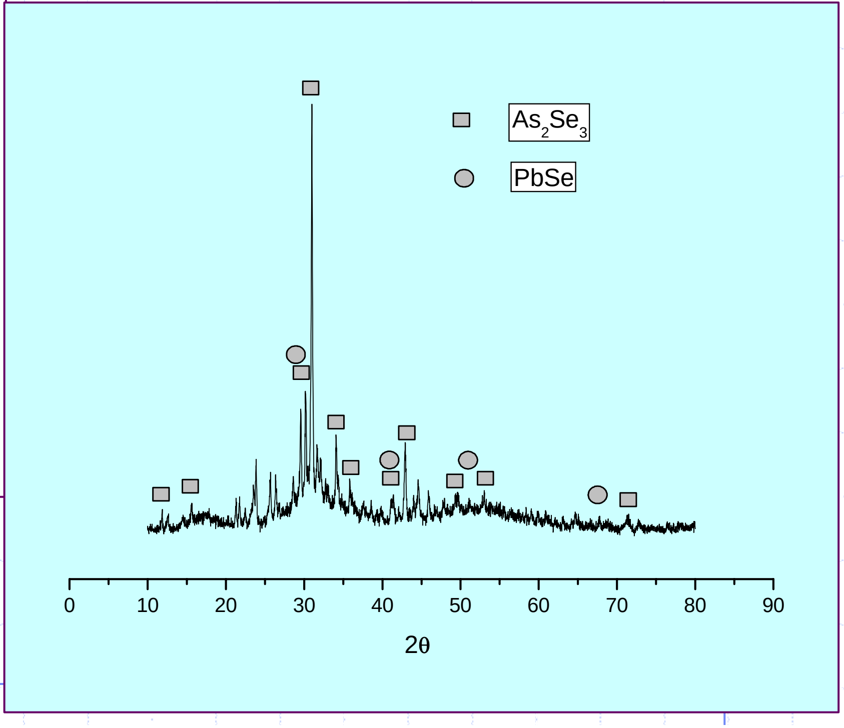
(e) P5 at 310℃ for 32h

(f) P5 at 310℃ for 85h



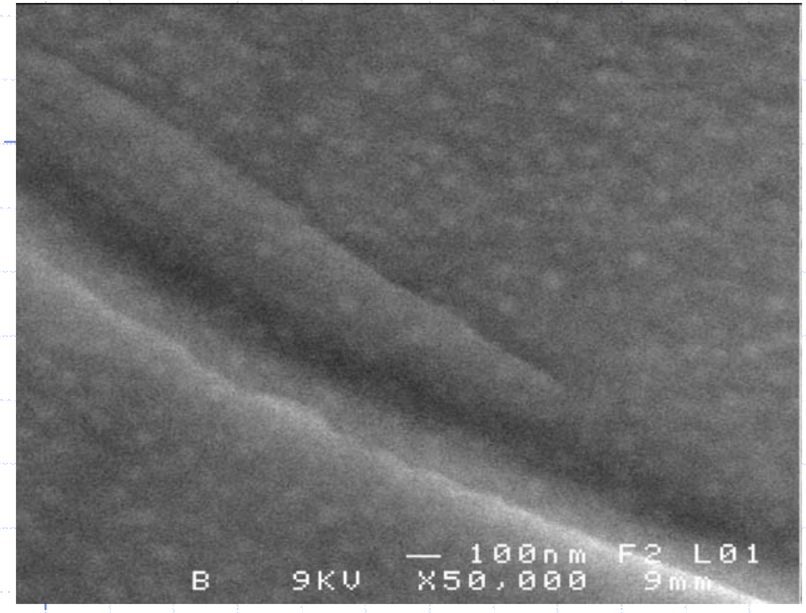
Sample	Base	GC1	GC2	GC3	GC4	GC5
α(μm/m.℃)	12.93	12.13	11.94	11.7	9.41	8.79

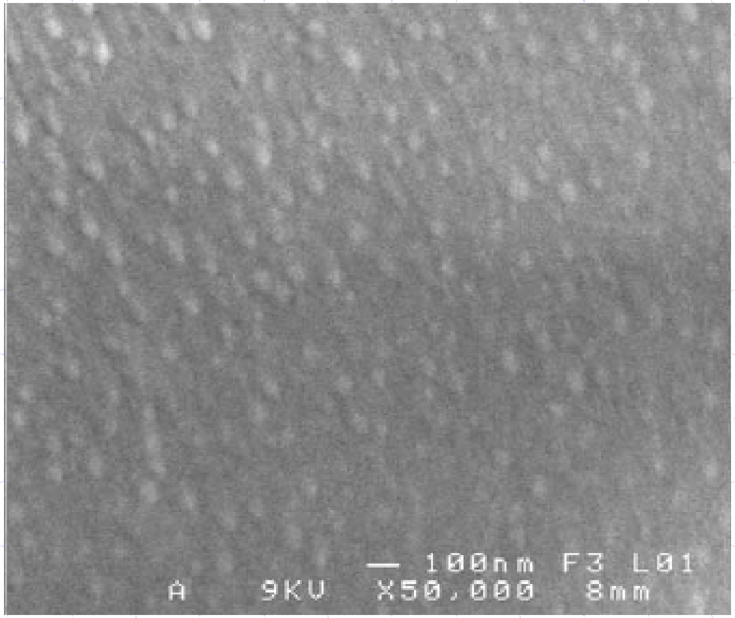


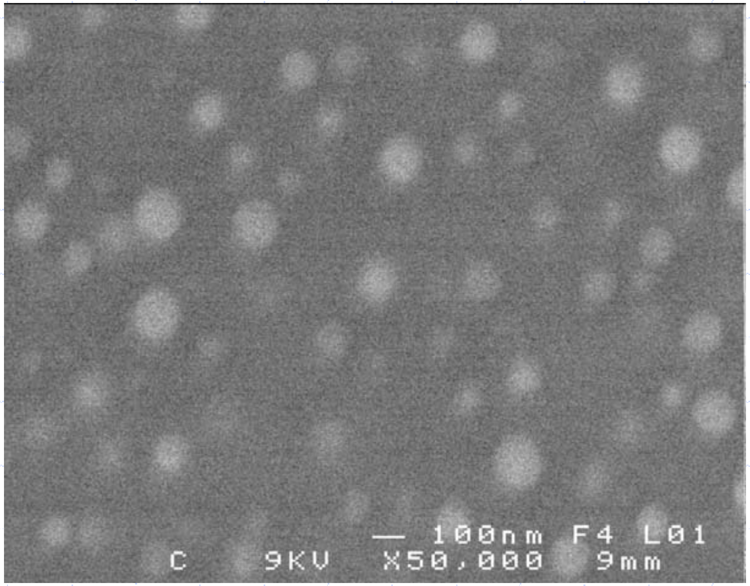


Transmission spectra and XRD patterns of sample 40$GeSe_2$-50As_2Se_3-10PbSe after different thermal treatments

Submit to J. Am. Ceram. Soc.







SEM observations

of sample annealed: (left)
230℃，20h；(right above)
250℃，10h；(right below)
270℃，10h；

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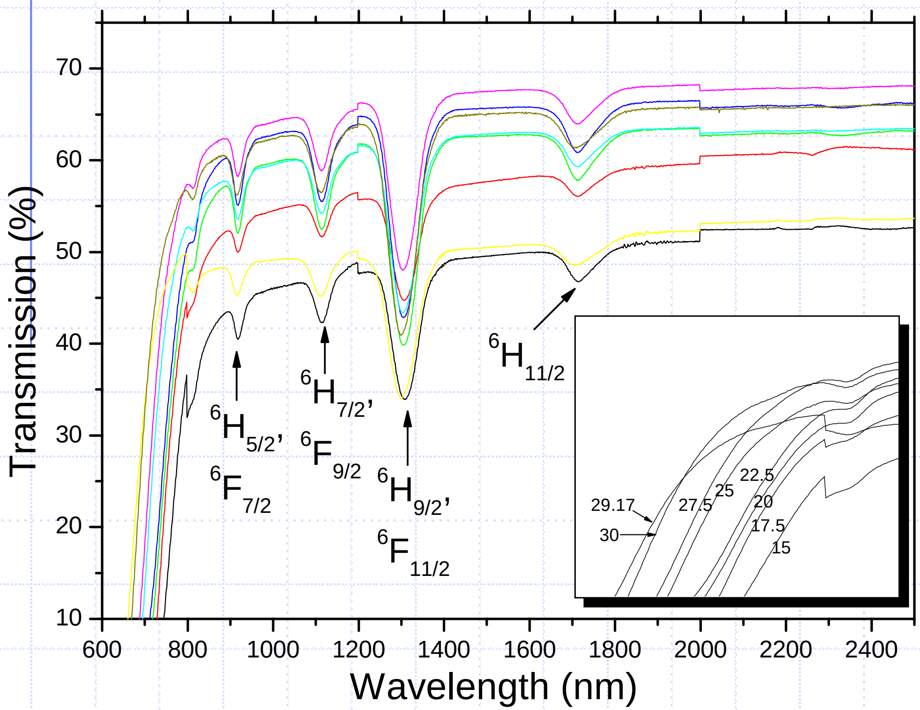
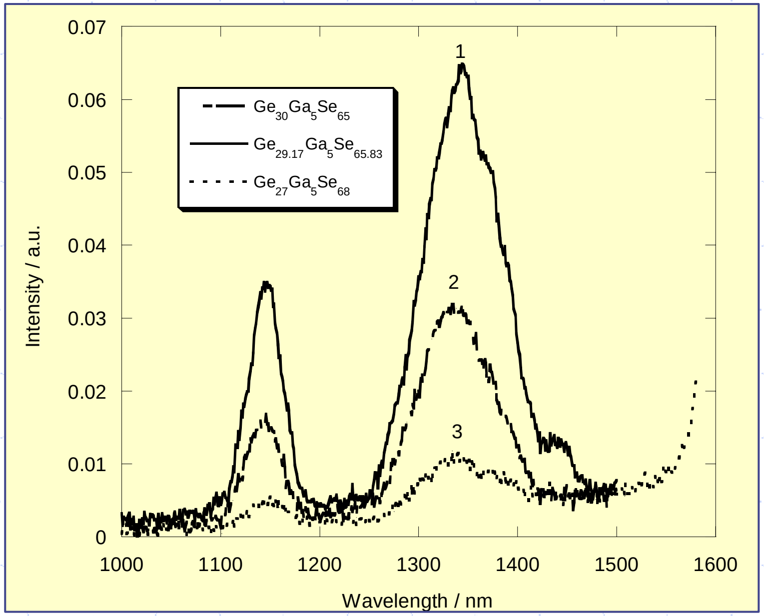
IR Luminescence

Average Coordination Number (ACN) >2.67   τ = 440-530 μs

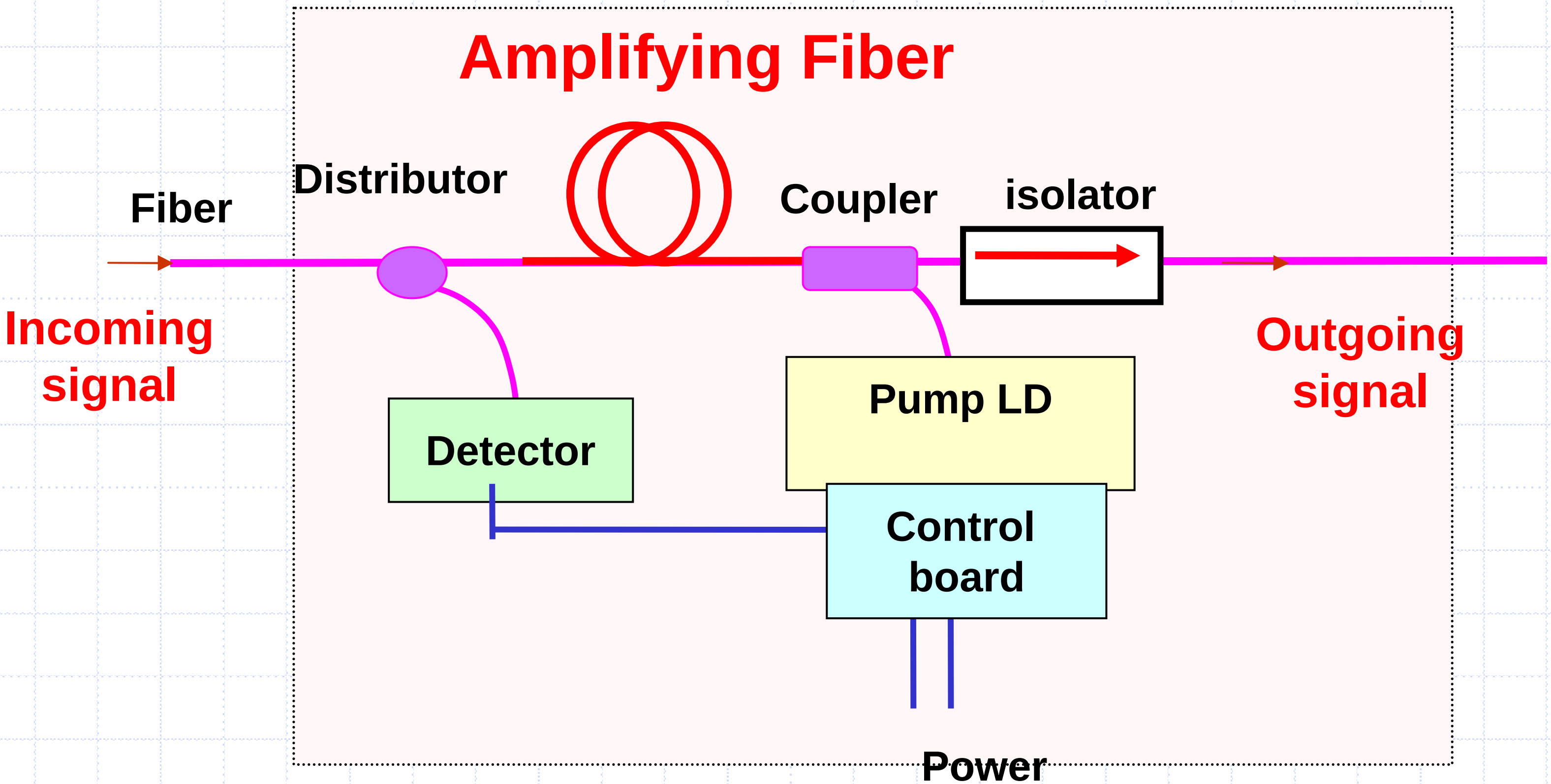




Transmission and emission spectra of Dy^{3+} doped Ge-Ga-Se glasses

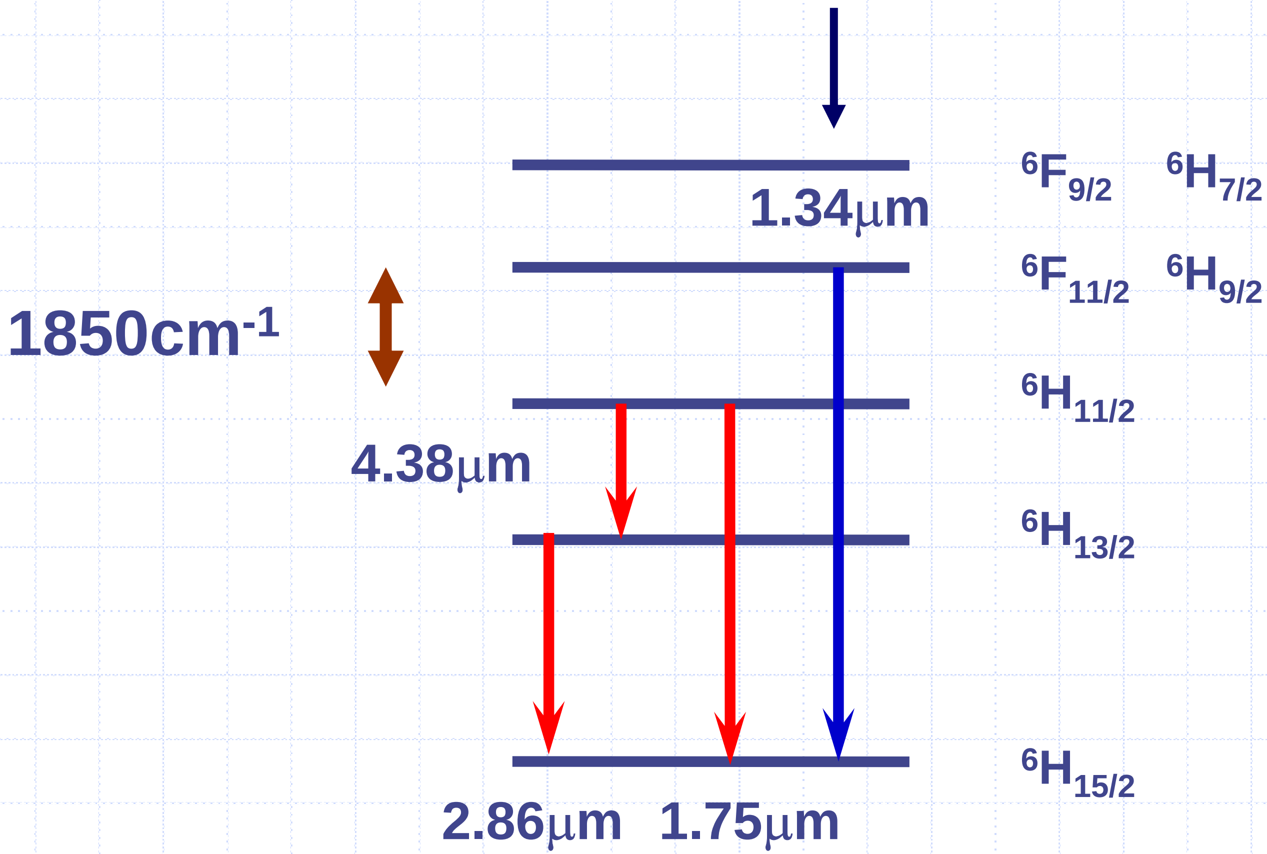
J. Chin. Ceram. Soc., **33(2005)639-643**

Background



Amplifying Fiber
Fiber
Distributor
Coupler
isolator
Incoming signal
Outgoing signal
Pump LD
Detector
Control board
Power

Energy Levels of Dy^{3+}



back

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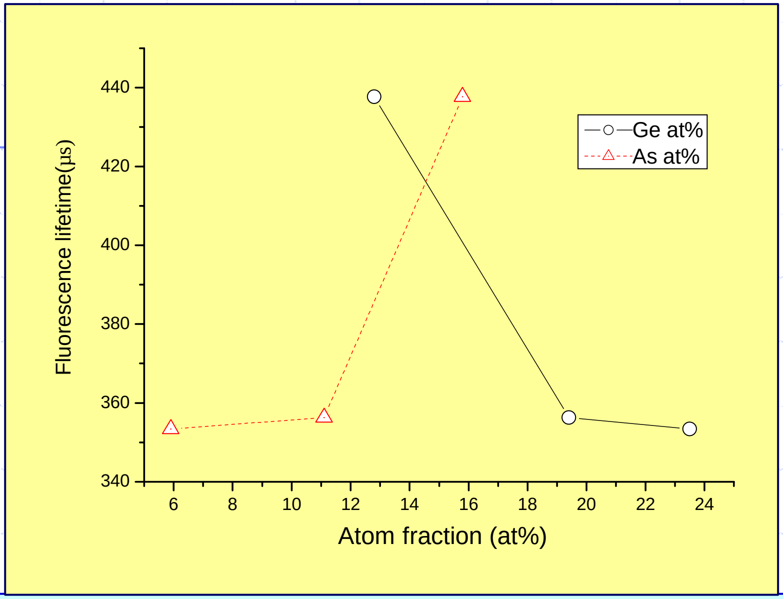
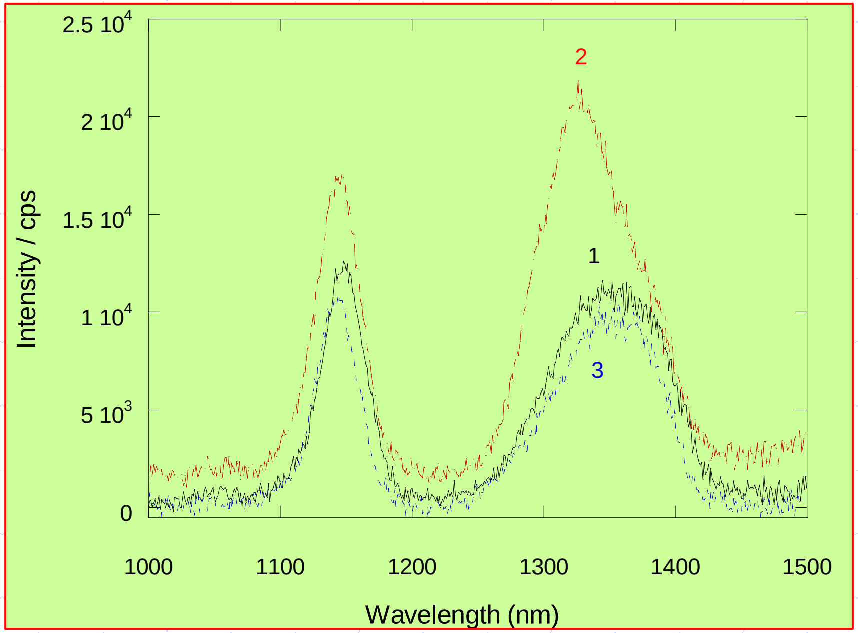
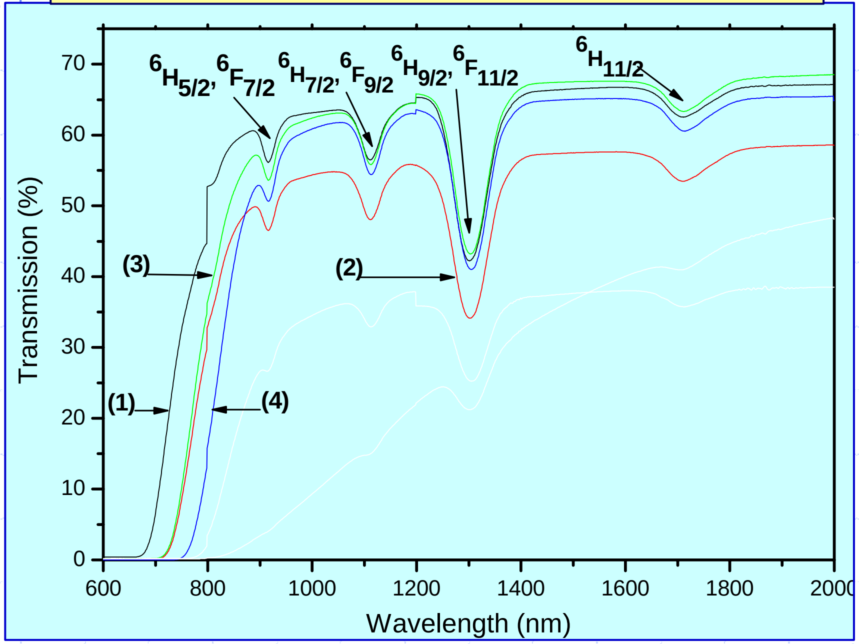
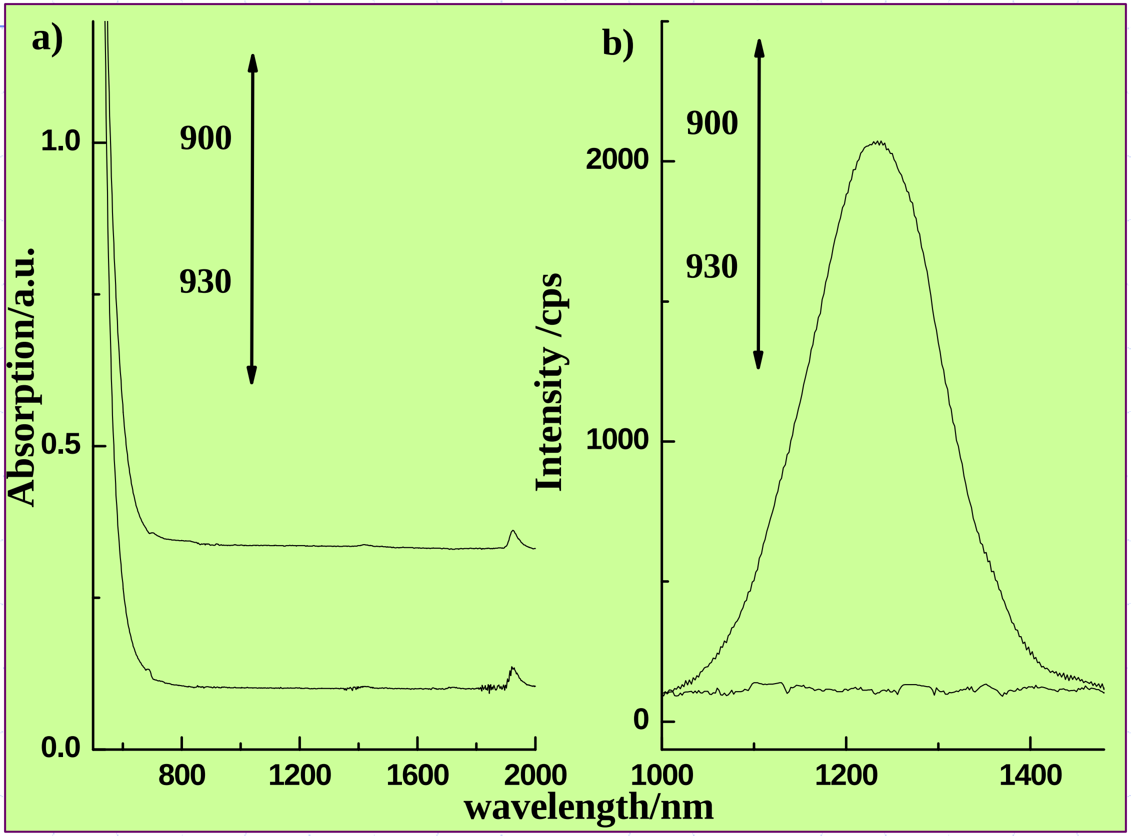






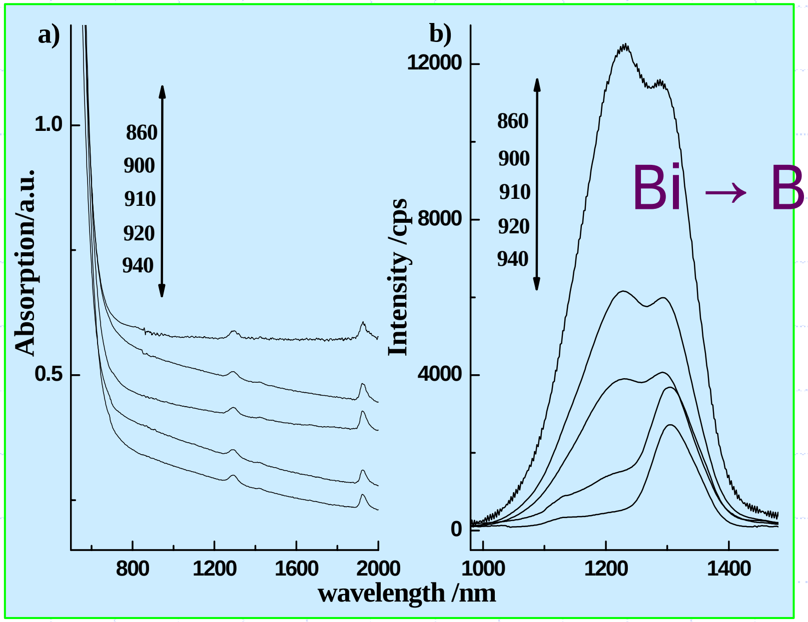
Transmission and emission spectra of Dy^{3+} doped Ge-Ga-As-Se chalcogenide glasses

J. Am. Ceram. Soc., 89(2006)2486-2389

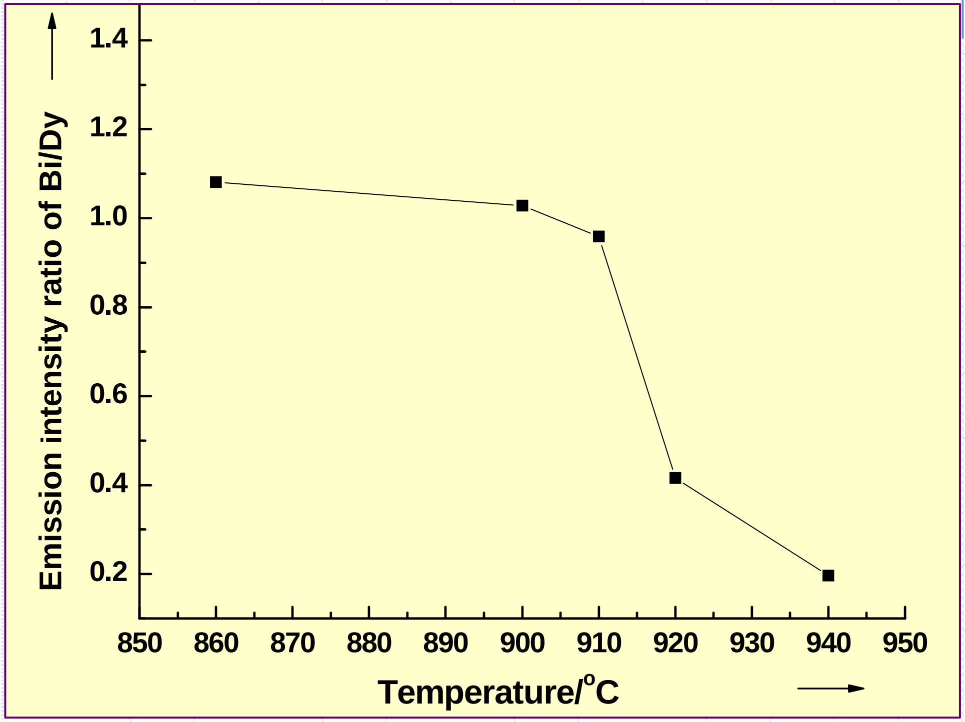


Absorption (a) and luminescence (b) spectra of Bi doped GeS_2-Ga_2S_3-KBr chalcohalide glasses at 900℃ and 930 ℃

Appl. Phys. Lett. (under review)

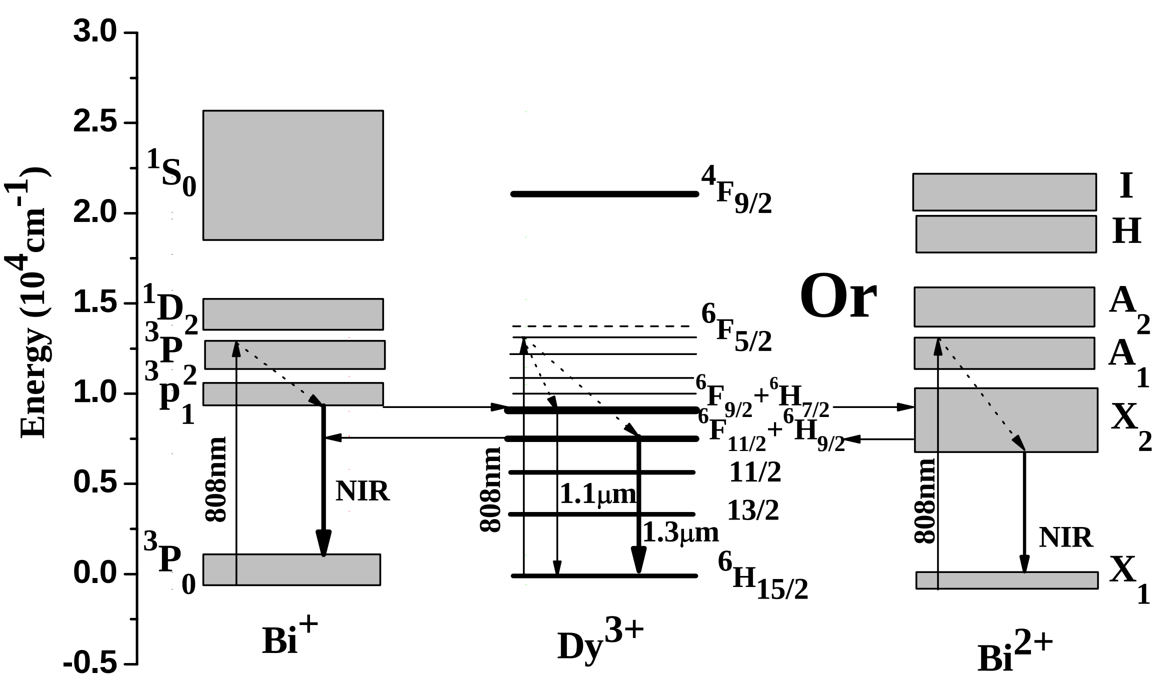


$Bi \rightarrow Bi^{+} + Bi^{2+} \rightarrow Bi^{3+}$



Absorption (a) and luminescence (b) spectra of Bi/Dy co-doped GeS_2-Ga_2S_3-KBr chalcohalide glasses at different temperatures

Chem. Mater. **(under review)**

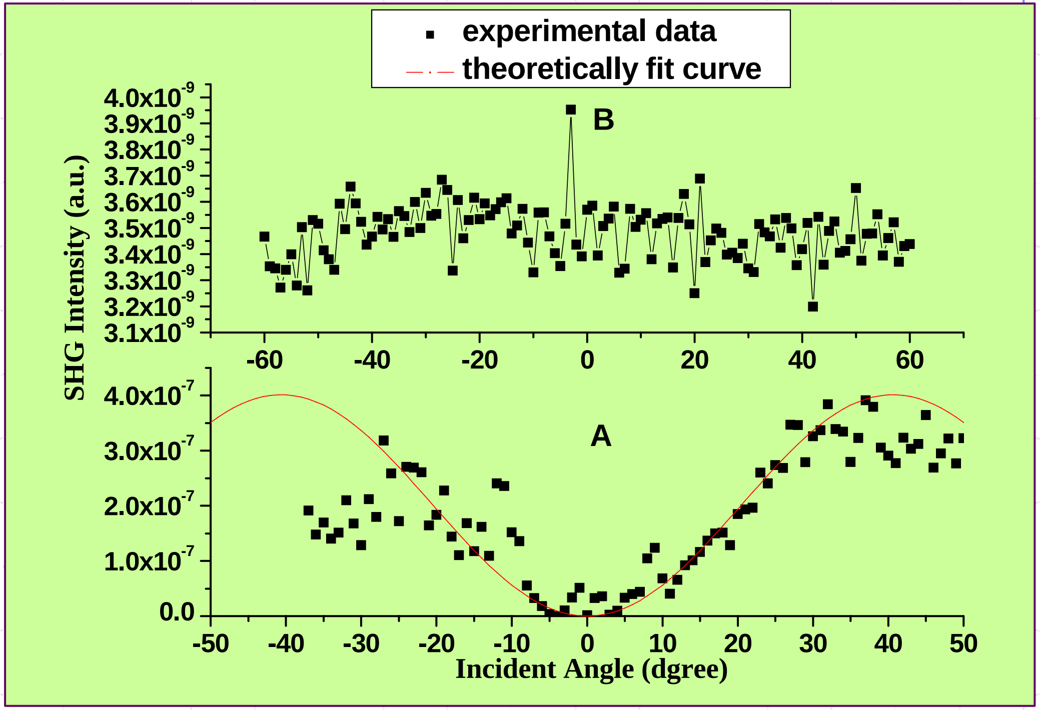


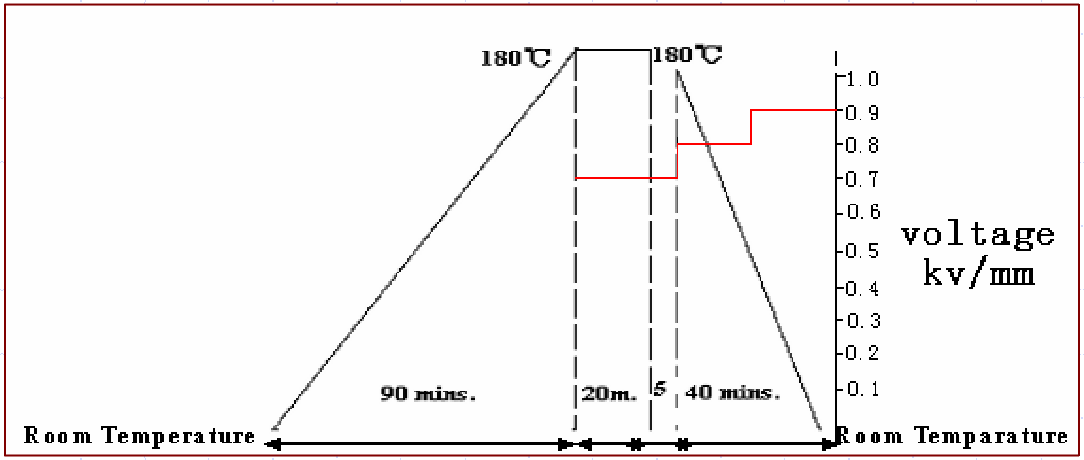
Absorption (a) and luminescence (b) spectra of Bi/Dy co-doped GeS_2-Ga_2S_3-KBr chalcohalide glasses at different temperatures

Chem. Mater. (under review)

Second Harmonic Generation

Diagram of modified thermal poling technique (below) for SHG measurement (Maker fringe pattern) of chalcohalide glasses with the higher content of alkali ions

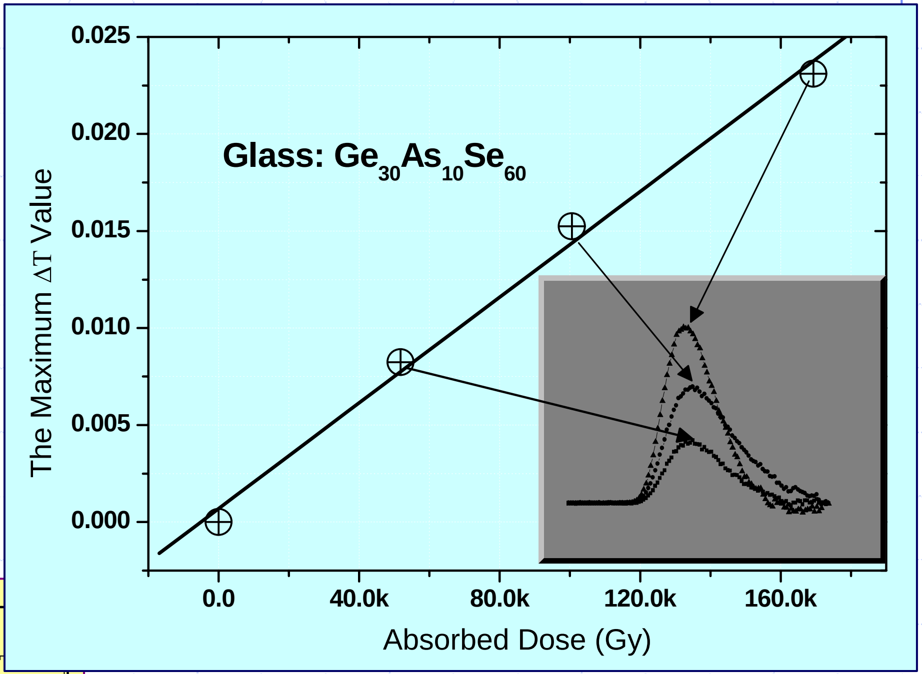


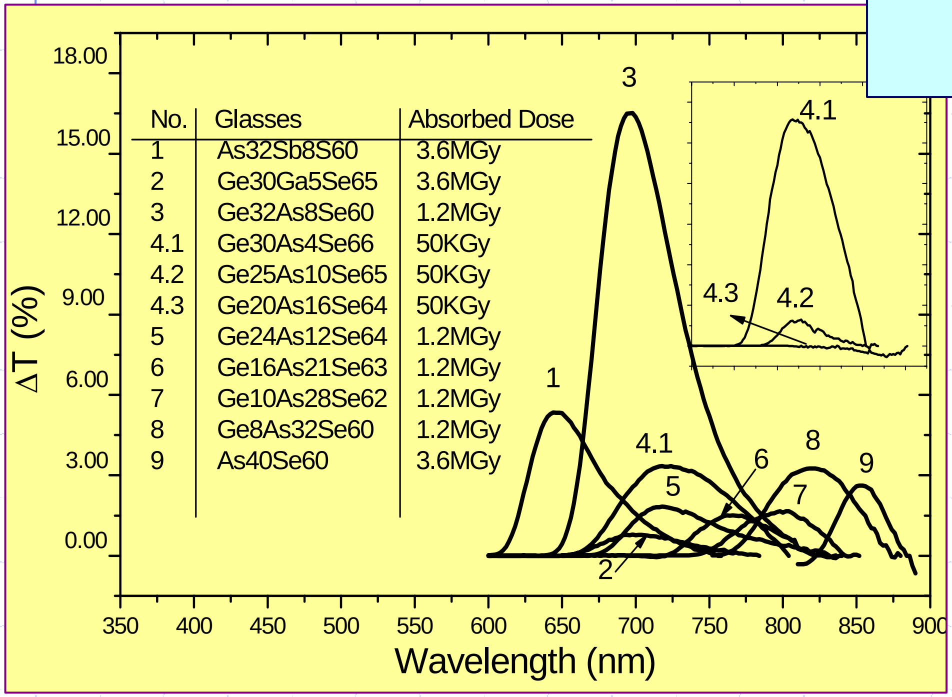


$n^{(2)} = 7.0$ pm/V

Opt. Lett. 31(2006)3492-3494

Optical transmission changes (ΔT)(below) and maximum ΔT versus the absorbed dose for glass sample 30Ge10As60Se

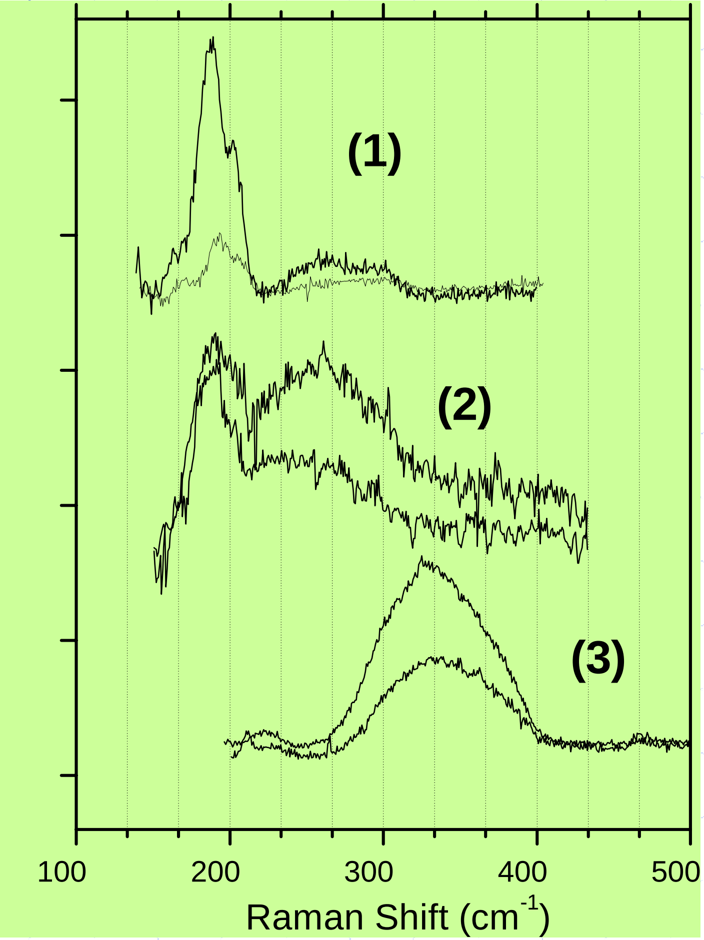




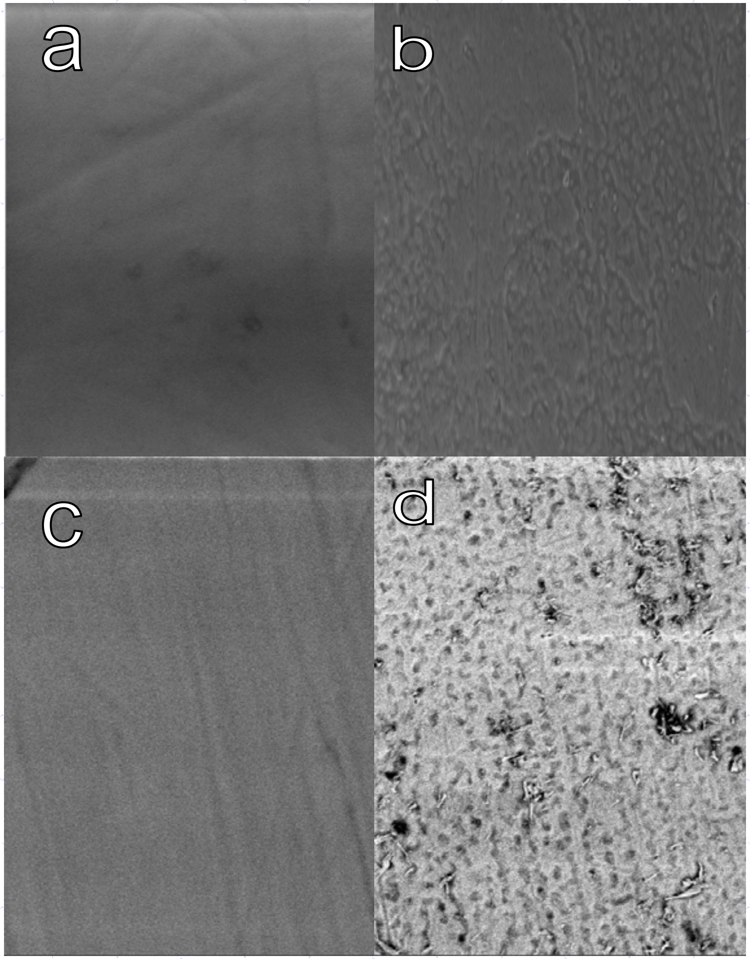
***NIMB*, 234(2005) 523-530**

J. Am. Ceram. Soc., 89(2006)3582-3584

Raman spectra for glasses (1) 30Ge5Ga65Se (3.6MGy), (2) 35Ge5As60Se (14KGy), (3) 40As60S (3.6MGy).



SEM observations of glass samples 42As58S (a, b) and 24Ge12As64Se(c, d) before and after irradiation (3.6MGy)



J. Am. Ceram. Soc., 89(2006)3582-3584

Thank You