| Papers’ Titles and Authors | Pages |
|---------------------------|-------|
| **Dynamics of Electrons in Free Electron Laser with Square Core Waveguides**<br>Farkhondeh Allahverdi, Amir Hossein Ahmadkhan Kordbacheh, and Farideh Allahverdi | 69-79 |
| **Optical and Thermal Properties of Mixed Alkali Phosphate Based Glasses**<br>Samira Vafaei and Mohammad Hossein Hekmatshoar | 81-90 |
| **Propagation and Interaction of Electrostatic and Electromagnetic Waves in Two Stream Free Electron Laser in the Presence of Self-Fields**<br>Taghi Mohsenpour, Hasan Ehsani Amri, and Zahra Norouzi | 91-100 |
| **An Analytical Model for Rare Earth Doped Fiber Lasers Consisting of High Reflectivity Mirrors**<br>Fatemeh Kazemizadeh, Rasoul Malekfar, and Fatemeh Shahshahani | 101-110 |
| **Photonic Crystal-Based Polarization Converter for Optical Communication Applications**<br>Mahmoud Nikoufard and Mohsen Hatami | 111-116 |
| **Linear and Nonlinear Dust Acoustic Waves in Quantum Dusty Electron-Positron-Ion Plasma**<br>Elham Emadi and Hossein Zahed | 117-122 |
| **Analysis of Protein Concentration Based on Photonic Crystal Ring Resonator**<br>Savarimuthu Robinson and Krishnan Vijaya Shanthi | 123-130 |
In the name of God, the Compassionate, the Merciful

International Journal of Optics and Photonics (IJOP)

ISSN: 1735-8590

EDITOR-IN-CHIEF:
Habib Tajalli
University of Tabriz, Tabriz, Iran

ASSOCIATE EDITOR:
Nosrat Granpayeh
K.N. Toosi University of Technology, Tehran, Iran

International Journal of Optics and Photonics (IJOP) is an open access journal published by the Optics and Photonics Society of Iran (OPSI). It is published online semiannually and its language is English. All publication expenses are paid by OPSI, hence the publication of paper in IJOP is free of charge.

For information on joining the OPSI and submitting papers, please visit http://www.ijop.ir, http://www.opsi.ir, or contact the society secretarial office via info@opsi.ir.

All correspondence and communication for Journal should be directed to:

IJOP Editorial Office
Optics and Photonics Society of Iran (OPSI)
Tehran, 1464675945, Iran
Phone: (+98) 21-44292731
Fax: (+98) 21-44255936
Email: info@ijop.ir

EDITORIAL BOARD

Mohammad Agha-Bolorizadeh
Kerman University of Technology Graduate Studies, Kerman, Iran

Reza Faraji-Dana
University of Tehran, Tehran, Iran

Hamid Latifi
Shahid Beheshti University, Tehran, Iran

Luigi Lugiato
University of Insubria, Como, Italy

Mohammad Kazem Moravvej-Farshi
Tarbiat Modares University, Tehran, Iran

Mahmood Soltanolkotabi
University of Isfahan, Isfahan, Iran

Abdonnaser. Zakery
Shiraz University, Shiraz, Iran

Muhammad Suhail Zubairy
Texas A & M University, TX, USA

ADVISORY COMMITTEE

Masud Mansuripur
University of Arizona, AZ, USA

Jean Michel Nunzi
University of Angers, Angers, France

Gang Ding Peng
University of N.S.W., Sydney, Australia

Nasser N. Peyghambarian
University of Arizona, AZ, USA

Jawad A. Salehi
Sharif University of Technology, Tehran Iran

Surendra Pal Singh
University of Arkansas, AR, USA
ABSTRACT—Glassy samples with a composition of 40P2O5–30V2O5–(30−x)Li2O–xK2O, 0<x<30 (mol %) were prepared by the conventional melt quenching technique in two forms of bulk and blown film. X-ray diffraction patterns corroborated the amorphous feature of the samples. Density of samples was investigated by using Archimedes principle. Based on absorption and reflection spectra, indirect allowed optical gaps, Urbach energies, refractive index and dielectric coefficients were calculated. Study of FTIR spectra revealed that all of the samples mainly contain metaphosphate and pyrophosphate units. Glass transition temperatures were also evaluated using DSC curves. Non-linear variation of many physical properties by gradually substitution of Li ions with K, confirmed the existence of mixed alkali effect in glassy system.

KEYWORDS: Phosphate Glasses, Mixed alkali effect, Refractive index, UV, FTIR, DSC

I. INTRODUCTION

Many glassy networks containing alkali elements have exhibited a non-linear behavior of physical properties, including electrical conductivity, glass transition temperature, density, viscosity and spectroscopic parameters by progressive substitution of one alkali element with another one. This fact is well-known as mixed alkali effect (MAE) [1-8]. Order of departure from linearity depends on total concentration of alkali elements, size and mass difference of alkali elements and temperature of observation [1-3]. It should be mentioned that the MAE is just detected, when the total alkali concentration is higher than ~10mol% [1]. Glasses with non-linear behavior can have fundamental role in tuning favorable properties in technology and industry [6, 9]. Schott and co-workers developed phosphate based glasses, with comparatively higher refractive indices than silicate optical glasses about 100 years ago [10]. P2O5 glasses form tetrahedral PO4 units with three bridging oxygen (BO) and one non-bridging oxygen (NBO) in which, PO4 units are connected to each other via bridging oxygen atoms [10, 12]. Phosphate based glasses have attracted considerable attention, due to their technological and biological applications and some unique physical properties, compared with borate and silicate glasses, such as high thermal expansion coefficients, lower transition temperatures (Tg), UV transmission and optical features [12-16]. Several investigations have shown that, in spite of low chemical durability of pure phosphate glasses, the addition of some transition metal ions (TMIs), alkali and alkaline earth oxides into glass networks can remarkably increase their durability. It is shown that the chemical durability of these glasses increase by displacement of P–O–P bonds with more stable P–O–M (M= V, W, Fe, Mo, …) bonds [13-15, 17-19]. Structural units of phosphate glasses are classified in the Qn groups, where n represents the number of BOs per unit. As the modifying oxides are added to P2O5, structural groups pass from Q3 (Ultraphosphate) to Q2 (Metaphosphate), Q1 (Pyrophosphate), Q0 (Orthophosphate) and...
creating NBOs [10, 20]. Furthermore, spectroscopic studies have shown that TMs in alkali phosphate glasses mostly exist in more favorable low valance state or octahedral coordination than in high valance state or tetrahedral coordination [15, 21].

Previously, mixed alkali effect was studied mostly in borate systems. The aim of the present paper is to investigate the MAE for its optical, thermal and also other physical properties of new quaternary 40P_2O_5–30V_2O_5–(30-x)Li_2O–xK_2O, with 0<x<30 (mol %) phosphate based glassy samples.

II. EXPERIMENTAL TECHNIQUE

New glassy samples with general formula 40P_2O_5–30V_2O_5–(30-x)Li_2O–xK_2O where x=1, 5, 15, 25, 29 mol%, were prepared by the conventional melt quenching technique. Stoichiometric amount of initial materials were weighed and the well-ground mixtures were heated in alumina crucibles up to their melting temperature, typically 850°C in an electric furnace. After one hour, the melt was poured on a preheated stainless steel plate into annealing furnace. The obtained samples were then annealed for 3h near the glass transition temperature to relieve the mechanical and thermal stresses resulting from the quenching. In order to prepare blown films, alumina tube was used so that, end of the alumina tube was dipped into a molten material in crucible. Finally, by steady blowing, thin blown films were prepared with constant micro thickness from each composition.

A. X-ray diffraction pattern
X-ray diffractometry (XRD) was used to confirm the amorphous nature of the samples with an equipment, manufactured by Bruker, model D8 Advance X-ray diffractometer and the measurements were carried out in the range of 10° < 2θ < 120° angles.

B. Density
The density of the glassy samples was determined by using the Archimedes principle with ethyl-methyl-ketone as the immersion liquid at room temperature.

C. Ultraviolet and visible spectra
The optical absorption and reflectance spectra of the blown glassy films were recorded with an UV-Vis spectrophotometer, manufactured by Scinco, model s4100 in the wavelength region of 200-900 nm at room temperature.

D. Infrared spectra
The FTIR spectra of glassy blown films were recorded using KBr pellet technique with a spectrometer, manufactured by Unicam, model 4600 in the frequency range of 4000-400 cm^-1 at room temperature.

E. Differential scanning calorimetry
Differential scanning calorimetry (DSC) was used to investigate the thermal behavior of the glass samples and to determine the glass transition temperature with a DSC, manufactured by Netzsch, model 400. For this purpose 6-9 (mg) of the powdered glass samples were sealed in alumina pans and heated with a rate of 10°C/min using Ar as purge gas in the temperature range of 100-550°C.

III. RESULTS AND DISCUSSION

A. Amorphous structure
XRD patterns confirmed the amorphous nature of the samples. As is shown in Fig. 1 the patterns do not manifest any distinct or sharp peak. A broad halo in patterns is displaying an amorphous phase of samples [14, 22].

B. Density
The density of samples, \( D \), was determined by using Archimedes principle. From the density values, the molar volume, \( V_m \), of the samples was calculated by using the equation:

\[
V_m = \frac{M}{D}
\]
where \( M = \sum x_i M_i \), \( x_i \) is the mole fraction of oxide \((i)\), \( M_i \) is the molecular weight of oxide \((i)\). Fig. 2 depicts the compositional dependence of density and molar volume. As is shown in this figure, their non-linear variation proves the existence of MAE.

### Table 1. Physical properties of PVLK glassy system

| PVLK (mol%) | \( D \) (g/cm\(^3\)) | \( V_m \) (cm\(^3\)) | OPD (\(10^2\) ion/cm\(^3\)) | \( N_{Li} \) | \( N_V \) (\(10^2\) ion/cm\(^3\)) | \( E_{opt} \) (eV) | \( E_{U} \) (eV) | \( \beta \) (cm\(^{-1}\)eV\(^{-1}\)) | \( T_g \) (°C) |
|------------|----------------|----------------|----------------|-------------|----------------|----------------|-------------|----------------|-------------|
| 40-30-29-1 | 2.828          | 42.80          | 88.78          | 0.82        | 0.84           | 2.06           | 0.38        | 18.85          | 365         |
| 40-30-25-5 | 2.901          | 42.60          | 89.19          | 0.71        | 0.85           | 2.10           | 0.43        | 17.30          | 348         |
| 40-30-15-15| 2.723          | 47.74          | 79.60          | 0.38        | 0.75           | 2.20           | 0.34        | 23.16          | 345         |
| 40-30-5-25 | 2.523          | 54.06          | 70.29          | 0.11        | 0.67           | 2.29           | 0.29        | 25.27          | 341         |
| 40-30-1-29 | 2.711          | 51.26          | 74.14          | 0.02        | 0.70           | 2.07           | 0.37        | 21.53          | 343         |

Fig. 1. XRD patterns of samples.

C. Optical band gap and Urbach energy

The study of optical absorption in the ultraviolet and visible regions is a useful technique for investigation of band structure and band gap energy in crystalline and non-crystalline systems. Fig. 3 represents the optical absorption spectra of all samples. It is clear that, the absence of sharp absorption edge in spectra, exhibits the amorphous nature of samples [9, 28].

The optical absorption coefficient, \( \alpha(\nu) \), can be calculated from the absorption spectra data using the equation:

\[
\alpha(\nu) = \frac{1}{l} \left( \frac{I_0}{I_t} \right)
\]

where \( I_0 \) and \( I_t \) are the intensities of the incident and transmitted UV-Vis ray and \( l \) is the thickness of the blown films.
Fig. 4 represents the $\ln \alpha$ versus $h\nu$. As is seen, optical absorption coefficient $\alpha(\nu)$ of glassy semiconductors increases with photon energy and divided into three regions: A, B, and C.

The first absorption region, A, is shown in low energies, which there is no excited states and the order of the absorption coefficient depends only on the material and its purity [12, 29]. In the second absorption region (B) or Urbach absorption range, the absorption coefficient $\alpha(\nu)$ is an exponential function of the photon energy $h\nu$ and follows the Urbach rule:

$$\alpha(\nu) = \alpha_0 \exp \left( \frac{h\nu}{E_U} \right)$$

where $\alpha_0$ is a constant, $h\nu$ is the incident photon energy, and $E_U$ is the Urbach energy, which determines the extent of localized states tailing in the band gap. Sumi and Toyozawa attributed the exponential behavior of absorption coefficient to the interaction of excitons and electrons with phonons.

$E_U$ values of all samples have been calculated by using the above equation and slopes of the Fig. 4 in the B region, which are listed in Table 1. According to Table 1 the Urbach energy vary between 0.29-0.43 eV, which is in accordant with reported data for inorganic glassy systems [9, 23, 28, and 30].

In the third absorption region (C) or high absorption region, the photons have enough energy to excite electrons from valance to conduction band and the absorption coefficient $\alpha(\nu)$ can be written as follow:

$$\alpha(\nu) = \beta \left( \frac{h\nu - E_{opt}}{h\nu} \right)^\nu$$

where $\beta$ is a constant, $E_{opt}$ is an optical band gap and the index $m$ depends on type of electron transitions in $k$-space and takes the values 2, 1/2 for indirect allowed and direct allowed transitions, respectively. Fig. 5 represents the plots of $(ah\nu)^{1/2}$ versus $h\nu$, for $m = 2$ and the values of optical band gap have been calculated by extrapolation linear region of the $(ah\nu)^{1/2}$ versus $h\nu$ curve to $(ah\nu)^{1/2} = 0$. The values of $E_{opt}$ and constant parameter $\beta$ are listed in Table 1. According to Table 1, values of optical band gap and Urbach energy vary non-linearly with concentration of $x$, which manifest the existence of mixed alkali effect. Mixed alkali effect also observed in physical properties of borate glasses and in the absence of acceptable universal theory to explain MAE in optical properties of glasses, the non-linear variation of optical gap is attributed to the formation of large number of non-bridging oxygens (NBO) [9, 12, 14, 23, 28, and 31].

The refractive index plays a crucial role in the optical materials and application of glasses.
Fig. 6 represents the reflectance spectra of samples in the visible range. The refractive index of blown films was calculated by using the following equation (for normal incident angle):

\[
n = \left(1 + \frac{1}{n}\right) + \sqrt{\left(1 - \frac{1}{n}\right)^2 - \frac{k}{n}}
\]

where \(R\) is the reflectance and \(k = \frac{\alpha \lambda}{4\pi}\) is the extinction coefficient [1, 32]. Fig. 7 shows the wavelength dependence of the refractive index. Furthermore, other physical parameters such as dielectric coefficient (\(\varepsilon\)), molar refractivity (\(R_M\)) and electronic polarizability (\(\alpha_e\)) were calculated in two wavelengths (400 and 700 nm) by using the following equations:

\[
\varepsilon = n^2
\]

\[
R_M = \frac{M}{D} \left(\frac{n^2 - 1}{n^2 + 2}\right)
\]

\[
\alpha_e = \frac{3}{4\pi N_i} \left(\frac{n^2 - 1}{n^2 + 2}\right)
\]

where \(N_i\) is the number of vanadium ions per unit volume [32-34]. The obtained values are given in Table 2. As is observed, due to MAE refractive index, dielectric coefficient, molar refractivity and electronic polarizability have non-linear trend by changing alkali ions concentration in glassy system.
D. FTIR

Fourier transform infrared (FTIR) spectrum is a basic technique for investigation of structure and covalent bonds in chemical compositions, which each component absorb incident photon energy in specific wavenumber in IR region [12]. The FTIR spectra of all samples are shown in Fig. 8 in the wavenumber range of 400-4000 cm\(^{-1}\) and all detected bonds are summarized in Table 3. Glassy networks with structure of ultraphosphate, composed of one non-bridging and three bridging oxygens. The fundamental feature of ultraphosphate units is a P=O bond at about 1378 cm\(^{-1}\) [12, 14, 31, 35].

Table 2. Physical properties of PVLK glassy system

| PVLK (mol%) | \(n_{400}\) | \(\varepsilon_{400}\) | \(\varepsilon_{700}\) | \(R_M\) (cm\(^{-1}\)) | \(\alpha_c\) \(10^{-24}\) cm\(^2\)/ion |
|------------|-------------|-----------------|-----------------|-----------------|-----------------|
| 40-30-29-1 | 2.513       | 6.315           | 4.076           | 27.385          | 18.99           |
| 40-30-25-5 | 2.617       | 6.849           | 4.182           | 28.162          | 18.62           |
| 40-30-15-15| 2.346       | 5.504           | 4.000           | 28.655          | 18.94           |
| 40-30-5-25 | 2.276       | 5.180           | 3.265           | 31.474          | 20.82           |
| 40-30-1-29 | 2.370       | 5.617           | 4.235           | 31.070          | 20.54           |

Table 3. Bond assignments of samples in FTIR spectra.

| Wavenumber (cm\(^{-1}\)) | Bond assignment | x=1 | x=5 | x=15 | x=25 | x=29 |
|--------------------------|-----------------|-----|-----|------|------|------|
| ~1624                    | P\(_2\)O\(_5\)\(^4-\) | 1625| 1636| 1633 | 1629 | 1629 |
| ~930                     | Asymmetric P–O–P | 932 | 932 | 909  | 917  | 917  |
| ~760                     | Symmetric P–O–P | 767 | 764 | 770  | 762  | 762  |
| ~630-760                 | V–O–V V–O–P     | 767 | 767 | 770  | 762  | 762  |
| ~330-520                 | O–P–O           | 462 | 462 | 462  | 437  | 530  |
| ~1100                    | V=O             | 1094| 1094| 1101 | 1101 | 1101 |
| ~430-680                 | Lattice vibration of V\(_2\)O\(_5\) | 462 | 462 | 462  | 437  | 531  |
| ~3436                    | O–H             | 3432| 3455| 3455 | 3478 | 3470 |

However, when P\(_2\)O\(_5\) mixed with other oxides, such as transition metal oxides, some changes occur in position and extent of the bonds [31]. In glass networks, V\(_2\)O\(_5\) has a dual role, partly acts as a glass modifier and partly as a glass former [14, 20]. With addition of V\(_2\)O\(_5\) modifier oxide into glass network, it causes a position shift of P=O bond to lower frequency of ~1260 cm\(^{-1}\) and gradually conversion of ultraphosphate units to metaphosphate and pyrophosphate units [12]. Hence, we can attribute the broad bond around 1260 cm\(^{-1}\) to formation of metaphosphate and pyrophosphate units. Moreover, V\(_2\)O\(_5\) modifier causes a depolymerization of the glass network and shortens the long chains by converting P–O–P to P–O–V bonds [14, 20].

The broad bonds around 1160 cm\(^{-1}\) are related to asymmetric stretching of PO\(_2\) units [14]. Also the peaks around 1624 cm\(^{-1}\) are due to stretching vibration of P\(_2\)O\(_7\)\(^4-\) (pyrophosphate) units [36]. Absorption bonds around 1260 cm\(^{-1}\), 1160 cm\(^{-1}\) and 1624 cm\(^{-1}\) manifest that all samples under investigation contain mainly metaphosphate and pyrophosphate units. The peaks around 930 cm\(^{-1}\) and 760 cm\(^{-1}\) are related to the asymmetric and symmetric P-O-P bonds, respectively [14, 35, 37].

The bonds observed in ~ 330-520 cm\(^{-1}\) range belong to the bending vibration of O–P–O phosphate chains [20, 37]. The peaks obtained in the region ~ 630-760 cm\(^{-1}\) are due to V–O–V and V–O–P bonds [20]. The bonds situated in the range ~ 430-680 cm\(^{-1}\) are attributed to the lattice vibration of V\(_2\)O\(_5\) [37]. The bonds around 1100 cm\(^{-1}\) pertain to V=O vanadyl groups in VO\(_5\) trigonal bipyramids and a stretching vibration of V=O [14, 37]. It is worth to note that, the vibration modes of mobile ions occur in low frequencies (a few tens in units of cm\(^{-1}\)) and far-infrared spectroscopy is suitable in detecting such
peaks [12]. Furthermore, the absorption peaks at ~3436 cm\(^{-1}\) are assigned to stretching vibration of O–H bonds, due to hygroscopic nature of P\(_2\)O\(_5\) [12, 36, 38]. Finally non-linear variation of peaks position with concentration of x, exhibits the existence of MAE.

![Fig. 7. Refractive index spectra.](image)

![Fig. 8. FTIR spectra of samples.](image)

**E. DSC**

Glass transition temperature, \(T_g\) is a significant feature, which is exhibited by the supercooled liquids and play important role in material science [39]. Fig. 9 shows the DSC curves of all samples in the temperature range of 100-550°C. As is shown, all samples manifest the endothermic peak as a feature of glass transition temperature. The obtained \(T_g\) values are listed in Table 1. Fig. 10 shows the compositional dependence of glass transition temperature. \(T_g\) decreases with increasing of concentration x and reaches a minima in composition x=25 (mol%) and then increases, which non-linear variation of \(T_g\) reveals the existences of MAE. The decrease in \(T_g\) can be attributed to small increase in formation of non-bridging oxygen [40].

![Fig. 9. DSC curve of all samples](image)

![Fig. 10. Compositional dependence of \(T_g\)](image)

**IV. CONCLUSION**

Glassy samples with general formula 40P\(_2\)O\(_5\)–30V\(_2\)O\(_5\)–(30-x) Li\(_2\)O–xK\(_2\)O, 0<x<30 (mol %) were prepared by standard melt quenching method and following results achieved from physical analyses:

a. Absence of distinct and sharp peaks in XRD patterns, confirmed the amorphous nature of samples.
b. Values of density, molar volume and oxygen packing density were evaluated and confirmed mixed alkali effect.

c. Optical gaps and Urbach energies were calculated by using ultraviolet and visible spectra. Results of Urbach energies varied between 0.29-0.43 eV, which are in accordant with inorganic glass systems and also non-linear variation of $E_{o\text{pt}}$ and $E_U$ proved the existence of mixed alkali effect.

d. Refractive index, dielectric coefficient, molar refractivity and electronic polarizability changed non-linearly as a consequence of mixed alkali effect phenomena.

e. Study of FTIR spectra, showed the basic bonds of phosphate and vanadium units, also most of the bond positions varied non-linearly by replacing Li ions with K ions.

f. Thermal behavior of samples were investigated and glass transition temperature ($T_g$) varied non-linearly with concentration x. The decreasing of $T_g$, is attributed to small increase in number of non-bridging oxygens.

g. Finally, mixed alkali effect phenomenon was strongly revealed in several physical properties of present prepared glassy samples, which can be useful in designing suitable compound for particular applications in technology and industry.

ACKNOWLEDGEMENT

The authors wish to appreciate the two referees for the precise reviews and valuable comments.

REFERENCES

[1] K.J. Rao, *Structural Chemistry of Glasses*, Amsterdam: Elsevier, 2002.

[2] M. Harish Bhat, M. Ganguli, and K.J. Rao, “Investigation of the mixed alkali effect in boro-tellurite glasses-the role of NBO-BO switching in ion transport,” Curr. Sci. Vol. 86, pp. 676-691, 2004.

[3] M.A. Samee, S.K. Ahmmad, S.M.D. Taqullah, A. Edukondalu, S. Bale, and S. Rahman, “Mixed alkali effect in (40-x) K$_2$O–xLi$_2$O-10Na$_2$O–50B$_2$O$_3$ glasses-physical and optical absorption studies,” Int. J. Modern Phys: Conf. Series, Vol. 22, pp. 261-267, 2013.

[4] K.J. Rao and S. Kumar, “Multialkali phosphate glasses: A new window to understand the mechanism of ion transport,” Curr. Sci. Vol. 85, pp. 945-955, 2003.

[5] Y.C. Ratnakaram, N.V. Srihari, A. Vijaya Kumar, D. T. Naidu, and R.P.S. Chakradhar, “Optical absorption and photoluminescence properties of Nd$^{3+}$ doped mixed alkali phosphate glasses- spectroscopic investigations,” Spectrochim. Acta, Part A, Vol. 72, pp. 171-177, 2009.

[6] A. Edukondalu, B. Kavitha, M.A. Samee, S.K. Ahmed, S Rahman, and K. S. Kumar, “Mixed alkali tungsten borate glasses-Optical and structural properties,” J. Alloys Comp. Vol. 552, pp. 157-165, 2013.

[7] T.R. Rao, C.R. Krishna, U.S. Udayachandran Thampy, C.V. Reddy, Y.P. Reddy, P.S. Rao, and R.V.S.S.N. Ravikumar, “Effect of Li$_2$O content on physical and structural properties of vanadyl doped alkali zinc borate glasses,” Physica B, Vol. 406, pp. 2132-2137, 2011.

[8] G. Padmaja and P. Kistaiah, “Infrared and Raman spectroscopic studies on alkali borate glasses: evidence of mixed alkali effect,” J. Phys. Chem. A, Vol. 113, pp. 2397-2404, 2009.

[9] A. Edukondalu, M.A. Samee, S.K. Ahmad, S.M.D. Taqullah, S. Rahman, and K.S. Kumar, “Optical properties on Li$_2$O-K$_2$O-WO$_3$-B$_2$O$_3$ glass system,” Int. J. Modern Phys.: Conf. Series, Vol. 22, pp. 278-283, 2013.

[10] R.M. Moss, “Structural studies of metal doped phosphate glasses and computational developments in diffraction analysis,” Ph.D. thesis, Dept. Physics, Kent Univ, Canterbury, England, 2009.
[11] E.E. Assem and I. Elmehasseb, “Structure, magnetic, and electrical studies on vanadium phosphate glasses containing different oxides,” J. Mater Sci. Vol. 46, pp. 2071-2076, 2011.

[12] M. Mirzayi and M.H. Hekmatshoar, “Optical and IR study of Li2O-CuO-P2O5 glasses,” Ionics, Vol. 15, pp. 121-127, 2009.

[13] E. Soheyli and M.H. Hekmatshoar, “Investigation of thermal and electrical conductivity of phosphate glasses containing two transition metal oxides, lithium oxide and calcium oxide,” Phys. Scripta, Vol. 89, pp. 075801-075806, 2014.

[14] M. Mirzayi and M.H. Hekmatshoar, “The role of V2O5 in changing the structure, optical properties and thermal behavior of zinc vanadium phosphate glasses,” Phys. Chem. Glasses, Vol. 54, pp. 264-269, 2013.

[15] H.A. ElBatal, A.M. Abdelghany, F.H. ElBatal, K. M. ElBadry, and F.A. Moustaffa, “UV–visible and infrared absorption spectra of gamma irradiated CuO-doped lithium phosphate, lead phosphate and zinc phosphate glasses: A comparative study,” Physica B, Vol. 406, pp. 3694-3703, 2011.

[16] N. Vedeanu, O. Cozar, R. Stanescu, I.B. Cozar, and I. Ardelean, “Structural investigation of new vanadium-bismuth-phosphate glasses by IR and ESR spectroscopy,” J. Mol. Struct. Vol. 1044, pp. 323-327, 2013.

[17] A. Santic, A. Mogus-Milankovic, K. Furic, V. Bermanec, C.W. Kim, and D.E. Day, “Structural properties of Cr2O3–Fe2O3–P2O5 glasses, Part I,” J. Non-Cryst. Solids, Vol. 353, pp. 1070–1077, 2007.

[18] N.S. Vedeanu and D.A. Magdas, “The influence of some transition metal ions in lead- and calcium-phosphate glasses,” J. Alloys Comp. Vol. 534, pp. 93-96, 2012.

[19] A.G. Mostafa, M.Y. Hassaan, A.B. Ramadan, A.Z. Hussein, and A.Y. Abdel-Haseib, “Characterization of Iron Sodium Phosphate Glasses Doped Ba2+ Cations for Using as Radioactive Waste Encapsulation,” Nature and Sci. Vol. 11, pp. 148-155, 2013.

[20] N. Vedeanu, O. Cozar, I. Ardelean, and V. Ioncu, “Raman and EPR investigation of some lead-phosphate glasses with vanadium and copper ions,” J. Optoelectron. Adv. Mater. Vol. 9, pp. 844-847, 2007.

[21] F.H. ElBatal, Y.M. Hamdy, and S.Y. Marzouk, “UV–visible and infrared absorption spectra of transition metals-doped lead phosphate glasses and the effect of gamma irradiation,” J. Non-Cryst. Solids, Vol. 355, pp. 2439-2447, 2009.

[22] M. Mirzayi and M.H. Hekmatshoar, “Study of electrical conductivity and memory switching in the zinc – vanadium-phosphate glasses,” Physica B, Vol. 420, pp. 70-73, 2013.

[23] M. Subhadra and P. Kistaiah, “Characterization and optical absorption studies of VO2+:Li2O–K2O–Bi2O3–B2O3 glass system,” J. Alloys Comp. Vol. 505, pp. 634-639, 2010.

[24] M. Altaf and M. A. Chaudhry, “Physical Properties of Lithium Containing Cadmium Phosphate Glasses,” J. Mod. Phys. Vol. 1, pp. 201-205, 2010.

[25] G. Rama Sundari, V.P. Manjari, T.R. Rao, D.V. Satish, C.R. Krishna, C.V. Reddy, and R.V.S.S.N. Ravikumar, “Characterization of Cr3+ doped mixed alkali ions effect in zinc borate glasses – Physical and spectroscopic investigations,” Opt. Mater. Vol. 36, pp. 1329-1335, 2014.

[26] S.L.S. Rao, G. Ramadevudu, M. Shareefuddin, A. Hameed, M.N. Chary, and M.L.A. Rao, “Optical properties of alkaline earth borate glasses,” Int. J. Eng., Science and Technol. Vol. 4, pp. 25-35, 2012.

[27] M.A. Ghauri, S.A. Siddiqi, W.A. Shah, M.G. B. Ashiq, and M. Iqbal, “Optical properties of zinc molybdenum phosphate glasses,” J. Non-Cryst. Solids, Vol. 355, pp. 2466-2471, 2009.

[28] A. Agarwal, V.P. Seth, S. Sanghi, P. Gahlot, and S. Khasa, “Mixed alkali effect in optical properties of lithium-potassium bismuth borate glass system,” Mater. Lett. Vol. 58, pp. 694-698, 2004.

[29] M. Mirzayi, Investigation of some physical properties of semiconductors ceramics and glasses containing zinc oxide and vanadium pentoxide, PhD. Thesis, Physics Dept. Sahand Univ., Tabriz, Iran, 2013.

[30] S.M. Wasim, C. Rincon, G. Marin, and P. Bocaranda, “Effect of structural disorder on
the Urbach energy in Cu ternaries,” Phys. Rev. B, Vol. 64, pp. 195101-195107, 2001.

[31] M. Azmoonfar, M.H. Hekmat-Shoar, M. Mirzayi, and H. Behzad, “Optical properties of glasses in the Li₂O–MoO₃–P₂O₅ system,” Ionics, Vol. 15, pp. 513-518, 2009.

[32] M. Caglar, S. Ilican, and Y. Caglar, “Influence of dopant concentration on the optical properties of ZnO: In films by sol–gel method,” Thin Solid Films, Vol. 517, pp. 5023-5028, 2009.

[33] G. Krishna Kumari, C.R. Krishna, S.M. Begum, V.P. Manjari, P.N. Murthy, and R.V.S.S.N. Ravikumar, “Mixed alkali effect in Mn²⁺ doped 20ZnO+xLi₂O+(30–x)K₂O+50B₂O₃ (5<x<25) Glasses,” Spectrochim. Acta, Part A, Vol. 101, pp. 140-147, 2013.

[34] G.K. Kumari, S.M. Begum, C.R. Krishna, D.V. Satish, P.N. Murthy, P.S. Rao, and R.V.S.S.N. Ravikumar, “Physical and optical properties of Co²⁺, Ni²⁺ doped 20ZnO+xLi₂O +(30-x)K₂O+50B₂O₃ (5<x<25) glasses: Observation of mixed alkali effect,” J. Mater. Res. Bull, Vol. 47, pp. 2646-2654, 2012.

[35] E. Metwalli, M. Karabulut, D.L. Sidebottom, M.M. Morsi, and R.K. Brow, “Properties and structure of copper ultraphosphate glasses,” J. Non-Cryst. Solids, Vol. 344, pp. 128-134, 2004.

[36] H.W. Guo, X.F. Wang, Y.X. Gong, and D.N. Gao, “Mixed alkali effect in xK₂O-(30–x) Na₂O-30P₂O₅-40ZnO glasses,” J. Non-Cryst. Solids, Vol. 356, pp. 2109-2113, 2010.

[37] N. Vedeanu, R. Stanescu, S. Filip, I. Ardelean, and O. Cozar, “IR and ESR investigations on V2O5–P2O5–BaO glass system with optoelectronic potential,” J. Non-Cryst. Solids, Vol. 358, pp. 1881-1885, 2012.

[38] R.M.M. Morsi and S. Ibrahim, “Effect of Li₂O on the structure, electrical and dielectric properties of xLi₂O-(20-x) CaO-30P₂O₅-30V₂O₅-20Fe₂O₃ glasses,” Physica B, Vol. 406, pp. 2982-2989, 2011.

[39] A. Rajiv, M.S. Reddy, R. Viswanatha, J. Uchil, and C. NarayanaReddy, “Modulated DSC, IR, Raman, MAS NMR Studies On TMO Doped Glasses Synthesized By Microwave Method,” Int. J. Advance Sci. Technic. Res. Vol. 3, pp. 789-804, 2014.

[40] M. Subhadra and P. Kistaiah, “Infrared and Raman spectroscopic studies of alkali bismuth borate glasses: evidence of mixed alkali effect,” J. Vibrational Spectroscopy, Vol. 62, pp. 23-27, 2012.

Mohammad Hossein Hekmatshoar is the professor of Solid State Physics at Sahand University of Technology. He received his M.Sc. and Ph.D. degree from Brunel University of London. He is interested in fiber optics, amorphous semiconductors and solar cells. He is a member of Physics society of Iran.

Samira Vafaei received her B.Sc. degree in Solid State Physics from Tabriz University in 2012 and M.Sc. degree in Amorphous Semiconductors from Sahand University of Technology in 2014. She is currently Ph.D. student at Sahand University of Technology. She is a member of Physics, Optics and Photonics society of Iran.
**SCOPE**

Original contributions relating to advances, or state-of-the-art capabilities in the theory, design, applications, fabrication, performance, and characterization of: Lasers and optical devices; Laser Spectroscopy; Lightwave communication systems and subsystems; Nanophotonics; Nonlinear Optics; Optical Based Measurements; Optical Fiber and waveguide technologies; Optical Imaging; Optical Materials; Optical Signal Processing; Photonic crystals; and Quantum optics, and any other related topics are welcomed.

**INFORMATION FOR AUTHORS**

International Journal of Optics and Photonics (IJOP) is an open access Journal, published online semiannually with the purpose of publication of original and significant contributions relating to photonic-lightwave components and applications, laser physics and systems, and laser-electro-optic technology. Please submit your manuscripts through the Web Site of the Journal (http://www.ijop.ir). Authors should include full mailing address, telephone and fax numbers, as well as e-mail address. Submission of a manuscript amounts to assurance that it has not been copyrighted, published, accepted for publication elsewhere, and that it will not be submitted elsewhere while under consideration.

**MANUSCRIPTS**

The electronic file of the manuscript including all illustrations must be submitted. The manuscript must be in double column with the format of IJOP Paper Template which for ease of application all over the world is in MS-Word 2003. The manuscript must include an abstract. The abstract should cover four points: statement of problem, assumptions, and methods of solutions, results and conclusion or discussion of the importance of the results. All pages, including figures, should be numbered in a single series. The styles for references, abbreviations, etc. should follow the IJOP format. For information on preparing a manuscript, please refer to the IJOP webpage at: http://www.ijop.ir.

Prospective authors are urged to read this instruction and follow its recommendations on the organization of their paper. References require a complete title, a complete author list, and first and last pages cited for each entry. All references should be archived material such as journal articles, books, and conference proceedings. Due to the changes of contents and accessibility over time, Web pages must be referenced as low as possible.

**Figure captions** should be sufficiently clear so that the figures can be understood without referring to the accompanying text. Lettering and details of the figures and tables should be large enough to be readily legible when the drawing is reduced to one-column width of the double column article. Axes of graphs should have self-explanatory labels, not just symbols (e.g., Electric Field rather than E). Photographs and figures must be glossy prints in electronic files with GIF or JPEG Formats.

**Article Keywords** are mandatory and must be included with all manuscripts. Please choose approximately 4 to 8 keywords which describe the major points or topics covered in your article.

**COPYRIGHT TRANSFER FORM**

Authors are required to sign an IJOP copyright transfer form before publication. Authors must submit the signed copyright form with their manuscript. The form is available online at http://www.ijop.ir.
