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The journal publishes research papers in the fields of Physical and Applied Sciences such as Astronomy and astrophysics, Chemistry, Earth and atmospheric sciences, Physics, Biology in general, Agriculture, Biophysics and biochemistry, Botany, Environmental Science, Forestry, Genetics, Horticulture, Husbandry, Neuroscience, Zoology, Computer science, Engineering, Robotics and Automation, Materials science, Mathematics, Mechanics, Statistics, Health Care & Public Health, Nutrition and Food Science, Pharmaceutical Sciences, and so on.

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Effect of Magnesium Content on the Growth Thick Films of Epoxy Prepared by the Casting Method

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A B S T R A C T

In this study, the magnesium(Mg) content at different concentrations (0, 0.05, 0.10, 0.15 and 0.20 wt. %) with epoxy resins was used to fabricate the polymer blend. The influence of Mg doping epoxy thick films are reported in this study. Thick films were prepared on glass substrate, and the films deposited at lab. temperature by casting method. The effects of polymeric blends were studied carefully investigated on the optical properties of the blends through a variation on the concentration of additions of magnesium. The thick films study results revealed additive of Mg lead to a structure improvement on the polymer blend and then improve optical properties. The optical properties of the blends were characterizes by the clear effect of the additions on the all optical properties coefficients of the polymer blends.

The optical properties were characterized by absorption, transmittance and reflectance spectroscopy measurements.

Transmittance and absorbance measurements in the waves length range(200-1000)nm were used to calculate the refractive index n and extinction coefficient k . The optical band gap Eg , complex dielectric constant ε1, ε2, ε∞average interband oscillator wave length λ0,average oscillator strength So, N/m*(N the free charge carrier concentration , m* the effective mass of the free charge carrier). According to Wemple and Didomenico method, the optical dispersion parameters Eo and Ed were determined. For all the films, the average (absorption and transmission) in the U.V wavelength region (200-1000) nm was (increased, decreased) as the magnesium concentration increased. The optical energy band gap of magnesium content different concentrations (0, 0.05, 0.10, 0.15 and 0.20 wt. %) with epoxy resins was used on the growth thick films of epoxy , has been found between (3.6 – 2.95) eV , whereas refractive index controlled between(1.696 – 6.205).

Keywords :thick films; magnesium(Mg); epoxy resins ;optical constant;; UV/VIS spectroscopy; optical properties: energy band gap; refractive index.

1. Introduction

Magnesium is a chemical element with the symbol Mg and atomic number 12. It is a shiny gray solid which bears a close physical resemblance to the other five elements in the second column (group 2, or alkaline earth metals) of the periodic table: all group 2 elements have the same electron configuration in the outer electron shell and a similar crystal structure.

Magnesium is the ninth most abundant element in the universe.[1,2] It is produced in large, aging stars from the sequential addition of three helium nuclei to a carbon nucleus. When such stars explode as supernovas, much of the magnesium is expelled into the interstellar medium where it may recycle into new star systems. Magnesium is the eighth most abundant element in the Earth's crust[3] and the fourth most common element in the Earth (after iron, oxygen and silicon), making up 13% of the planet's mass

and a large fraction of the planet's mantle. It is the third most abundant element dissolved in sea water, after sodium and chlorine.[4]

Magnesium belongs to group 2 of the periodic table, along with Be, Ca, Sr and Ba. The element has an atomic number of 12, an atomic mass of 24, one main oxidation state (+2) and three naturally occurring isotopes (24Mg, 25Mg and 26Mg), of which 24Mg is the major isotope at 79% of the total mass. Magnesium is the seventh most abundant element in the Earth's crust with a quoted average of 2.76% [2,3], and the Mg2+ ion is the second most abundant cation in sea water, after Na+. Its chemistry is intermediate between that of Be and the heavier alkali earth elements.

Magnesium occurs naturally only in combination with other elements, where it invariably has a +2 oxidation state. The free element (metal) can be produced artificially, and is highly reactive (though in the atmosphere, it is soon coated in a thin layer of oxide that partly inhibits reactivity – see passivation). The free metal burns with a characteristic brilliant-white light. The metal is now obtained mainly by electrolysis of magnesium salts obtained from brine, and is used primarily as a component in aluminum-magnesium alloys, sometimes called magnalium or magnelium. Magnesium is less dense than aluminum, and the alloy is prized for its combination of lightness and strength.

Magnesium is the eleventh most abundant element by mass in the human body and is essential to all cells and some 300 enzymes.[5] Magnesium ions interact with polyphosphate compounds such as ATP, DNA, and RNA. Hundreds of enzymes require magnesium ions to function. Magnesium compounds are used medicinally as common laxatives, antacids (e.g., milk of magnesia), and to stabilize abnormal nerve excitation or blood vessel spasm in such conditions as eclampsia.[5]

1.1 Physical properties of magnesium

Elemental magnesium(as shown in fig.(1)) is a gray-white lightweight metal, two-thirds the density of aluminum. Magnesium has the lowest melting (923 K (1,202 °F)) and the lowest boiling point 1,363 K (1,994 °F) of all the alkaline earth metals.

Pure polycrystalline magnesium is brittle and easily fractures along shear bands. It becomes much more ductile when alloyed with small amount of other metals, such as 1% aluminum.[6] Ductility of polycrystalline magnesium can also be significantly improved by reducing its grain size to ca. 1 micron or less.[7]

Magnesium is the third-most-commonly-used structural metal, following iron and aluminum.[8] The main applications of magnesium are, in order: aluminum alloys, die-casting (alloyed with zinc)[9] removing sulfur in the production of iron and steel, and the production of titanium in the Kroll process.[10] Magnesium is used in super-strong, lightweight materials and alloys. For example, when infused with silicon carbide nanoparticles, it has extremely high specific strength.[11]

Fig(1) : magnesium element

1.2 Chemical properties(General chemistry) of magnesium

It tarnishes slightly when exposed to air, although, unlike the heavier alkaline earth metals, an oxygen-free environment is unnecessary for storage because magnesium is protected by a thin layer of oxide that is fairly impermeable and difficult to remove.[12]

Magnesium reacts with water at room temperature, though it reacts much more slowly than calcium, a similar group 2 metal. When submerged in water, hydrogen bubbles form slowly on the surface of the metal – though, if powdered, it reacts much more rapidly. The reaction occurs faster with higher temperatures (see safety precautions). Magnesium's reversible reaction with water can be harnessed to store energy and run a magnesium-based engine. Magnesium also reacts exothermically with most acids such as hydrochloric acid (HCl), producing the metal chloride and hydrogen gas, similar to the HCl reaction with aluminum, zinc, and many other metals.[13]

2. MATERIALS AND METHODS

The thick polymer blends films were fabricate with varying amounts of magnesium 0, 0.05, 0.10, 0.15 and 0.20 by undergoes the following three stages:

2.1 prepare bases:

A glass substrates (of dimensions 2x4 cm2) were cleaned with acetone and then rinsed thoroughly with ethanol and distilled water .And then dried by hot air.

2.2 Preparation materials:

(0.0, 0.01, 0.015, 0.02, 0.025) gm of crushed magnesium Mg (the additive was magnesium particle size 100 μm) was added with a purity of 100 μm (using sieves with a diameter of 100 μm) as an additive to one gram of polymeric (epoxy) in weight proportions (0.66 gm of (Resin) and 0.33 gm (Hardener)). The ratio of resin to hardening material was (3:1)[14,15], produced by united chemical company Ltd (UNICHEM-Jordan, type 368 WG). The properties of epoxy resin shown in table(1). And use triethylene tetra amine as hardener for epoxy resin product by same company.

Table(1): properties of Epoxy Resin

Molecular weight(gm/mol)	624
Weight per epoxy (Kg/mol)	312
Density (gm/cm^3)	1.27
n-value	0.9 - 1

2.3 Mixing process

The above weight ratios, equivalent to(0%,5%, 10 %, 15%, 20 %) of the additive (magnesium powder) to the epoxy, have been mixed for a period of (10 to 15) min. for the purpose of obtaining homogeneity between the host (epoxy) and the added filling of the magnesium filings .

2.4 Casting method

The homogeneous mixture prepared from the magnesium and epoxy filings was poured on a base of glass slides on a flat surface for the purpose of obtaining a homogeneous surface for the prepared form. The sample was then left for 48 hours for the purpose of obtaining complete solidification of the model and at room temperature where a model with a thickness of 0.3mm was obtained.

2.5 Optical measurement

The absorption and transmission spectrums of prepared films were studied by using (6800UV/VIS Jenway Double Beam Spectrophotometer – England) UV-VIS spectrophotometer in the wave length range of (200-1000)nm. The data from absorption(A) and transmission(T) spectrums could use in the calculation of the reflection(R) spectrum by using the following equation[16,17]:

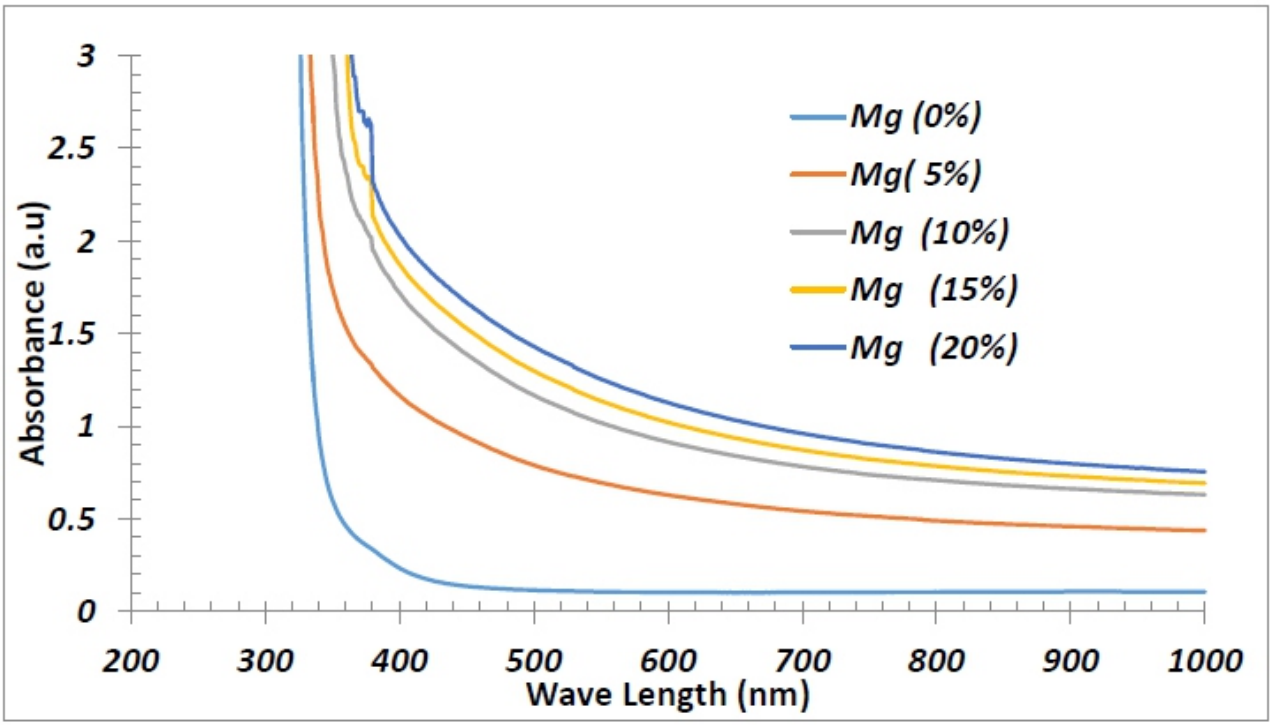
$$A + T + R = 1 \quad \ldots\ldots\ldots (1)$$

3. RESULTS AND DISCUSSIONS

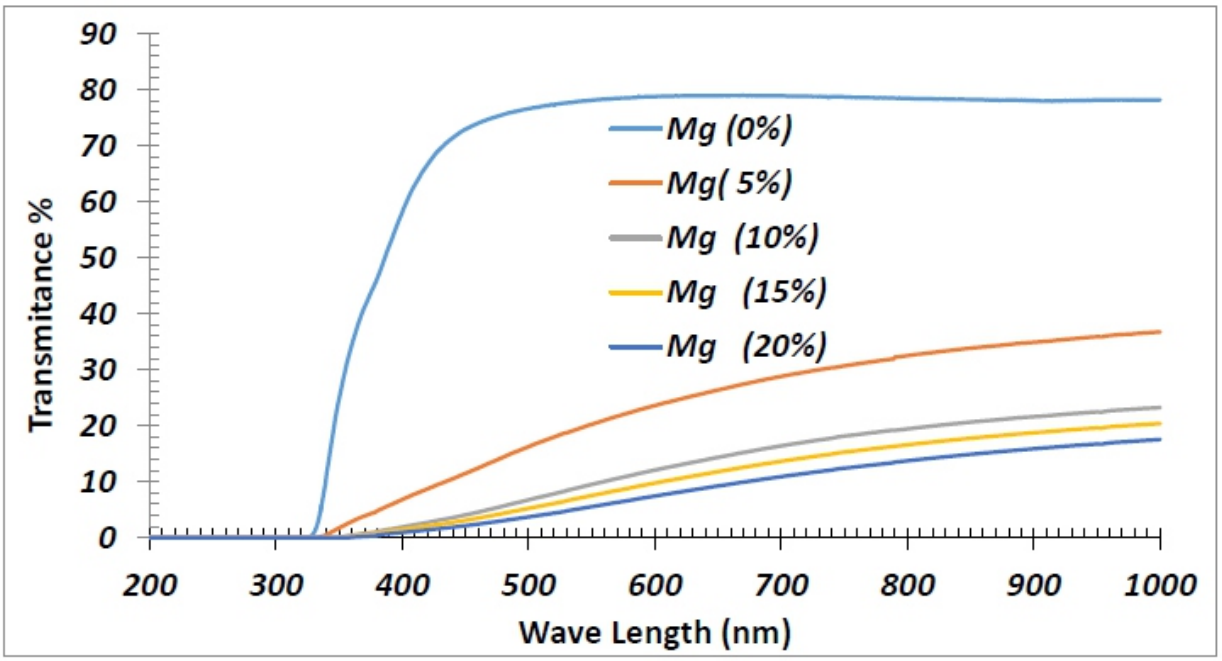
The optical properties of magnesium content different concentrations (0, 0.05, 0.10, 0.15 and 0.20 wt. %) with epoxy resins thick films were determined from transmission and absorption measurements in the range (200-1000) nm were recorded by using UV-VIS spectrophotometer.

The analysis of the absorption coefficient has been carried out to obtain the direct and indirect optical energy gap Eg and also the analysis of the refractive index n with the help of the absorption index k has been carried out to obtain the real and imaginary part of complex dielectric constant (Ɛr , Ɛi), average interband oscillator wave length λo , average oscillator strength So and N/m* (N the free charge carrier, m* the effective mass of the free charge carrier).

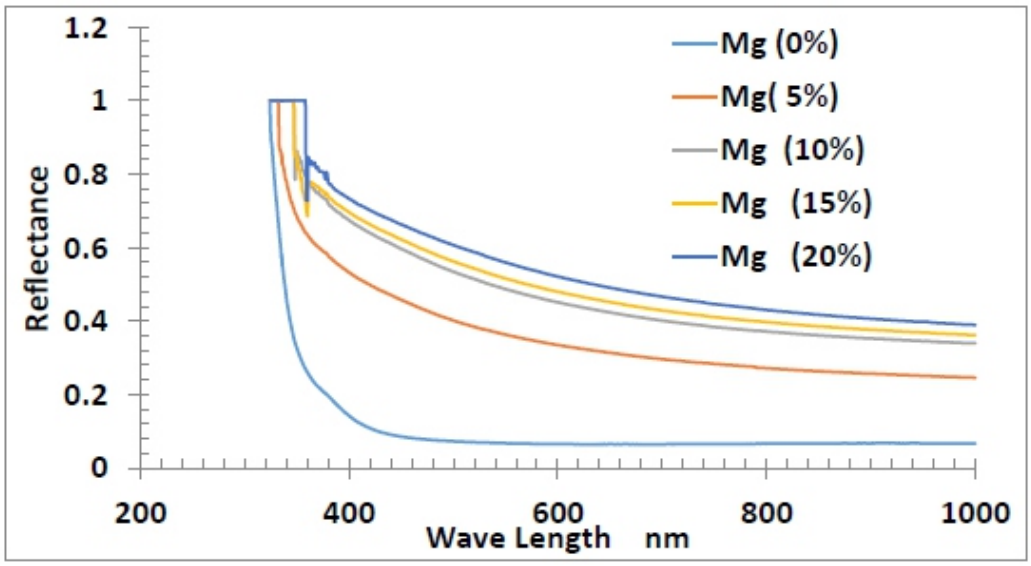
The optical properties of pure and doped epoxy with magnesium (0.05, 0.10, 0.15 and 0.20 wt. %) thick films is determined from absorbance, transmittance and reflectance in the range (200 – 1000)nm, as shown in fig.(2,4) respectively. While transmittance decrease when doping concentration increases , as shown in fig.(3). In general absorbance and reflectance increase when doping concentration increases as



Fig(2):The Absorbance spectra of epoxy doped with magnesium thick films



Fig(3):The Transmittance spectra of epoxy doped with magnesium thick films



Fig(4):The Reflectance spectra of epoxy doped with magnesium thick films

shown in fig.(2-4) respectively, while transmittance decrease when doping concentration increase (see fig.(3)).

The absorption coefficient (α) associated the strong absorption region of the film was calculated from absorbance (A) and the film thickness (t) using relation [18,19]

$$\alpha = 2.3026 \frac{A}{t} \quad \ldots\ldots\ldots (2)$$

The absorption coefficient (α) cm^{-1} and optical energy band gap (Eg) are related by[20]

$$\alpha h\nu = A(h\nu - E_g)^n \quad \ldots\ldots\ldots (3)$$

hv: is the energy of excitation photon (eV) , Eg is the energy band gap (eV) and n=½

The usual method for determine the values of energy band gap Eg are involves by plotting (αhv)½ as a function of photon energy (hv) as shown in figs.(5) and determined the values of Eg as shown in table(2) and fig.(6).

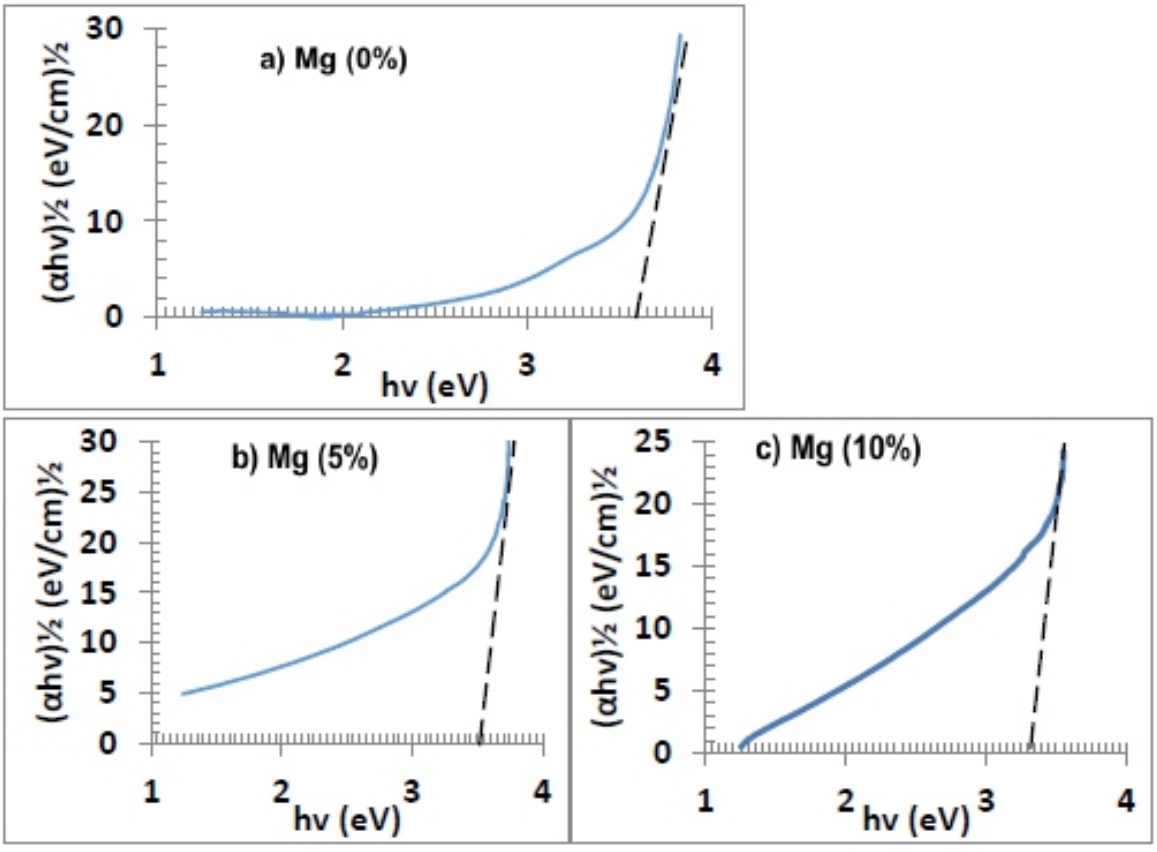
The extinction coefficient (k) is a measure of the fraction of light lost due to scattering and absorption per unit distance of the penetration medium. Extinction coefficient is estimated in the range (200-1000)nm from the values of α and λ using the following relation [21]:

$$k = \frac{\alpha\lambda}{4\pi} \quad \ldots\ldots\ldots (4)$$

Fig(7) shows the dependence of extinction coefficient k on the wavelength for all epoxy films doped with magnesium (0, 5, 10, 15, 20)%.

The refractive index n of pure and epoxy doped with magnesium (0, 5, 10, 15, 20)%. films can be determined from a transmittance spectrum and absorbance spectrum (or reflectance spectrum) in the wave length range (200-1000) nm. by using Swanepoel's method [23] applying the following equation [24]:

$$n = \frac{1+\sqrt{R}}{1-\sqrt{R}} \quad \ldots\ldots\ldots (5)$$



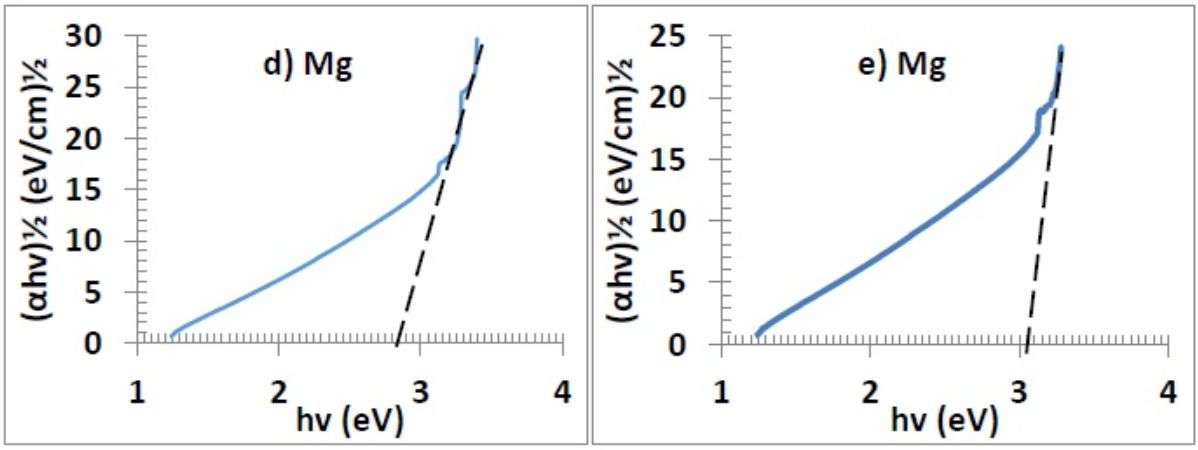
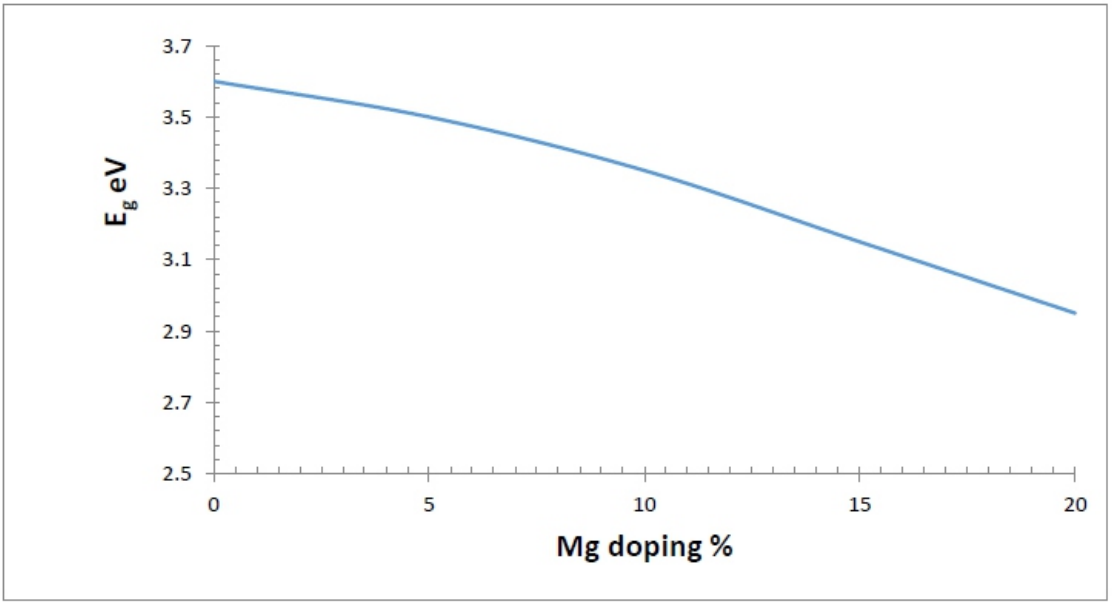


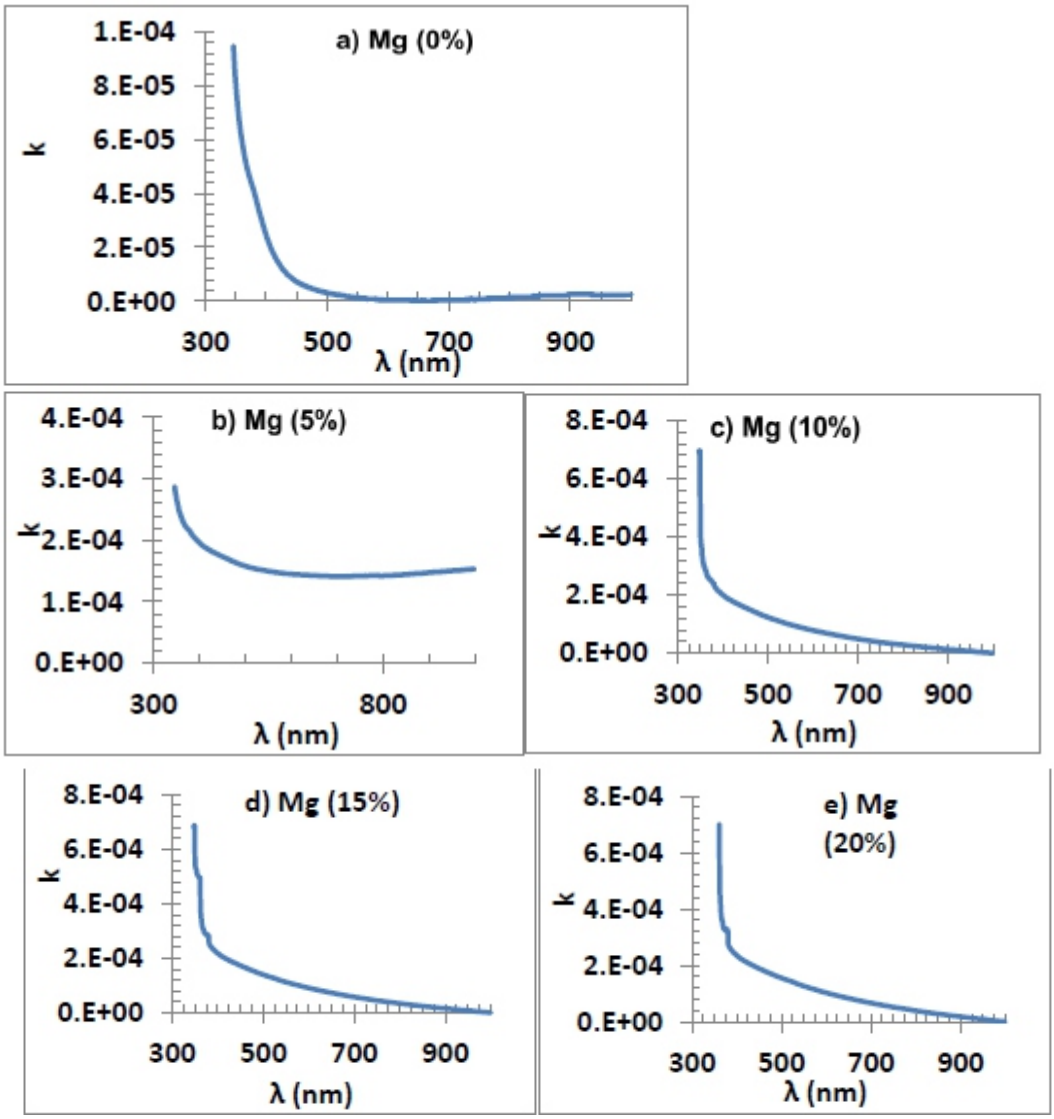
Fig (5) : The optical energy gap of epoxy doped with magnesium thick films



Fig(6): The relation between Energy band gap(Eg) and epoxy doped with magnesium thick films

Table(1): The values of optical parameters for epoxy doped with magnesium thick films

Mg doping%	E_g (eV)	ε_r	$\varepsilon_{\infty(2)}$	n_o	S_0 (m^{-2})	E_d (eV)	E_0 (eV)	E_{op} (eV)	$\varepsilon_{\infty(1)} = n^2$	N/m*	n
0	3.6	2.87	4.226	2.056	6.67E+1	5.502	3.742	1.87	2.875	1.17E+56	1.696
5	3.5	15	30.85	5.554	5.57E+1	44.384	3.578	1.864	15	1.01E+58	3.873
10	3.35	27	82.967	9.109	1.39E+1	89.443	3.578	1.789	27	1.92E+58	5.196
15	3.15	30	82.967	9.109	1.39E+1	111.80	3.578	1.789	31	2.27E+58	5.568
20	2.95	38	120.04	10.95	1.79E+1	140.30	3.578	1.732	38.5	3.02E+58	6.205



Fig(7): The relation between extinction coefficient k and wave length epoxy doped with magnesium thick films

As shown in figure(8), there is a sharp decrease in the refractive indexes for pure and doped films with magnesium (0, 5, 10, 15, 20)%. in the wave lengths range near 400nm. After that, the refractive indexes decrease slightly and steadily.

The values of [energy band gap Eg, real and imaginary part of complex dielectric constant (Ɛr ,Ɛi) , average interband oscillator wave length λ0 , average oscillator strength So , N/m*(N the free charge carrier, m* the mass of free charge carrier, n the refractive index , Ed single oscillator constants (dispersion energy), E0 energy of the effective dispersion oscillator] parameters given in table(2) can be calculated as shown in ref.[24] after drawing Figs.(9 – 13).

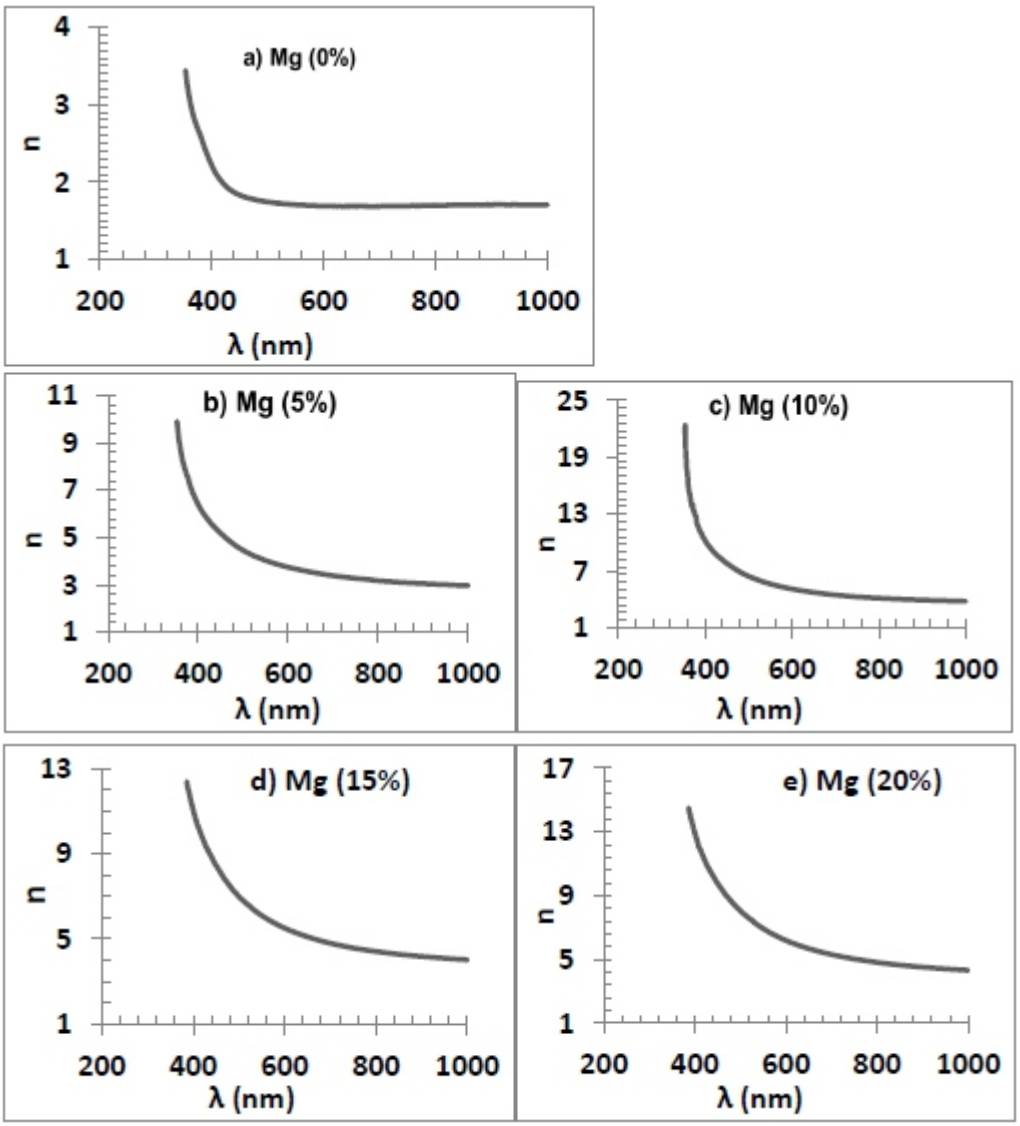
4. CONCLUSIONS

The optical absorbance and transmittance for pure and doped films with magnesium (0, 5, 10, 15, 20)%. was measured by (6800 UV/VIS Jenway Double Beam Spectrophotometer –England) UV-Vis spectrophotometer within the wavelengths range of (200-1000)nm. It was observed that the absorbance increase whereas transmittance decrease with increasing doping concentration of Mg.

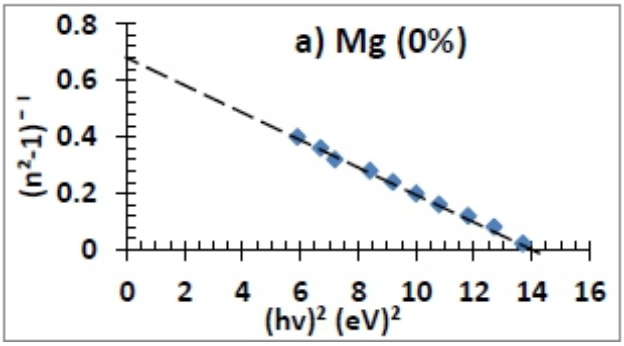
The value of band gap decrease from 3.6 eV for pure sample to 2.95 eV for sample 20% doped with Mg .

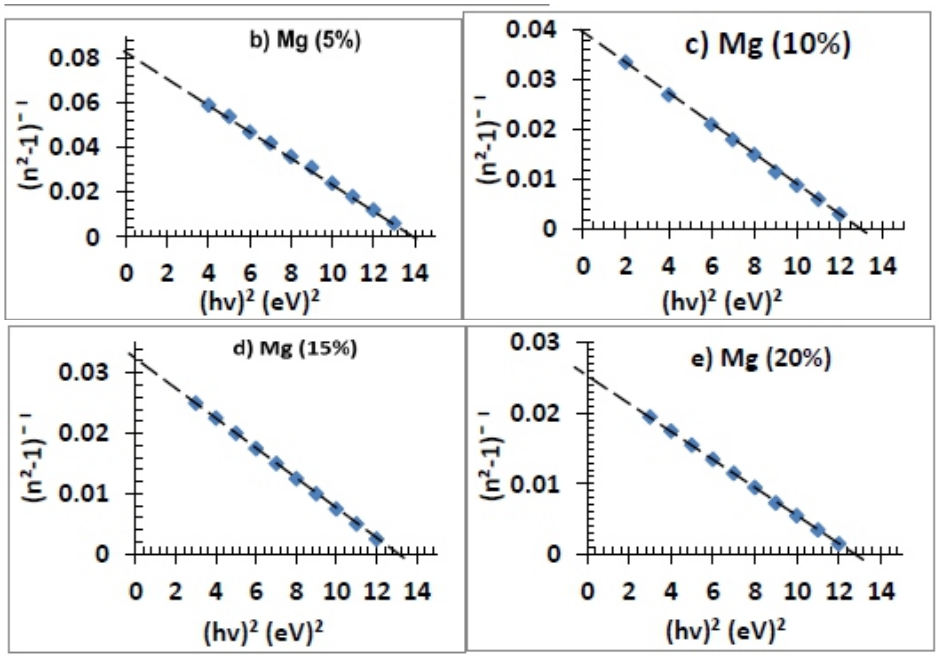
The refractive indexes (n) increase with increase from 1.696 for pure sample to 6.205 for sample 20% doped with Mg .

The dielectric constants (real εr and imaginary εi) are observed be increases from (2.87, 4.226) for pure sample to (38, 120.48) for sample 20% doped with Mg .



Fig(8): The relation between refractive index n and wave length for epoxy doped with magnesium thick films





Fig(9):A plot of $(hv)^2$ against $(n^2-1)^{-1}$ length for epoxy doped with magnesium thick films

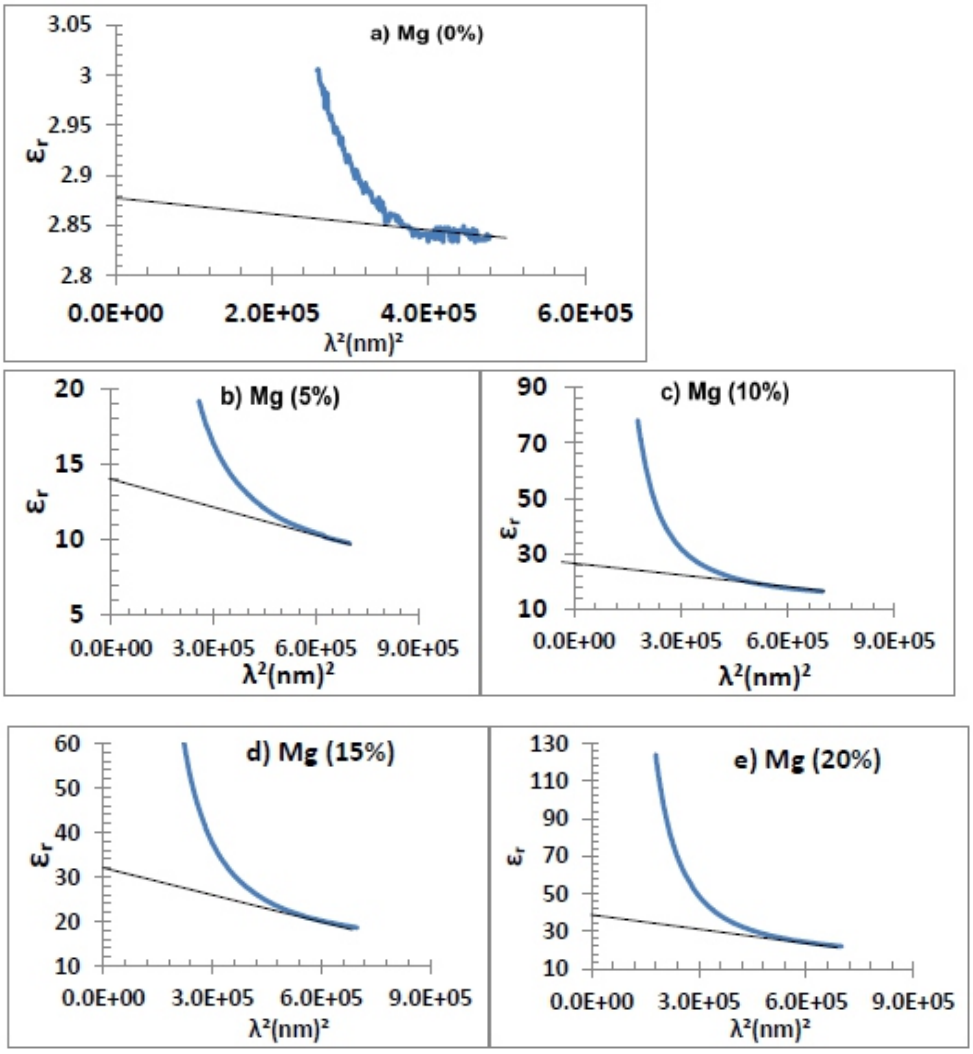


Fig (10) : A plot of ($\varepsilon_r = n^2$) as a function of λ^2 for epoxy doped with magnesium thick films

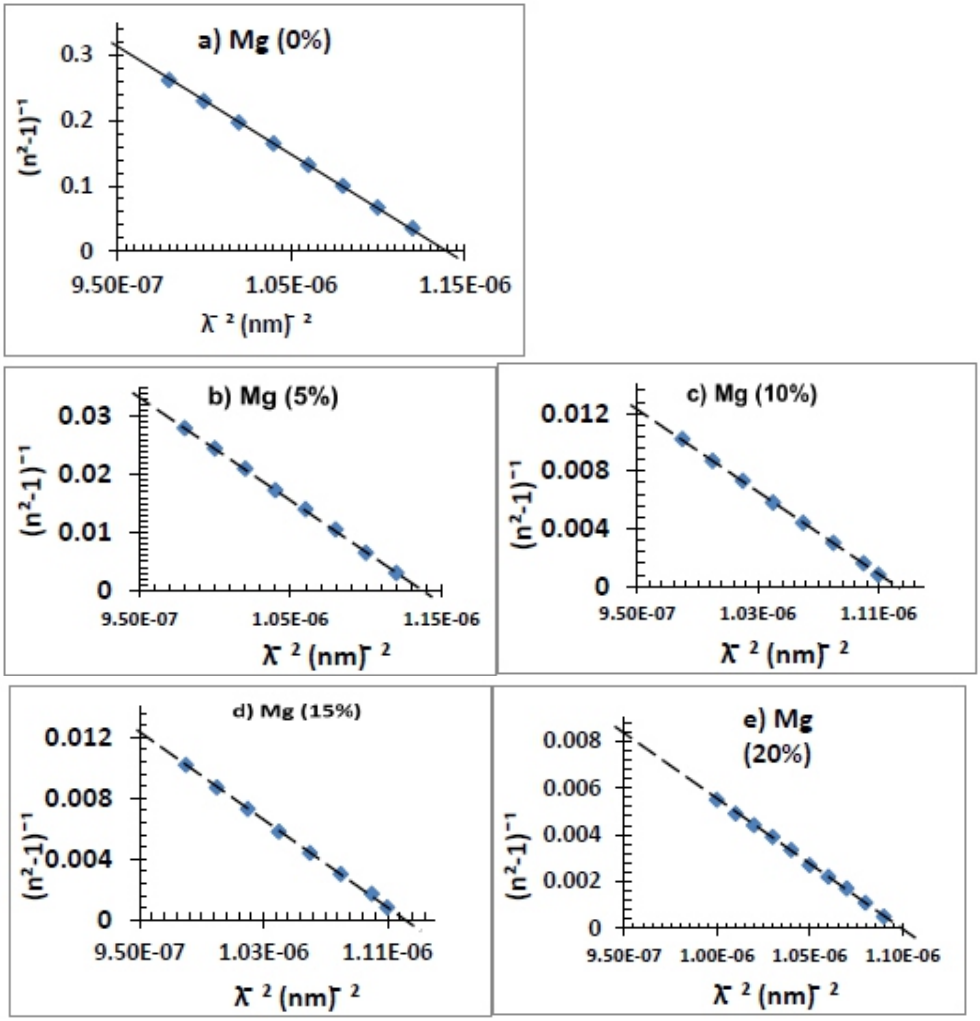
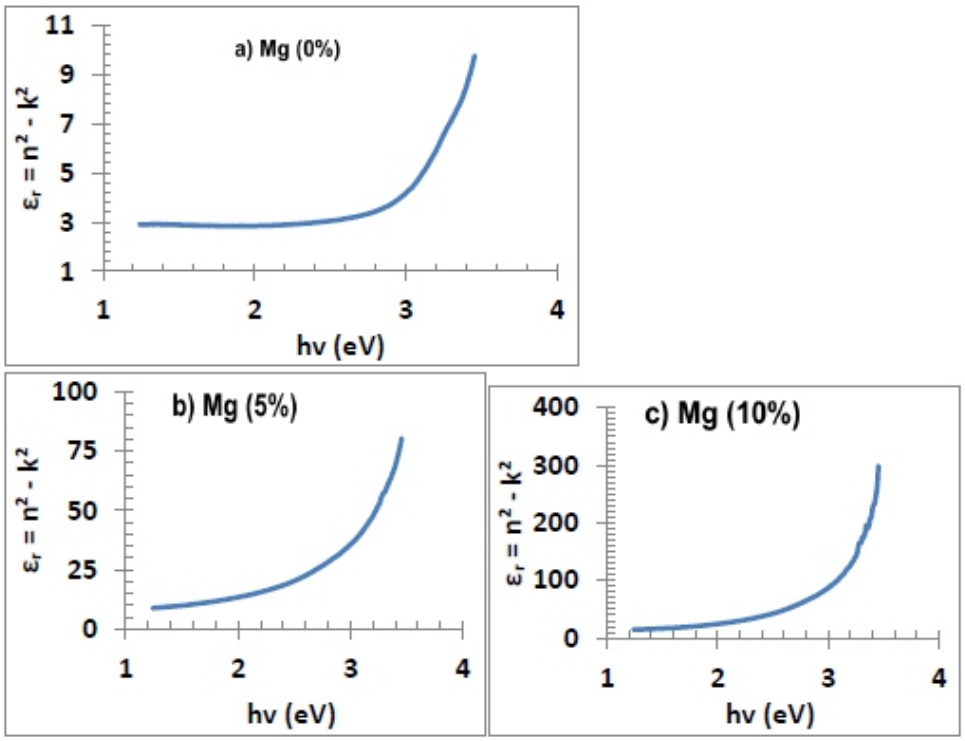
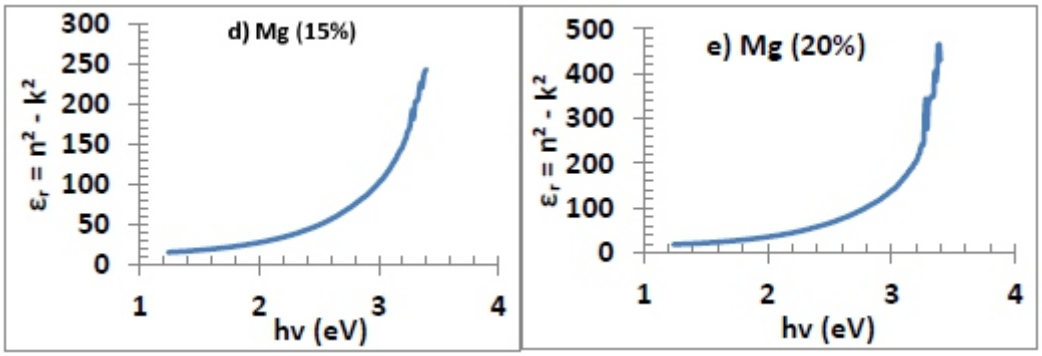
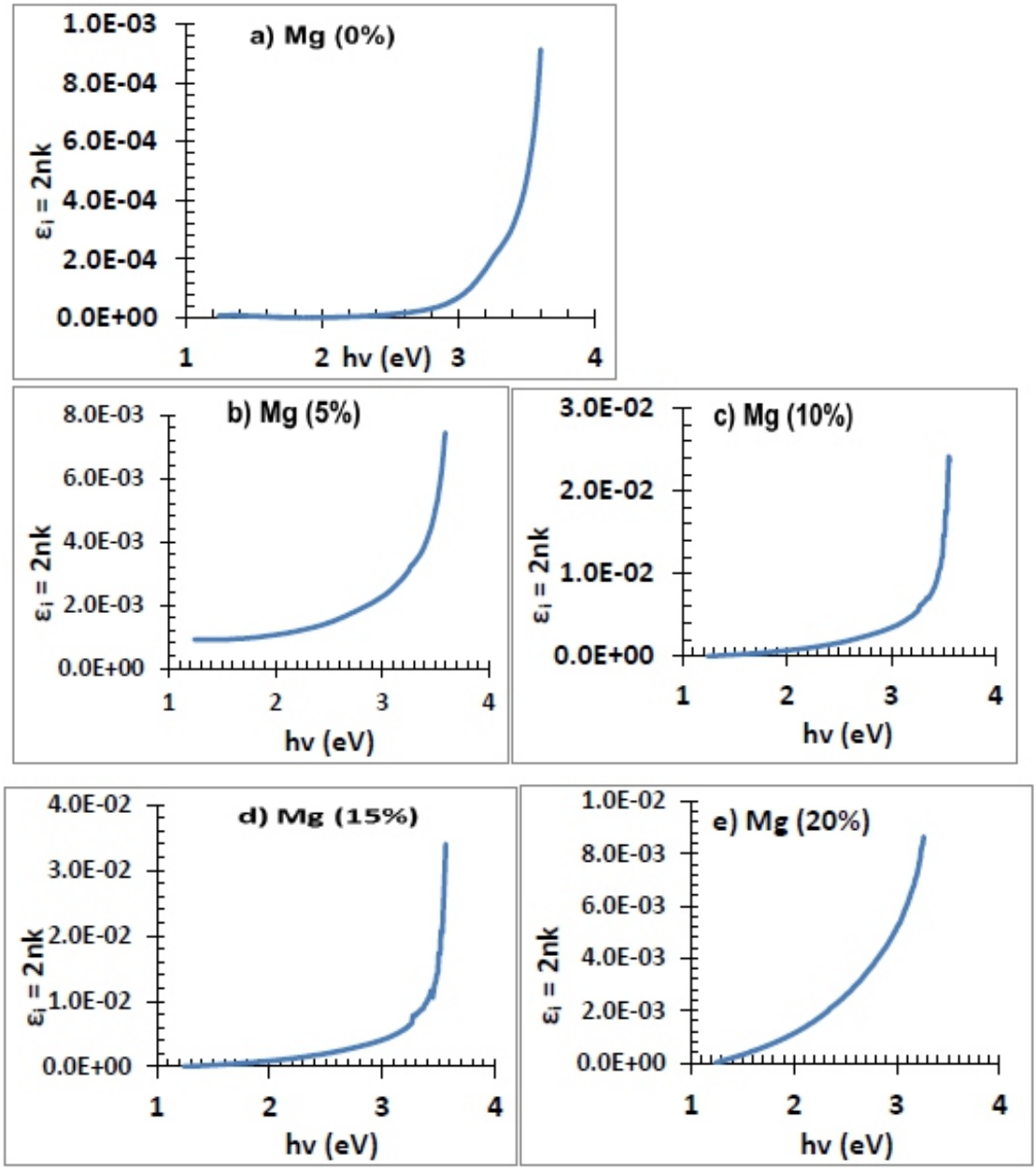


Fig (11) : A plot of λ^{-2}against $(n^2-1)^{-1}$ for epoxy doped with magnesium thick films





Fig(12): Real dielectric constant as a function of photon energy for epoxy doped with magnesium thick films



Fig(13): Imaginary dielectric constant as a function of photon energy for epoxy doped with magnesium thick films

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Enhance Method A Vector Controlled Machine Drive for Minimization of Electrical Losses

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A B S T R A C T

The induction motor has in the industry. More attention has been a focus to develop and design of induction motor drives. With vector control, novelty proves the efficiency of induction motors over their entire speed range. In this paper, it is desirable to design a loss minimization controller that can improve efficiency. Also, this research described the Modeling of an induction motor with core loss included. Realization of methods vector control for an induction motor drive with loss element had—the case of the loss minimization condition. The procedure was successful in calculating the gains of a PI controller. Though the problem of obtaining a robust and sensorless induction motor drive is by no means completely solved, the results obtained as part of this work point in a promising direction.

Keywords: Induction Motor, novelty method, vector control

INTRODUCTION.

IM are critical components in industrial processes. A motor failure may yield an unexpected interruption at the industrial plant, with consequences in costs, product quality, commonly used in adjustable speed drive systems. Induction motors have been widely employed in various industries as actuators or drivers to produce mechanical motions and forces. Since it is estimated that more than 50% of the world's electric energy is generated and consumed by electric machines, improving the efficiency of electric drives is important [1.2]. Induction motors require a total operating range of speed and fast torque response in operational conditions, regardless of load variations. Namely, induction motors have high efficiency at rated speed and torque.

Its efficient control requires a suitable model with accurate parameters, the minimization of the objective function is carried out using the Particle Swarm Optimization. Particle Swarm Optimization (PSO) is an evolutionary algorithm inspired by social interaction. PSO is an evolutionary once technique (a search method based on a natural system) developed by Kennedy and Eberhart.

The basic concept of the PSO technique 'lies in accelerating each particle towards its p best and g best locations, with a random weighted acceleration at each time step. PSO has many parameters, and these are described as follows: V max is the maximum allowable velocity of the particles (i.e., in the case where the rate of the particle exceeds Vmax, then it is limited to Vmax). Particle swarm optimization (PSO) is one of the modern heuristic algorithms [16], [17]. PSO has attracted significant attention due to its features of easy implementation, robustness to control parameters, and computation efficiency compared with other existing heuristic algorithms and has been successful. Particle swarm optimization (PSO) is an evolutionary computation technique the system initially has a population of random solutions. Each potential solution called an electromagnetic torque is given by a particle. In this research paper, a new minimum-time minimum-loss control algorithm for induction motors using system particle swarm optimization is suggested to obtain high performance and high efficiency under practical constraints on voltage and current. The validity of the proposed scheme, which carries out minimum

-time speed control in the transient state and minimum-loss supervision in the steady-state, will be revealed via simulation, including an induction motor model.

2. INDUCTION MOTOR LOSS MODEL

This paper described an equivalent circuit which points out the rotor magnetic current is used. An iron loss resistance Rf was added in parallel with magnetic inductance in the rotor flux reference frame which is shown in figure.1 [2,5,7]. Information related to this machine is presented in Appendix

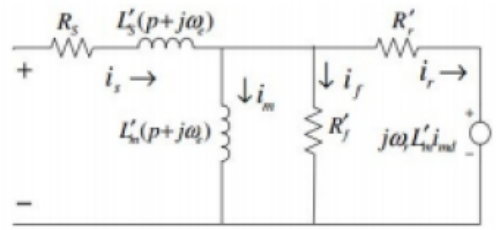

Fig 1. Equivalent circuit of induction motor containing iron loss resistance.

In permanent state, there is no leakage inductance on the motor and the equivalent circuit will be the same as fig.2.

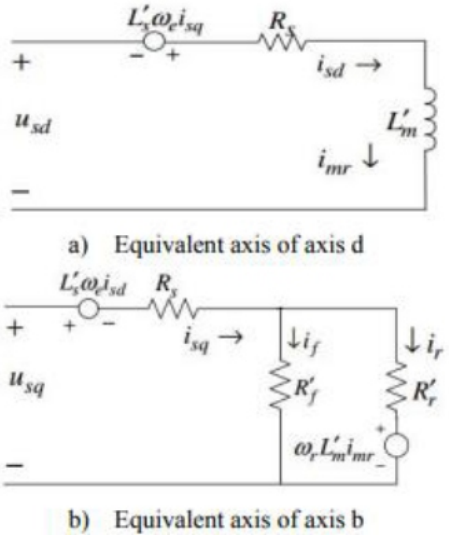

Fig 2. Motor equivalent circuit in the permanent state.

To develop the loss model, a typical simple approach has been discussed in the previous kinds of literature[1,2,5].Copper loss of stator, copper loss of rotor and iron loss which are stated as equation 1:

$$v_{f,g}^{(t+1)} \rightleftarrows = \rightleftarrows w \cdot v_j^{(t)} + c_1^* \,\mathrm{rand}()^* (\mathrm{pbest}_{j,g} - k_{j,g}^{(t)}) + c_2^* \,\mathrm{Rand}()^* (\mathrm{gbest}_g - k_{j,g}^{(t)}),$$

$$j = 1, 2, \ldots, n, \quad g = 1, 2, \ldots, m.$$

$$k_{j,g}^{(t+1)} = k_{j,g}^{(t)} + v_{j,g}^{(t+1)}, \quad k_g^{\min} \le k_{j,g}^{(t+1)} \le k_g^{\max}$$

3. PARAMETER PSO IN INDUCTION MOTOR

We think that a magnetic flux axis d is set up on the magnetic flux electric current vector as shown in figure 1. In the induction motor vector control, the voltage and ampere equations on the d-q axes are following.

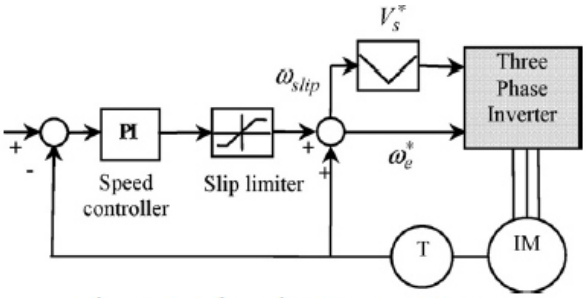

Figure3. Electric Current Vector

Voltage equation:

$$\begin{bmatrix} v_{sd} \\ v_{sq} \end{bmatrix} = R_s \begin{bmatrix} i_{sd} \\ i_{sq} \end{bmatrix} + \omega_i \begin{bmatrix} 0 & -Lom \\ Lom & 0 \end{bmatrix} \begin{bmatrix} i_{sd} \\ i_{sq} \end{bmatrix} + Lom \frac{d}{dt} \begin{bmatrix} i_{sd} \\ i_{sq} \end{bmatrix}$$

$$+ \frac{M^2}{L_R^{'}} R_R^{'} \begin{bmatrix} i_{sd} \\ i_{sq} \end{bmatrix} + \frac{M^2}{L_R^{'}} \begin{bmatrix} -\frac{R_R^{'}}{L_R^{'}} & -\omega_R \\ \omega_R & -\frac{R_R^{'}}{L_R^{'}} \end{bmatrix} \begin{bmatrix} i_\mu \\ 0 \end{bmatrix}$$

Ampere equation:

$$\frac{d}{dt} I_\mu = -\frac{R_R^{'}}{L_R^{'}} I_\mu + \frac{R_R^{'}}{L_R^{'}} I_{sq}$$

$$\omega_i - \omega_R = \frac{R_R^{'}}{L_R^{'}} \frac{I_{sq}}{I_\mu}$$

In this section, the procedure of PSO in online system parameter identification is described. Here, each particle represents all parameters of estimated model. The proposed algorithm sequentially gives data set by sampling periodically. While starting, in the first period, the best system parameter is found by minimizing the SSE introduced. Here, the simulation for next period does not begin until the fitness of global best becomes lower than a predefined threshold. After that, the estimated parameters will not be updated unless a change in the system parameters are detected. to detect any change. In system parameters, the global optimum in the later period is noticed as a sentry particle. In the beginning of each of the next periods, the sentry reevaluates its fitness and if the fitness changes significantly or it becomes bigger than a predefined threshold, the changes in parameters are confirmed. If no changes are detected, the algorithm leaves this period without changing the positions of particles. In contrast, when any change in parameters occurs, the sentry alerts the swarm to reset their best location memories and then the algorithm runs further to find the new optimum values. For this purpose, the fitness of global optimum particle and personal bests of all particles are evaporated at the rate of a big evaporation constant. As a result, other particles have a chance to find better solutions than those stored on their pervious global and personal memories. Moreover, the velocities of particles are increased to search in a bigger solution space for new best solution

The diagram block of the proposed optimized approach is shown in fig.4. Motor control method was based on rotor flux vector control method (FOC). In this structure, speed and electromagnetic torque of the motor are measured to obtain magnetic current, An FLC is the conversion of Linguistic expressions based on expert knowledge into the control strategy[9]. First , the speed error and its variation derivative are input as FLC variables. Then, FLC output variable is introduced as the reference value. then these numerical variables are converted into the Linguistic variables. Five fuzzy sets are seen in table.1 as NL(Negative large), NS(Negative small), Z(Zero), PS (Positive small) and PL(Positive large)[11-15]. Fuzzy control structure is defined as follow: 1 Five fuzzy sets for each input and output variable

2 Fuzzification by using continuous universe of discourse
3 Using mamdani performance (min)
4 Defuzzification by using centroid.

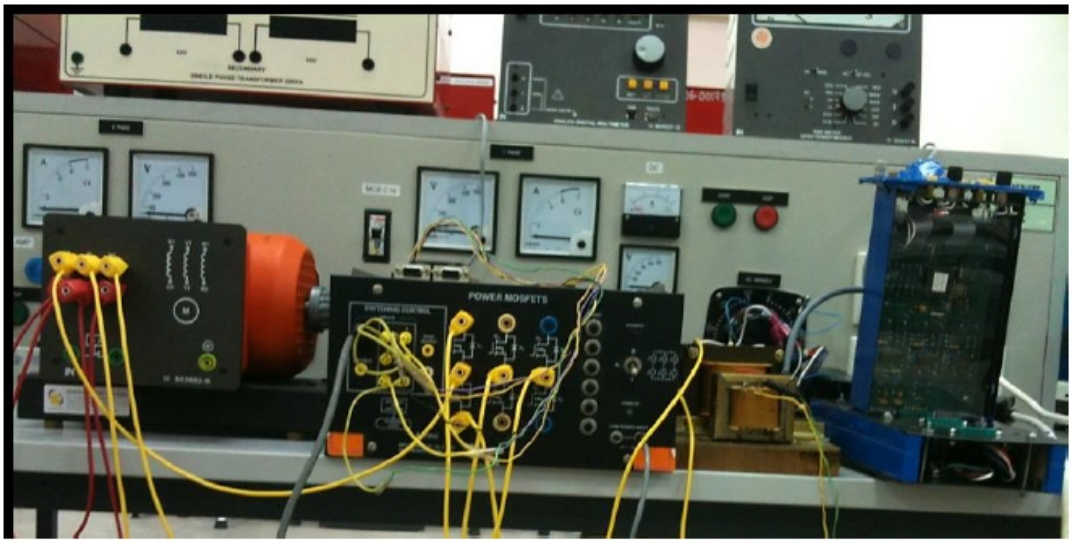

Fig 5. The physics Proposed Controlled

4. RESULT AND DISCUSSION

To certify both, steady state and transient behavior of the proposed algorithm some simulation has been carried out. The three phase induction motor has the following parameters: To know everything, I use a range Rr = 0.0025 ohms, Rs = 0.0015 ohms, f = 60Hz, P = 2, V= 120 V, for my induction motor.

A. Steady State

The steady state of stator flux and Electromagnetic

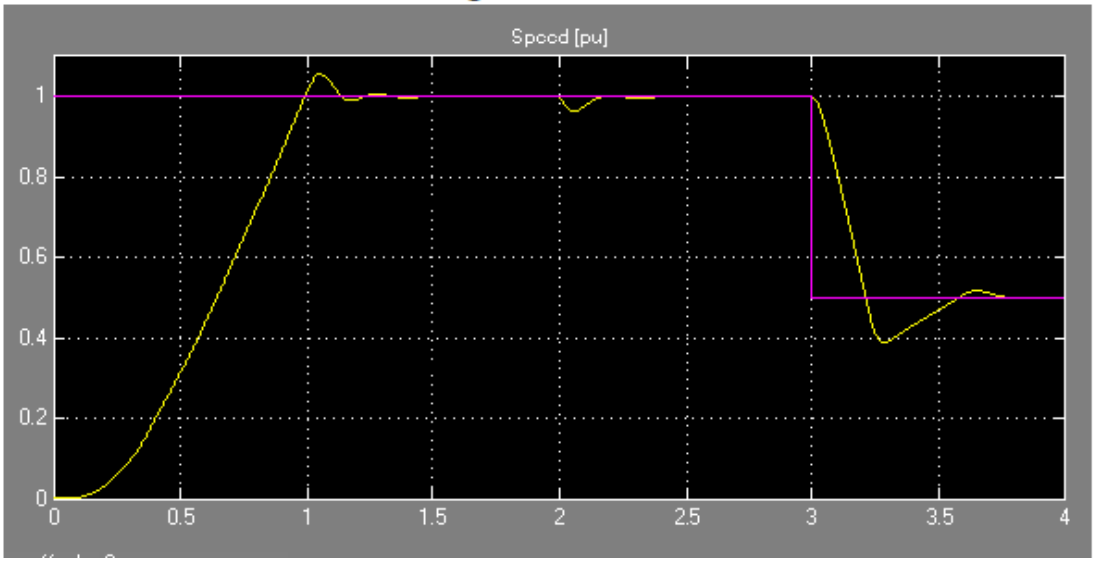

Figure4. Motor speed and reference speed during using HPSO

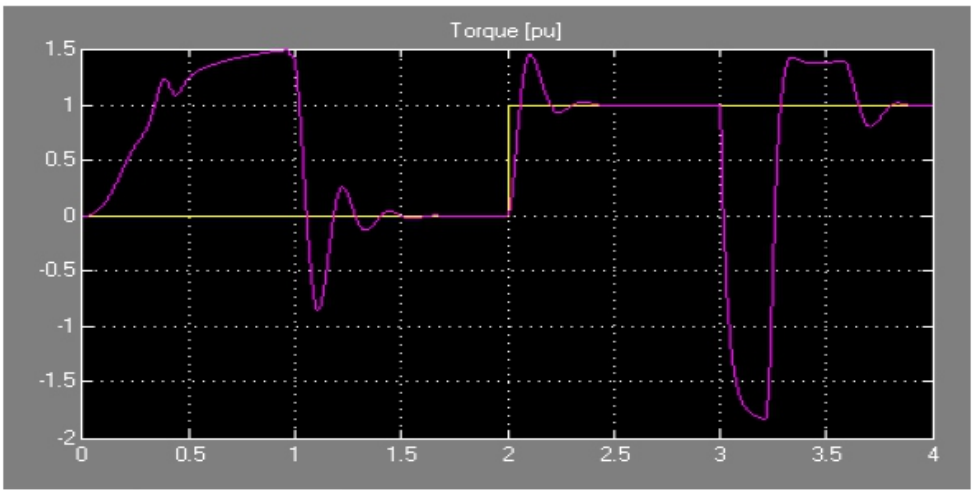

Figure5. Torque from Motor Induction Based HPSO

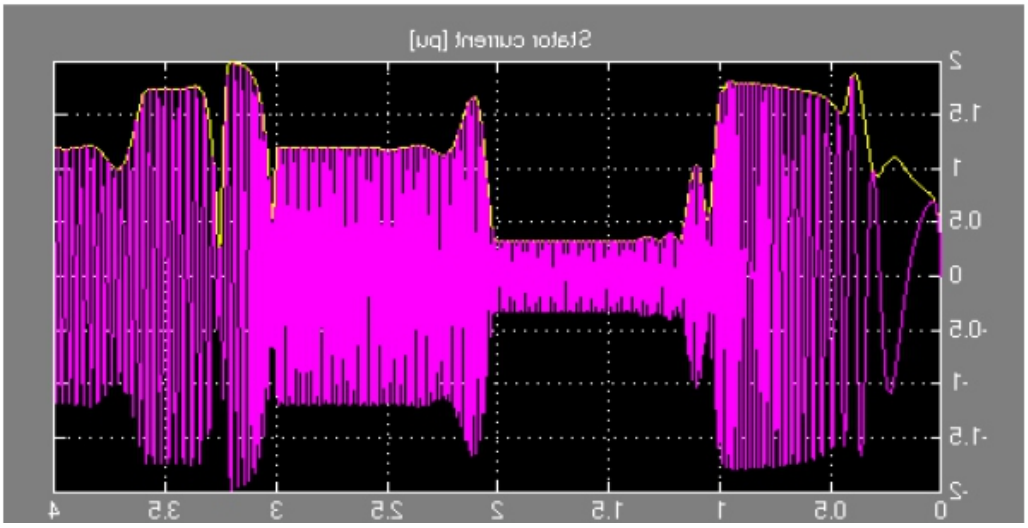

Figure6. Stator Current From HPSO Based Induction Motor

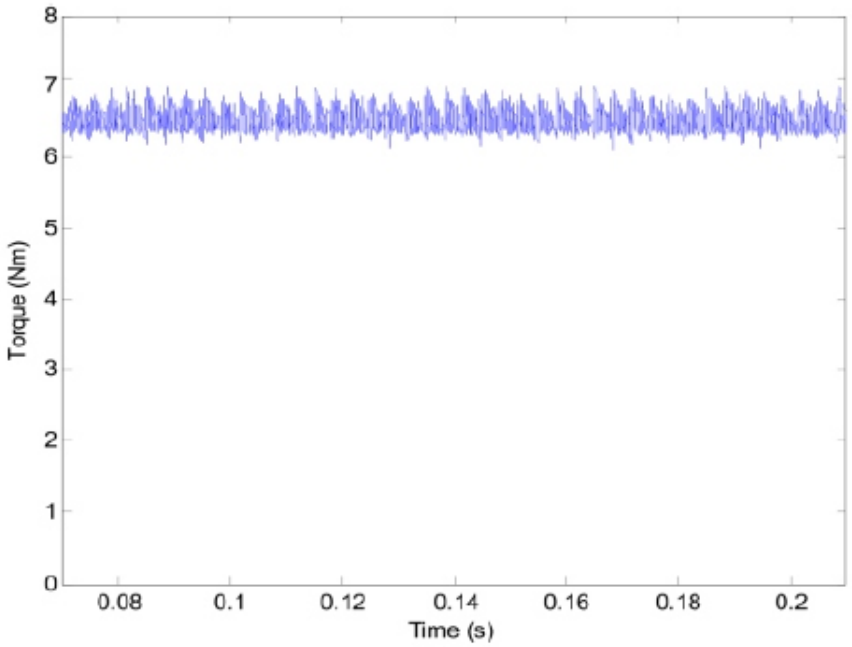

Figure7. Electromagnetic Torque

In the Figure 4, 5, 6, and 7, showed the speed, torque and stator currents of induction motors using system HPSO, where everything is quite stable when compared to using other systems.

5. CONCLUSION.

In this research, the system is presented to improve the Efficiency and decrease the losses. In order to increase the motor drive stability, during variations of speed and load, a fuzzy controller was used, which had higher results than a PI controller, the selected voltage vector in the new PSO schemes which produce the lowest start-up stator that may be current and torque ripple is reduced thereby increasing the performance of induction motor. Therefore, the tuning approach simultaneously evaluated in PI controller tuning speed and current PI controllers for vector control of induction motors in the simulation and experiment. Therefore, the following functions speed torque, speed, and efficiencies that can be jointly satisfied. HPSO induction motor model allows estimation of relevant parameters in motor speed, stator flux, rotor flux and torque without using sensors. This means that with a lower input power, the torque of input reference load has been supplied. When the load torque varies between 1 and 20 Nm, the input power using FG algorithm was reduced up to approximately 30%. On the other hand, the amount of loss with FG method had a significant advantage over the other two different torques.

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Comparative Study Between the Effects of Radiation on F75 Co-Cr-Mo and Co-Ni-Cr-Mo Biomaterials by The Application of Micro Tomography X-rays

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ABSTRACT

This paper study and compare the effect radiation on F75 Co-Cr-Mo and Co-Ni-Cr-Mo biomaterials. The biomaterial were subjected to radiation by the use of CT scan machine and the 3D slice image of the material under study were obtain for microtographic study, and the materials were tested mechanically to determine the hardness, compression and tensile strength. These mechanical properties are very helpful and important in the process of material selection for implants and biocompatibility. The XRD pattern of the biomaterial were obtain and indicate the peak value of the spectrum, the SEM image obtain show the surface micro structure of the materials. This article focuses on the comparative study on the effect of radiation on the mechanical aspect of the metallic biomaterials that can be use for replacement or dental implants made from a stainless steel alloy of cobalt.

Key words: Biomaterial, X-ray, Microtography, Cobalt alloy, Chromium alloy.

1. INTRODUCTION

Metallic biomaterials are the prime biomaterials utilized for shoulder, elbow, prostheses, and joint replacement their uses are becoming increasingly Important. The metallic biomaterials utilized for orthopedic applications can be categorized as stainless steel, cobalt–chrome (Co–Cr) alloys, and titanium alloys. Currently, Cobalt-based alloys are among the unharmed metallic biomaterials for hip implants, owing to their superior corrosion properties, mechanical strength, and biocompatibility. Cobalt–chrome alloy is much attuned to the human body. As a result of this, it is commonly used as implants and fixations. In contrast with other materials used in orthopedic fixations, cobalt chrome alloys have a superior biocompatibility than stainless steel [1-2]. Co–Cr–Mo–Ni alloy, cobalt is the main constituent and its content in the material is regarded for the elastic modulus, strength and hardness. Chromium is the second main constituent and is responsible for its tarnish and corrosion resistance. The chromium content on this alloy, however, should not exceed 30wt.% because it gets more arduous to cast. One more point associated with this weight percentage of Cr is that the material starts forming a brittle phase known as sigma (σ) phase. The attendance of third constituent i.e. molybdenum (4wt.%) in the material composition causes higher strength due making finer grains. In this alloy, nickel (1wt.%) is the forth constituent. Typically, the inclusion of this element in the composition increases the corrosion resistance of the material and yields improved mechanical properties. cobalt-based alloys with low quantities of nickel are designated as F75 In fact, nickel is a hard and ductile transition metal which improves the workability and cast ability of the alloy [2]. Biomaterials are used in different parts of the human body as artificial valves in the heart, stents in blood vessels, replacement implants in shoulders, knees, hips, elbows, ears and ortho dental structures. Amongst all these, the number of implants used for spinal, hip and knee replacements are extremely high. Cobalt-chromium-based alloys have been developed and employed in high-demanding medical applications including orthopedics and dentistry.

In spite of the favorable outcomes gained, some inevitable problems still exist in some applications[3-4]. X-ray computed tomography (XCT) is a technology with increasing applications in material science. It exploits the penetrating power of a high density focused x-ray beam, the field of materials characterization by means of X-ray micro tomography. This technique is non-destructive and permits to obtain three-dimensional (3D) images of the interior of a material. It shows all the micro structural features (other phases, inclusions, cracks, pores) inducing a modification of the attenuation or of the optical phase along the path of an X-ray beam. It has been used in medicine for about 30 years with a typical resolution. X-ray micro tomography has now proved to be a very powerful tool. to investigate the microstructure and the deformation mechanisms of various structural materials, which range from foams and alloys to high performance composites [5-6].The current study examine the mechanical properties of Co-Cr-Mo and Co-Ni-Cr-Mo after exposure to radiation by a micro tomography X-ray will be investigated. Since the exposure to radiation may or may not change the mechanical property of the biomaterial, this determined the longevity of an implant in addition to its biocompatibility, this can result to an oxidation in the biomaterials. Hence, this project aimed at studying and comparing the effect of radiation on a biomaterial Co-Cr-Mo and Co-Ni-Cr-Mo which has not been reported directly. In this study the micro structural properties, the strength and the diffraction pattern of the biomaterials after the exposure to X-ray is going to be investigated.

2. EXPERIMENTAL METHODS

The material studied here are F75 Co-Cr-Mo and Co-Ni-Cr-Mo Biomaterials (Commercially available Co-Cr-Mo alloy) that was previously tested in fatigue and found to be prone to crack initiation at pores

2.1 X-ray computed tomography

X-ray computed tomography (XCT) is a technology with increasing applications in material science. It exploits the penetrating power of a high density focused x-ray beam. The present experiments were performed at Aminu kano Teaching Hospital; CT scan machine Unit kano state. The microtomographic-imaging set-up consists of a precision sample stage that allows for accurate rotation and translation of the sample and an electronic high-resolution detector system. Due to limitation of x-ray penetration the volume of material examined is limited. Initially, a large number of XCT scans of a material volume taken over 180° rotation are acquired. These scans are projections of the specimen, representing pixel by pixel the absorption coefficient of the material crossed by X-rays. From these scans, cross-section images (i.e. slices) of the material volume were obtained with a back-projection algorithm. Finally, the 3D reconstruction of pores from the series of slices is obtained via software. The X-rays are emitted in a narrow cone tangentially to the trajectory of the electrons (i.e., tangentially to the storage ring). Such a source can be found for instance at the ESRF in Grenoble. The X-ray beam produced is very interesting for microtomography because of its many original features, the main of which being the very high intensity of the X-ray beam and the monochromatic character of the beam (this suppresses for example the beam hardening effect and allows for quantitative reconstructions). The X-ray beam can be assumed to be parallel in such a device[6,7].

2.2 Mechanical properties testing

The mechanical properties decide the type of material that will be selected for a specific application. Some of the properties that are of prime importance are hardness, tensile strength, modulus and elongation. The response of the material to the repeated cyclic loads or strains is determined by the fatigue strength of the material and this property determines the long term success of the implant subjected to cyclic loading. If an implant fractures due to inadequate strength or mismatch in mechanical

property between the bone and implant, then this is referred to as biomechanical incompatibility. Test of micro hardness are analyzed over a micro hardness testing machine having a square-based pyramidal (Angle 136_ between opposite faces) diamond indenter by applying a load (N) for a period of sometimes (s). All measurements will be carried out as per ASTM F75 standard. The micro hardness will be measured at Three different locations and the mean was considered in this study. For evaluation of hardness, the specimens are tested and mean values are reported.

2.3 Micro-hardness and compression tests

Micro-hardness measurement was done using a Walter Uhl Vicker's Micro-hardness Tester. A diamond indenter, in the form of a right pyramid with a square base and an angle of 136° between opposite faces, was forced into the material under a load 0.5 N for 5 s. Compression test was performed on rectangular shaped specimens as per ASTM F75 test standards using a universal testing machine (UTM) Instron 1195 at a crosshead speed of 2 mm/min. For evaluation of density, hardness and compression properties, Three specimens were tested and mean values were reported[2].

3. RESULT AND DISCUSSION

X-ray tomography has recently emerged as a powerful technique capable of giving a non-destructive picture of the interior of the structural materials, The materials were scanned for microtomographic analysis in its initial state. It was then compressed for two increasing values of remnant strain (true strain measured after unloading). The internal microstructure was imaged using microtomography at these two steps after removal of the compression load. We then have a picture of the interior of the materials. In Fig 1 (i) and (ii) below it can be observe that there is deformation by noting the circle in the picture, which are due to local buckling of several walls surrounding the circles. The tomography is valuable tools to investigate the amount of stress distributed in each cell wall and will help in explaining the collapse of the materials in compression this also stated in [6].

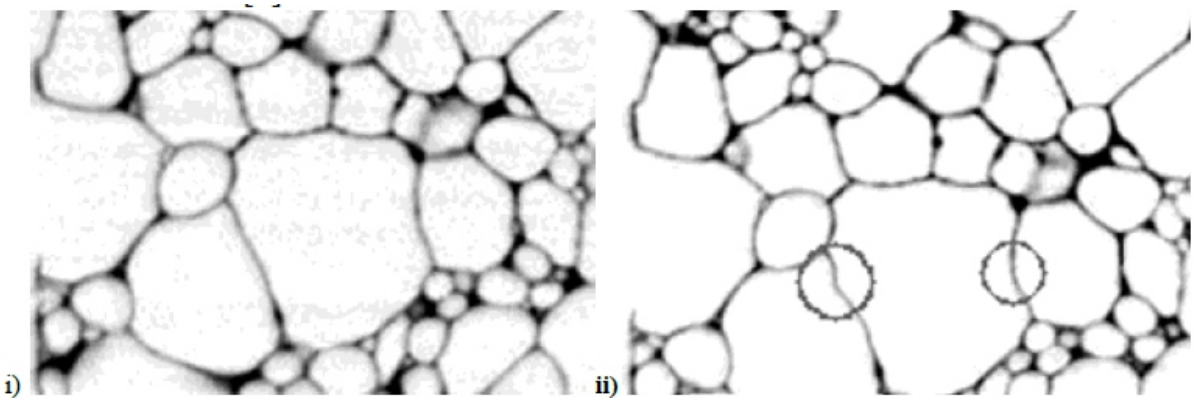


Fig 1(i) and (ii) Tomographic 2D results showing the internal structure of a material during compression: i) initial state; ii) for a plastic strain of 0.02 in compression

3.1 XRD Analysis

The XRD analysis of Co-Cr-Mo and Co- Ni- Cr-Mo are presented in Fig 2 (i), (ii) and (iii) below. In Fig 2 (i) Is the spectrum before the application of X-rays In which the spectrum is peak at $2\theta = 43.8^0$ this is in relation to [8]. In Fig 2 (ii) and (iii) for Co-Cr-Mo and Co- Ni- Cr-Mo the spectrum is peak for CO_2MO_3 for both the 4% and 3% Mo content, and for (iii) The two peaks are corresponding to Co_3Mo and Cr Ni respectively.

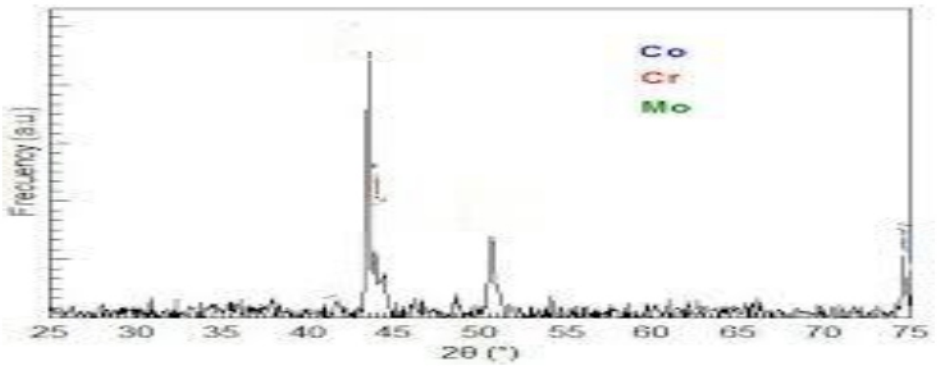


Fig 2 (i)The XRD of Co-Cr-Mo at 2θ

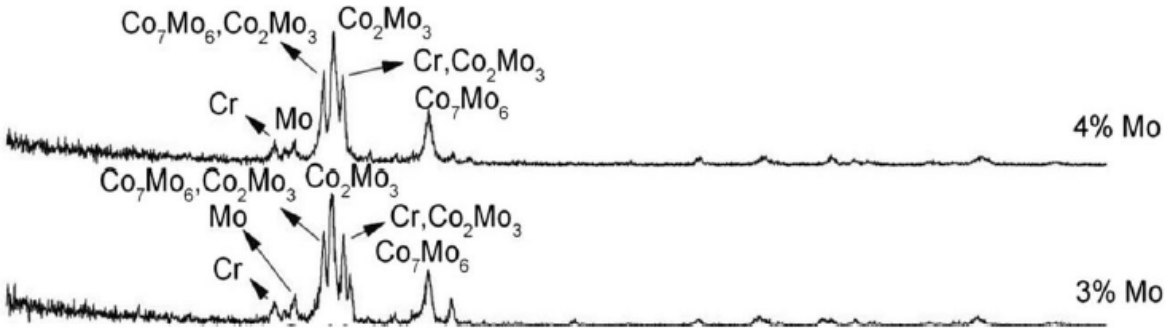


Fig. 2 (ii) XRD patterns of molybdenum content of F75 Co-Cr-Mo

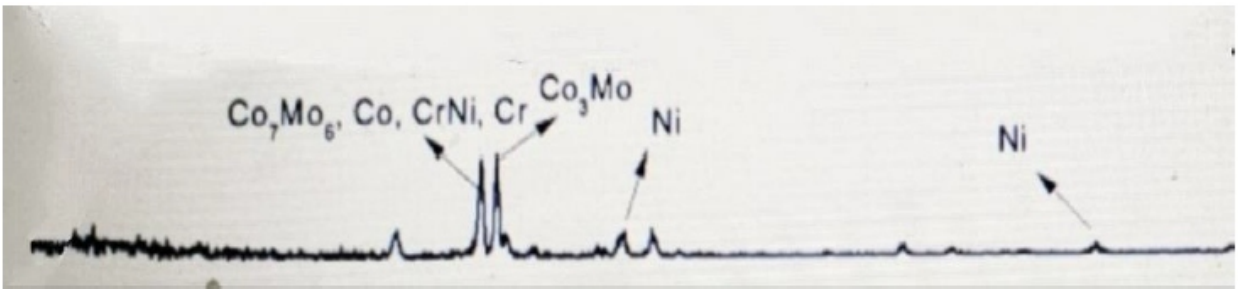


Fig. 2 (iii) XRD patterns of the content of Co-Ni-Cr-Mo

The XRD pattern for Co-Cr-Mo in Fig 2(ii) indicate the overlapping of peak of Cr-Ni in Fig2 (iii) of nickel and chromium [8].

3.2 SEM Image

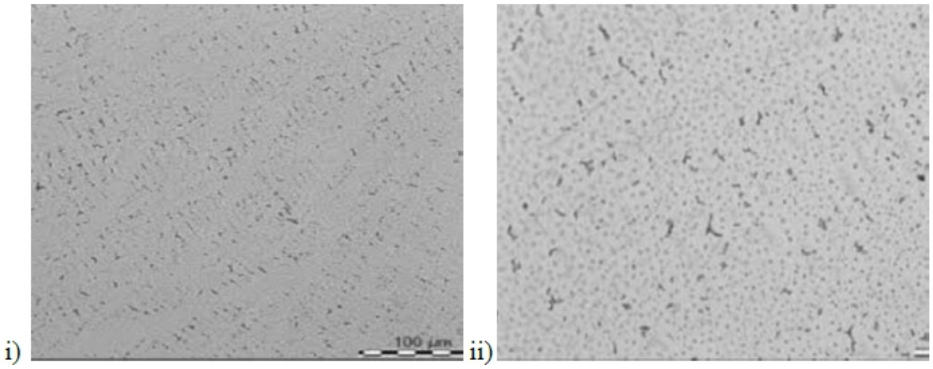


Fig 3 (i) and (ii) SEM Image for F75 Co-Cr-Mo and Co-Ni-Cr-Mo Respective, before applying Radiation

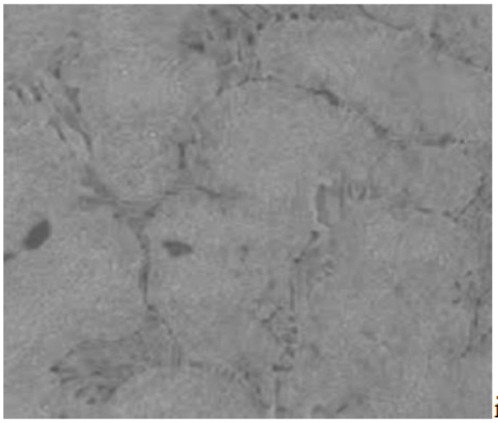
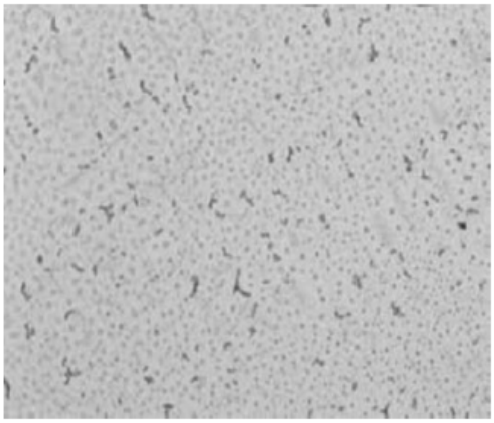
iii)  iv) 

Fig 3 (iii) and (iv) SEM Image for F75 Co-Cr-Mo and Co-Ni-Cr-Mo Respectively, after the effect of Radiation In The SEM image it is believed that the micro-packing of the Mo particulates in the alloys can provide superior mechanical integrity which causes the hardness value to be increased. The hardness of M-4 (4 wt.% Mo) as stated in [4].

3.2 Influence of Molybdenum Content on Hardness, Physical and mechanical properties

The mechanical properties decide the type of material that will be selected for a specific application. Some of the properties that are of prime importance are hardness, tensile strength. The effect of molybdenum content on hardness of the F75 Co-Cr-Mo and Co-Ni-Cr-Mo Biomaterials is effect of adding various amount of molybdenum to the matrix on the density, mechanical strength. The results showed the in Fig 3(iii) Shows increase in hardness, and mechanical strength by increase in molybdenum content in the base alloy. Meanwhile, the corrosion rate was reduced by addition of molybdenum weight percentages. However, for wear characteristics mostly a certain magnitude of Mo (4 wt.%) caused better performance than the base alloy under various testing conditions. Since no single alloy could merely fulfill all the desired Characteristics similar was reported with tungsten in [2]. As seen in XRD pattern and SEM images and contributed effectively in increase of the implant material's hardness.

4. CONCLUSION

These study on comparative study between the effects of radiation on f75 co-cr-mo and cr-ni-cr-mo biomaterials by the application of micro tomography x-rays. the microstructure and damage mechanisms in our studied biomaterial are observed by application of microtomography technique, that help us to visualize clearly the initial microstructure at a suitable resolution and when coupled with in mechanical properties experiments, It also shows quantitative differences between what can be derived from surface observations in SEM image and what is actually happening in the bulk of the studied materials as in slice tomography. The XRD diffractograms for each material are presented in Fig. 2(i-iii) It can be seen that the microstructure of 0-4 wt% Mo consists of a Co matrix with Cr regions. It is clear that the Co, in alliance with oxide forms CoxOy in the micro structure as stated in [1]. Which showed Cobalt-based alloys is one of the only alloys with its good corrosion resistance and good mechanical strength in chloride environments, which is due to alloying additions and the formation of the chromium oxide passive layer. Microscopic observation of the F75 Co-Cr-Mo and Co-Ni-Cr-Mo showed same structure before and after the effect of radiation (see Fig. 3(i)–(iv)). It was found that the mechanical properties such as hardness of the material enhanced after adding certain amount of molybdenum content in a beneficial way. In the future, we can anticipate to see a biomaterials developed that will increase the span of orthopedics implants life. In which less reaction will achieved, to get these a collaboration between material scientist/engineers, biologist is highly needed

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Conflict of interest

The authors have no conflict of interest to report.

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Spectral and Raman Analysis of SM^{3+} IONS Doped Zinc Lithium Cadmium Borophosphate Glasses

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A B S T R A C T

Glass of the system: (45-x) P_2O_5:10ZnO:10Li_2O:10CdO:25B_2O_3:xSm2O_3. (where x=1, 1.5,2 mol %) have been prepared by melt-quenching method (where x=1,1.5,2 mol%) have been prepared by melt-quenching technique. The amorphous nature of the prepared glass samples was confirmed by X-ray diffraction. The absorption spectra of three Sm^{3+} doped zinc lithium cadmium borophosphate glasses have been recorded at room temperature. The various interaction parameters like Slater-Condon parameters F^k (k=2,4,6), Lande parameters (ξ_{4f}), nephelauexetic ratio (β'),bonding parameters ($b^{1/2}$)and Racah parameters E^k(k=1,2 3) have been computed. Judd-Ofelt intensity parameters and laser parameters have also been calculated.

Keywords: ZLCBP Glasses, Thermal Properties, Optical properties, Raman analysis.

I. INTRODUCTION

Rare earth glasses have attracted much attention, because they have many applications in many fields, such as glass lasers, optical fiber amplifiers, electro-luminescent devices, and memory devices [1–7]. Besides the usual suitable features of oxide glasses, such compositions present high density and high linear and nonlinear refractive indexes, broad transmission window and low phonon energy enabling applications in several optoelectronic devices. B2O3 is one of the most common glass former oxides. It is often used as a dielectric and insulating material [8]. Among different glass hosts, phosphate glasses have unique properties. They have high thermal stability, high transparency, a low melting point, a high gain density, low dispersion rates , chemical properties and excellent optical properties [9-12]. Samarium doped oxide glasses have awaken technological interest due to their potential use as laser active media with emissions in the visible and near infrared spectral regions for high power, amplifying, optical reading and other applications [13-16]. Due to low melting point (Tm) and glass transition temperature (Tg) Sm3+ doped glasses are comparatively easier than other glass families.

The aim of the present study is to prepare the Sm3+ doped zinc lithium cadmium borophosphate glass with different Sm2O3 concentrations. The absorption spectra, fluorescence spectra of Sm3+of the glasses were investigated. The Judd-Ofelt theory has been applied to compute the intensity parameters Ωλ (λ=2, 4, 6).These intensity parameter have been used to evaluate optical optical properties such as spontaneous emission probability, branching ratio, radiative life time and stimulated emission cross section. Large stimulated emission cross section is one of the most important parameters required for the design of high peak power solid state lasers.

II. EXPERIMENTAL TECHNIQUES

Preparation of glasses

The following Sm^{3+} doped zinc lithium cadmium borophosphate glass samples (45-x) P_2O_5:10ZnO:10Li_2O:10CdO:25B_2O_3:xSm_2O_3. (where x =1, 1.5, 2) have been prepared by meltquenching method. Analytical reagent grade chemical used in the present study consist of P_2O_5, ZnO, Li2O, CdO, B_2O_3 and Sm_2O_3. They were thoroughly mixed by using an agate pestle mortar. then melted at 10650C by an electrical muffle furnace for 2h., After complete melting, the melts were quickly poured in to a preheated stainless steel mould and annealed at temperature of 250^0C for 2h to remove thermal strains and stresses. Every time fine powder of cerium oxide was used for polishing the samples. The glass samples so prepared were of good optical quality and were transparent. The chemical compositions of the glasses with the name of samples are summarized in Table 1.

Table 1

Chemical composition of the glasses

Sample	Glass composition (mol %)
ZLCBP (UD)	45P2O5:10ZnO:10Li2O:10CdO:25B2O3
ZLCBP (SM1)	44 P2O5:10PbO:10Li2O:10K2O:10Nb2O5:20B2O3:1Sm2O3
ZLCBP (SM 1.5)	43.5 P2O5:10PbO:10Li2O:10K2O:10Nb2O5:20B2O3:1.5Sm2O3
ZLCBP (SM 2)	43P2O5:10PbO:10Li2O:10K2O:10Nb2O5:20B2O3:2Sm2O3
ZLCBP (UD) - specimens.	Represents undoped Zinc Lithium Cadmium Borophosphate glass
ZLCBP (SM) - specimens.	Represents Sm^{3+} doped Zinc Lithium Cadmium Borophosphate glass

III. THEORY

3.1 Oscillator Strength

The intensity of spectral lines are expressed in terms of oscillator strengths using the relation [17].

$$f_{expt.} = 4.318 \times 10^{-9} \int \varepsilon(\nu)\, d\nu \qquad (1)$$

where, ε (ν) is molar absorption coefficient at a given energy ν (cm^{-1}), to be evaluated from Beer–Lambert law.

$$P_m = 4.6 \times 10^{-9} \times \frac{1}{cl} \log \frac{I_0}{I} \times \Delta\upsilon_{1/2} \qquad (2)$$

where c is the molar concentration of the absorbing ion per unit volume, I is the optical path length, $\log I_0/I$ is optical density and $\Delta\upsilon 1/2$ is half band width.

3.2. Judd-Ofelt Intensity Parameters

According to Judd [19] and Ofelt [20] theory, independently derived expression for the oscillator strength of the induced forced electric dipole transitions between an initial J manifold $|4f^N (S, L) J>$ level and the terminal J' manifold $|4f^N (S', L') J'>$ is given by:

$$\frac{8\Pi^2 mc\bar{\upsilon}}{3h(2J+1)} \frac{1}{n} \left[\frac{(n^2+2)^2}{9}\right] \times S(J, J') \qquad (3)$$

Where, the line strength S (S', L') is given by the equation

$$S(J, J') = e^2 \sum_{\lambda=2,4,6} \Omega_\lambda \langle 4f^N(S, L)\, J \| U^{(\lambda)} \| 4f^N(S', L')\, J' \rangle^2$$

In the above equation m is the mass of an electron, c is the velocity of light, ν is the wave number of the transition, h is Planck's constant, n is the refractive index, J and J' are the total angular momentum of the initial and final level respectively, Ω_λ ($\lambda = 2, 4, 6$) are known as Judd- Ofelt intensity parameters .

3.3 Radiative Properties

The Ω_λ parameters obtained using the absorption spectral results have been used to predict radiative properties such as spontaneous emission probability (A) and radiative life time (τ_R), and laser parameters like fluorescence branching ratio (β_R) and stimulated emission cross section (σ_p).

The spontaneous emission probability from initial manifold $|4f^N (S', L')\, J'\rangle$ to a final manifold $|4f^N (S, L)\, J\rangle$ is given by:

$$A[(S', L')\, J'; (S, L)\, J] = \frac{64\pi^2\nu^3}{3h(2J'+1)} \left[\frac{n(n^2+2)^2}{9}\right] \times S(J', J) \qquad (4)$$

where, $S(J', J) = e^2 [\Omega_2 \| U^{(2)} \|^2 + \Omega_4 \| U^{(4)} \|^2 + \Omega_6 \| U^{(6)} \|^2]$

The fluorescence branching ratio for the transitions originating from a specific initial manifold $|4f^N (S', L')\, J'\rangle$ to a final many fold $|4f^N (S, L)\, J\rangle$ is given by

$$\beta[(S', L')\, J'; (S, L)\, J] = \sum_{S\,L\,J} \frac{A[(S'\ L)]}{A[(S'\,L')\,J'(\bar{S}\ L)]} \qquad (5)$$

where, the sum is over all terminal manifolds.

The radiative life time is given by

$$\tau_{rad} = \sum_{S\,L\,J} A[(S', L')\, J'; (S, L)] = A_{Total}^{-1} \qquad (6)$$

where, the sum is over all possible terminal manifolds. The stimulated emission cross -section for a transition from an initial manifold $|4f^N (S', L')\, J'\rangle$ to a final manifold $|4f^N (S, L)\, J\rangle$ is expressed as

$$\sigma_p(\lambda_p) = \left[\frac{\lambda_p^4}{8\pi c n^2 \Delta\lambda_{eff}}\right] \times A[(S', L')\, J'; (\bar{S}, \bar{L})\bar{J}] \qquad (7)$$

where, λ_p the peak fluorescence wavelength of the emission band and $\Delta\lambda_{eff}$ is the effective fluorescence line width.

3.4 Nephelauxetic Ratio (β) and Bonding Parameter ($b^{1/2}$)

The nature of the R-O bond is known by the Nephelauxetic Ratio (β') and Bonding

Parameters ($b^{1/2}$), which are computed by using following formulae [21, 22]. The Nephelauxetic Ratio is given by

$$\beta' = \frac{\nu_g}{\nu_a} \qquad (8)$$

where, ν_a and ν_g refer to the energies of the corresponding transition in the glass and free ion, respectively. The values of bonding parameter $b^{1/2}$ are given by

$$b^{1/2} = \left[\frac{1-\beta'}{2}\right]^{1/2} \quad (9)$$

IV. RESULT AND DISCUSSION

4.1 XRD Measurement

Figure 1 presents the XRD pattern of the sample contain - P_2O_5 which is show no sharp Bragg's peak, but only a broad diffuse hump around low angle region. This is the clear indication of amorphous nature within the resolution limit of XRD instrument.

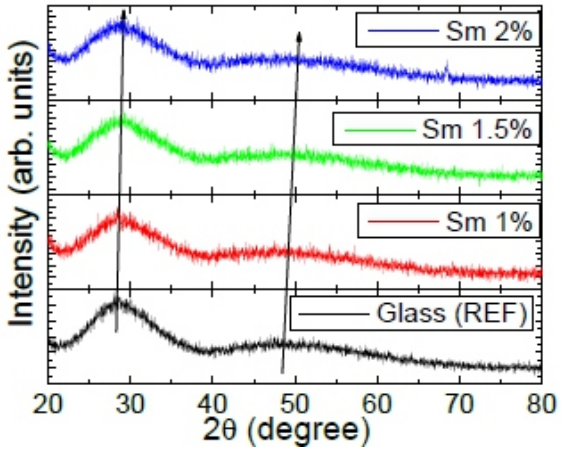

Fig. 1: X-ray diffraction pattern of P_2O_5:ZnO:Li_2O:CdO:B_2O_3:Sm_2O_3

4.2 Raman spectra

The Raman spectrum of Zinc Lithium Cadmium Borophosphate (ZLCBP) glass specimens is recorded and is shown in Fig. 2. The spectrum peaks located at 395 and 775 cm^{-1}. The band at 395 $cm^{-1}$is is related to the bending motion of phosphate polyhedral PO_4 units with cation like ZnO as the modifier. The broad band at 775 cm^{-1} is due to symmetric stretching of (P–O–P) bridging oxygen bonds in $(P_2O_7)_4$ units.

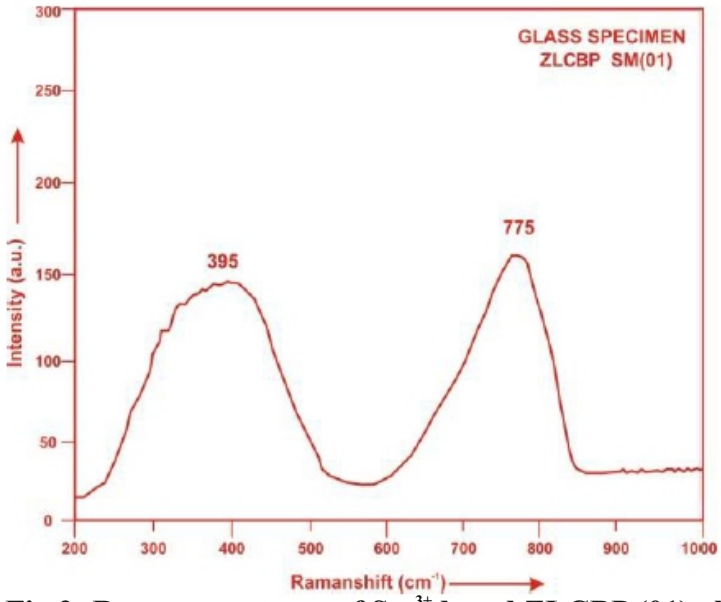

Fig.2: Raman spectrum of Sm^{3+}doped ZLCBP (01) glass.

4.3 Absorption Spectrum

The absorption spectra of Sm^{3+} doped ZLCBP (SM 01) glass specimen has been presented in Figure 3 in terms of optical density versus wavelength (nm). Ten absorption bands have been observed from the ground state $^6H_{5/2}$ to excited states $^6F_{1/2}$, $^6F_{7/2}$, $^6F_{9/2}$, $^4G_{7/2}$, $^4I_{9/2}$, $^4M_{7/2}$, $(^6P,^4P)_{5/2}$, $^4F_{7/2}$, $^4D_{1/2}$, and $(^4D,^6P)_{5/2}$ for Sm^{3+} doped ZLCBP glasses.

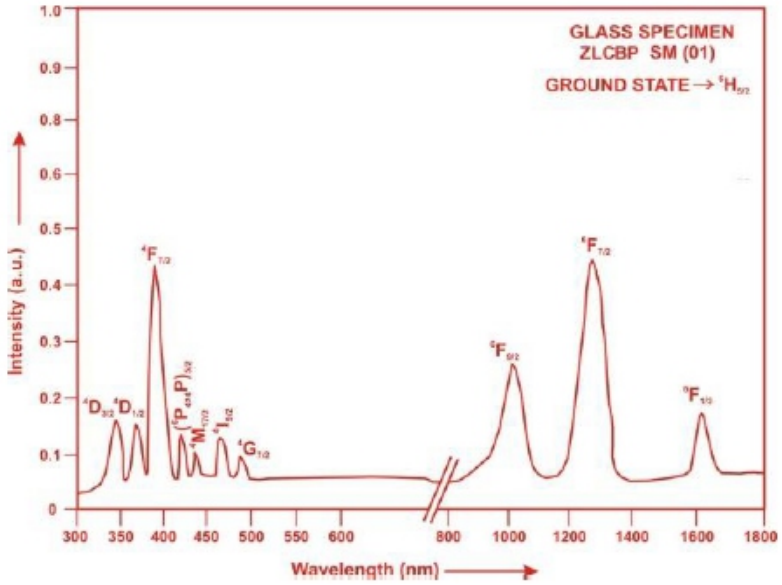

Fig.3: Absorption spectrum of Sm^{3+} doped ZLCBP (01) glass.

The experimental and calculated oscillator strengths for Sm^{3+} ions in zinc lithium cadmium borophosphate glasses are given in Table 3

Table3: Measured and calculated oscillator strength ($P_m \times 10^{+6}$) of Sm^{3+} ions in ZLCBP glasses.

Energy level from $^6H_{5/2}$	Glass ZLCBP (SM01)		Glass ZLCBP (SM1.5)		Glass ZLCBP (SM02)	
	$P_{exp.}$	$P_{cal.}$	$P_{exp.}$	$P_{cal.}$	$P_{exp.}$	$P_{cal.}$
$^6F_{1/2}$	1.64	1.68	1.61	1.66	1.58	1.64
$^6F_{7/2}$	5.48	5.55	5.42	5.50	5.39	5.49
$^6F_{9/2}$	3.88	3.88	3.84	3.85	3.81	3.83
$^4G_{7/2}$	0.18	0.12	0.15	0.12	0.13	0.12
$^4I_{9/2}$,$^4M_{15/2}$,$^4I_{11/2}$	1.18	1.90	1.12	1.88	1.08	1.87
$^4M_{17/2}$,$^4G_{9/2}$,$^4I_{15/2}$	0.29	0.25	0.25	0.25	0.21	0.24
$(^6P,^4P)_{5/2}$,$^4L_{13/2}$	1.34	1.30	1.31	1.29	1.27	1.29
$^4F_{7/2}$,$^6P_{3/2}$,$^4K_{11/2}$	5.58	5.57	5.51	5.54	5.47	5.53
$^4D_{1/2}$,$^6P_{7/2}$,$^4L_{17/2}$	2.49	2.46	2.42	2.44	2.38	2.43
$^4D_{3/2}$, $(^4D,^6P)_{5/2}$	2.59	3.46	2.56	3.44	2.51	3.43
r.m.s. deviation	0.3599		0.3696		0.3869	

Computed values of F_2, Lande′ parameter (ξ_{4f}), Nephlauxetic ratio (β') and bonding parameter($b^{1/2}$) for Sm^{3+} doped ZLCBP glass specimen are given in Table 4.

Table 4. F2, ξ4f, β' and $b^{1/2}$ parameters for Samarium doped glass specimen.

Glass Specimen	F_2	ξ_{4f}	β'	$b^{1/2}$
Sm^{3+}	358.82	1258.16	0.9337	0.1821

Judd-Ofelt intensity parameters Ω_λ (λ=2,4,6) were calculated by using the fitting approximation of the experimental oscillator strengths to the calculated oscillator strengths with respect to their electric dipole contributions. In the present case the three Ω_λ parameters follow the trend $\Omega_2 > \Omega_4 > \Omega_6$. The spectroscopic quality factor (Ω_4/Ω_6) related with the rigidity of the glass system has been found to lie between 1.081 and 1.099 in the present glasses.

The value of Judd-Ofelt intensity parameters are given in Table 5

Table5: Judd-Ofelt intensity parameters for Sm^{3+} doped ZLCBP glass specimens.

Glass Specimen	$\Omega_2(pm^2)$	$\Omega_4(pm^2)$	$\Omega_6(pm^2)$	Ω_4/Ω_6	Ref.
ZLCBP (SM01)	4.663	4.117	3.845	1.0707	[P.W.]
ZLCBP (SM1.5)	4.599	4.089	3.807	1.0741	[P.W.]
ZLCBP (SM02)	4.535	4.082	3.787	1.0779	[P.W.]
ST(SM)	1.584	0.544	0.394	1.381	[23]
Phosphotellurite	4.54	1.12	1.34	0.84	[24]

4.4. Fluorescence Spectrum

The fluorescence spectrum of Sm^{3+}doped in zinc lithium cadmium borophosphate glass is shown in Figure 4. There are five broad bands observed in the Fluorescence spectrum of Sm^{3+} doped zinc lithium cadmium borophosphate glass. The wavelengths of these bands along with their assignments are given in Table 6. Fig. (4).Shows the fluorescence spectrum with five peaks ($^4G_{5/2} \rightarrow {}^6H_{5/2}$), ($^4G_{5/2} \rightarrow {}^6H_{7/2}$), ($^4G_{5/2} \rightarrow {}^6H_{9/2}$), ($^4G_{5/2} \rightarrow {}^6H_{11/2}$) and ($^4G_{5/2} \rightarrow {}^6H_{13/2}$), respectively for glass specimens.

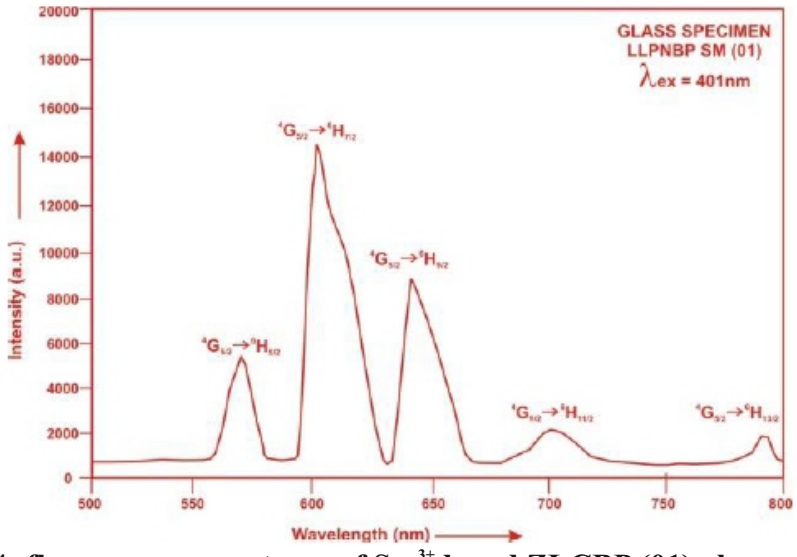

Fig.4: fluorescence spectrum of Sm^{3+}doped ZLCBP (01) glass.

Table 6. Emission peak wave lengths (λ_p),radiative transition probability (A_{rad}),branching ratio (β),stimulated emission cross-section(σ_p) and radiative life time(τ_R) for various transitions in Sm^{3+} doped ZLCBP glasses.

Transition		ZLCBP SM 01				ZLCBP SM 1.5				ZLCBP SM 02			
	λ_{max} (nm)	A_{rad} (s^{-1})	β	σ_p (10^{-20} cm^2)	τ_R(μs)	A_{rad} (s^{-1})	β	σ (10^{-20} cm^2)	τ_R(μs)	A_{rad} (s^{-1})	β	σ_p (10^{-20} cm^2)	τ_R(μs)
$^4G_{5/2}\rightarrow{}^6H_{5/2}$	562	12.28	0.0407	0.00402	3310.87	12.16	0.0407	0.0043	3344.57	12.146	0.0407	0.0492	3351.52
$^4G_{5/2}\rightarrow{}^6H_{7/2}$	602	129.27	0.4279	0.0453		128.42	0.4295	0.0485		128.15	0.4295	0.0521	
$^4G_{5/2}\rightarrow{}^6H_{9/2}$	645	125.84	0.4166	0.0437		123.97	0.4146	0.0453		123.69	0.4146	0.0477	
$^4G_{5/2}\rightarrow{}^6H_{11/2}$	705	31.60	0.1046	0.0134		31.42	0.1051	0.0139		31.37	0.1051	0.0145	
$^4G_{5/2}\rightarrow{}^6H_{13/2}$	786	3.042	0.0101	0.00177		3.017	0.0101	0.00183		3.007	0.0101	0.001884	

V. CONCLUSION

In the present study, the glass samples of composition (45-x) P_2O_5:10ZnO:10Li_2O:10CdO:25B_2O_3:xSm_2O_3. (where x=1, 1.5, 2mol %) have been prepared by melt-quenching method. The Judd-Ofelt theory has been applied to calculate the oscillator strength and intensity parameters Ω_λ (λ=2, 4, 6). The radiative transition probability, branching ratio are highest for ($^4G_{5/2}\rightarrow{}^6H_{7/2}$) transition and hence it is useful for laser action. The stimulated emission cross section (σ_p) has highest value for the transition ($^4G_{5/2}\rightarrow{}^6H_{7/2}$) in all the glass specimens doped with Sm^{3+} ion. This shows that ($^4G_{5/2}\rightarrow{}^6H_{7/2}$) transition is most probable transition.

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Determinants of Urban Households Saving: The Case of Wolaita Sodo Town, Southern Ethiopia

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ABSTRACT

The study was conducted to identify Determinants of Urban Households Savings in Wolaita Sodo town. Data for the research was collected from 240 urban households from four Kebeles. Data was collected using both primary and secondary sources; the multi-stage technique was used to meet with the study points. To attain the study's stated objectives used different data analysis methods, i.e. descriptive analysis and econometric analysis to identify independent variables' effect on the dependent variable. With descriptive analysis percentages, graphs, charts and tables were presented, which affects household saving. The result shows that 51(21.25%) of respondents were under age category 20-29; the 161(67.08%) of respondents were age category 30-64, and 28(11.67%) of the respondents were age greater than 64. According to table 4.1, most of the respondents were under age category 30 to 64, and their response to saving is highest than the rest of the age category. Out of 240 households, 32.92% were with family size 0 to 3, 58.75% household's family size 4 to 6 and the remaining 8.33% household's family size greater than 6. In logistic regression analyses, the variables positively related to the probability of saving are household education, marital status, sex, annual expenditure, interest rate, credit, and annual income. The variables that are negatively correlated with the probability of saving are family size, age, distance from the financial institution, and distance from market and transaction cost. In the table above out of 12 explanatory variables, 8 of the variables, family size, household education level, distance from the market, sex, interest rate, transaction cost, credit access, and annual income have a significant effect on the urban households saving at the significance level at 1 per cent, 5 per cent and 10 per cent.

Keywords: Households, Saving, Binary Logit Model, Income, Expenditure

INTRODUCTION

Background

Saving has been considered one of the factors affecting growth to lead the developing countries to the path of development. In developing countries, savings are essential factors of households' welfare. On the other hand, without savings, households have few different mechanisms to smooth out unexpected income variations. For individuals and households, savings provide a cushion of security against future contingencies, whereas national savings provide the funds needed in the developmental efforts (Gedela, 2012). Besides, saving enable households to maintain a relatively stable lifetime level of living. It is also likely that households refrain from current consumption to save for payment for children's education.

In many developing economies, particularly Africa, saving and investment are necessary engines for capital formation. It has been argued that saving constitutes the basis for capital formation and capital formation constitutes a critical factor of economic growth. However, available statistics indicate low saving mobilization base and investment in this part of the world (Issahaku, 2011). As a result, economists, international organizations, and governments in developing countries have emphasised the mobilization of deposits to increase urban households' savings and achieve sustained economic growth and development (Kifle, 2012).

Saving defines putting as idea part of current income, to consume or invest it later on. The money saved can be kept at home, deposited in a savings account or invested in different capital types. Because many low-income households in developing countries have a small informal family business or a farm, they invest part of their savings in the production unit, to increase future income. Saving refers to the fraction of income not instantly consumed but kept for future investment, consumption or unforeseen contingencies in the future. It is vital in improving individuals' well-being and serves as security at the times of shocks for the households. Saving is being seen as a method of diminishing the risk resulting from the inability to predict the future and act as a precaution (ibid).

According to Popovici (2012), unexpected events in individuals' life-cycle make saving an essential element in fulfilling the financial gap. Household savings could be intended to address household expenditure, but urban households are constrained due to seasonality of cash flows, work culture, and income, resulting in seasonal and irregular savings. Saving mobilization is also critical for individual welfare in that, at the individual level, it helps households' smoothen their consumption and finance productive investments in human and business capital Karlan et al. (2013).

Objectives

The general objective of the study is to assess factors affecting urban households' savings in Sodo town. The specific objectives were to identify forms of savings used by urban households and to identify the significant factors affecting urban households' savings in the study area.

METHODOLOGY

Description of the Study Area

This study was undertaken in Wolaita Sodo Town, which is located in Wolaita zone. The zone is one of the zones in SNNPR. It borders with Gamo Gofa zone in the South, With Dawro Zone in the West, with Sidama region in the East, with Kamabata &Tamabro and Hadiya Zones North with Oromia regional state in the Northern East. The total area of the zone is 4,471.3 km² or 447130 hectares. The zone is classified into 16 woredas and 6 towns, including Wolaita Sodo town (WZFED, 2013).

In the administrative hierarchy, the Town has equal status with other woredas. Spatially the Town is surrounded in ZodoZuria woreda. Wolaita Sodo Town is located at a distance of 329 km and 170 km south-west of Addis Ababa and Awassa. Astronomically, the Town is situated $6^0$46'_$6^0$53'North latitude and $37^0$42'_$37^0$56' East longitude. The altitude of the Town ranges from 1784_ 2346 meters above sea level. The Town's mean annual temperature is 200c, and the mean annual rainfall is 1,212 mm (STMO, 2013).

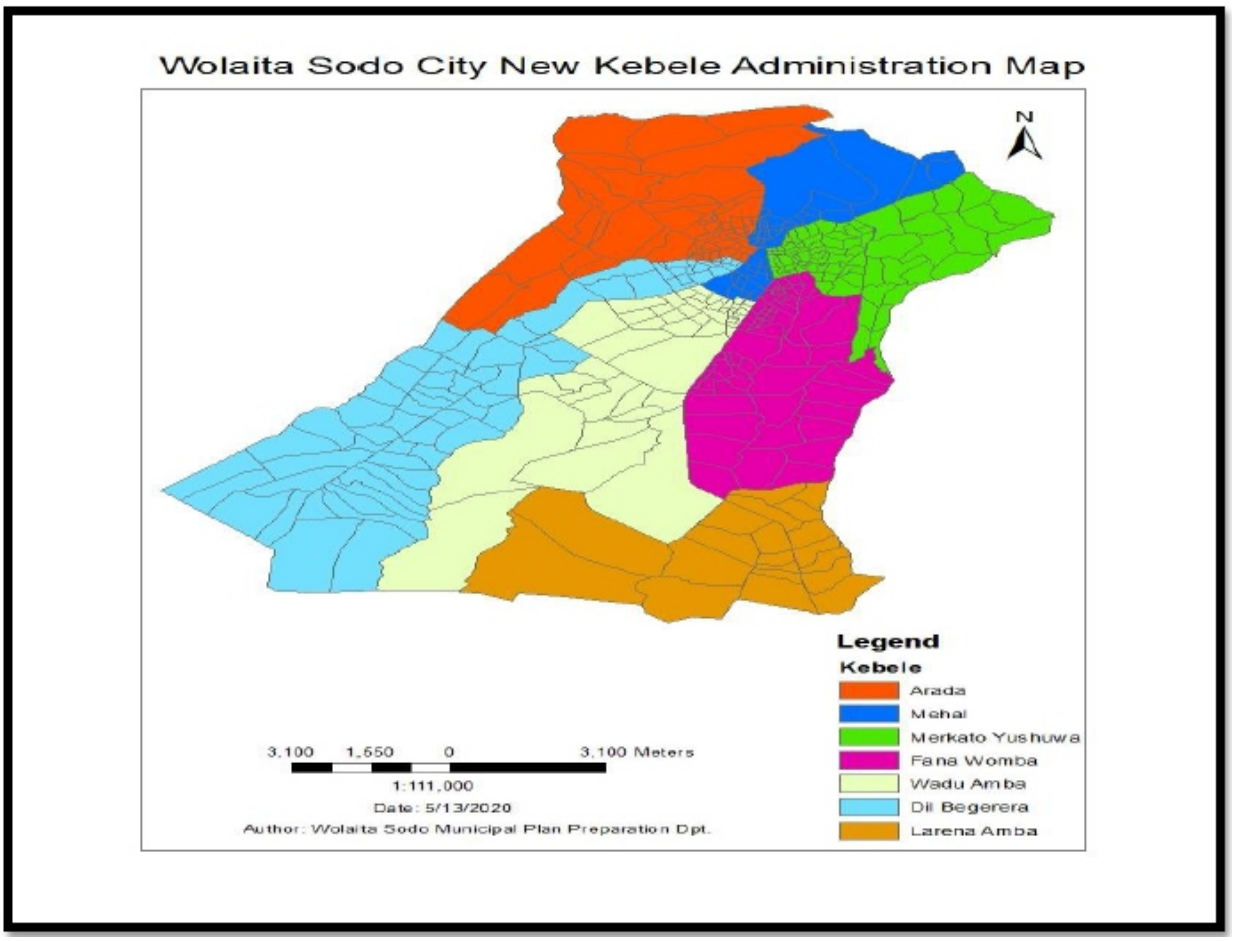

Figure 1: Map of the Wolaita Sodo City
Source: Sodo Town Municipality Office (2013)

Research Design

The study's primary focus was on describing information related to saving urban households by collecting cross-sectional data from the study area. So, the research method used for the study was descriptive research design to answer research questions. Moreover, the Binary logistic regression model was applied for independent or explanatory variables, which will significantly affect urban households' saving status.

Data Source

The study was used in both primary and secondary source of data. The primary source of data was derived from the answers that respondents were given in the interview schedule. The primary data source was used to obtain information related to the households' demographic characteristics and forms of savings used by urban households.

The interview schedule was used as a data collection method for the two objectives to collect quantitative data, whereas the Focus Group Discussion was conducted to collect qualitative data.

The Focus Group Discussion was used to obtain additional qualitative information on factors affecting urban households saving besides the interview schedule's data.

The researcher was administered the focus group discussion by telling the study's objectives and asking permission from financial institutions. On the other hand, secondary data was derived from the findings stated in published and unpublished documents and works of literature related to the research problem. It was taken from the recent literatures such as; articles, journals, reports, working papers, books, and internet sources related to urban households savings. Information related to factors influencing urban households' savings was collected from secondary sources of data.

Sample Size Determination

This study was conducted at the household level; i e. the unit of analysis was household. The sampling frame or the total population from which the required number of sample drawn was the total number of households found at four kebeles, a total of 240 respondents were surveyed.

This 240, the sample is determined using the minimum sample size formula

$$n_r = \left(\frac{1.98)^2 pq}{d^2}\right) \quad \ldots\ldots 1$$

Sampling Technique

In the study area, the household is responsible for making day to day decision on their activities. Thus, households were the basic units of the sample. Multi-stage sampling techniques were used to generate the required primary data. At the first stage, Sodo town was selected purposively.

In the second stage, out of 4 Kebeles within the Town, four Kebeles were selected by random sampling techniques. A probability proportionate size technique(s) was employed to determine sample size from each Kebele, and finally, 240 households were selected using systematic random sampling.

Method of Data Analysis

The tools for quantitative data analysis were descriptive statistics. Percentages, frequencies, mean and standard deviation were employed for demographic variables and objective one. The chi-square test was used to identify the relationship between urban households' saving status and dummy independent variables. The t-test was used to test the differences between urban households' saving status and continuous independent variables. Moreover, Binary logistic regression analysis was applied for identifying significant factors affecting urban households saving. The qualitative data which was gathered through Focus Group Discussion was analyzed through narration and description.

Two types of data analysis, namely descriptive statistics and econometrics models, were used to analyze the households' data. Quantitative categorical kinds of data were analyzed using percentage, frequency. Simultaneously, continuous quantitative types of variables were minimum, maximum, mean and standard deviation. After computing the descriptive statistics, Binary logistic regression was used to identify household savings determinants where the dependent variable was found to be a binary outcome.

The data analysis was conducted using the statistical package that is STATA 11.

Table 1: Number of Kebeles with their total Population and their sampled Households

S. No.	Name of the Kebeles	Total Population	Total Household	Proportion	Sample Household
1	Wadu Amaba	25264	5156	0.175	42
2	Dil Begerera	33397	6816	0.231	55
3	Arada	58757	11991	0.408	98
4	Merkato Yushuwa	26803	5470	0.186	45
Total		**144,221**	**29,433**	**1**	**240**

Binary Logit Model Specification

Logistic regression analysis examines various factors on a dichotomous outcome by estimating the events' probability. The logit model was used when the dependent variable is binary (also called dummy) which takes values 0 or 1. It is a non –linear regression model that forces the output (predicted value) to be either 0 or 1. This model's parameters were estimated using the maximum likelihood estimation rather than the movement estimation in which Ordinary least square regression technique relies on.

The logit method gives parameter estimates that are asymptotically efficient and consistent. Indeed, the logit approach is known to produce statistically sound results (Gujarati, 2004). The logit model usually takes two forms. It may be expressed in terms of logit or terms of event probability. When described in logit form, the model is specified as

$$\log\left(\frac{p(y=1}{1-p(y=1}\right)= \sum_{k=1}^{k} B_K X_K \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .1$$

This particular study deal about the probability to save or not and this expressed in mathematical form as follows

$$\Pr(y=\tfrac{1}{x}) = pr(y=1) = \frac{e^{\sum_{k=1}^{k} B_K X_K}}{1+e^{\sum_{k=1}^{k} B_K X_K}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .2$$

The above equation represents the probability of an event occurring. For a non-event, the probability is just 1 minus the event probability.

$$pr(y=\tfrac{1}{x}) = pr(y=0) = \frac{e^{-\sum_{K=1}^{K} B_K X_K}}{1+e^{-\sum_{K=1}^{K} B_K X_K}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots .3$$

The equation is of the form:

$$y_i = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_k x_k + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where;

y_i= probability of household to save in financial institutions

α= Intercept (constant) term

β_k=Coefficient of the explanatory variable

x_k= Explanatory variables

ε = Disturbance (Stochastic) term.

Logit model estimates the probability of the dependent variable to be 1 (y=1). This is the probability that some event happens. The logit model usually takes two forms. It may be expressed in terms of logit or terms of event probability.

Description of the Variables used in the Binary Logit Model and their hypothesis

Dependent Variable: Urban households' Savings Status

The dependent variable has a dichotomous nature measuring urban households' savings status informal financial institutions in 2019/2020. This is to distinguish or discriminate between those savers and non-savers in the study area. It takes a value of 1 if the households save informal financial institutions otherwise 0.

The Explanatory Variables are:

The study considers independent variables that include; education level, sex, age, marital status, family size, annual income, annual expenditure, market distance, distance from financial institutions, access to credit, transactional costs and interest rate) and were defined and hypothesized as follows.

Marital status (MARTS): it is a dummy variable and takes a value of 1 if they are married, 0 if they are single. Marital status has also been shown to affect asset accumulation (Grinstein- Weiss et al., 2006). Historically, marriage has been viewed as a source of financial security and a determining factor for economic well-being.

Education level (EDUL): it is a dummy variable, and 1 is assigned for literate, 0 for illiterate. Education affects saving performance by influencing the level of saving and asset accumulation options available to the household. Kulikov et al. (2007) found that education as a human wealth promotes household saving. Therefore, it was expected that households with a higher probability of saving households positively affected literate households.

Age (AGE): it is a continuous variable, defined as the household heads age at the time of the study measured in years. Rehman et al. (2010) found that age has a positive relationship with household savings. The life-cycle hypothesis suggests that there exists a relationship between age and saving rates. When the age of the households increases their saving status going decreases. Therefore, the expected effect of age on urban households saving was negative

Family Size of the household (FAMSIZE): this is a continuous variable measured by numbers, and it refers to the total number of family members of the household. A household with a high number of dependents in the family has fewer savings. Rehman et al. (2010) found that family size significantly and inversely affecting household saving. The expected effect of family size on urban household saving was negative for households with large family sizes.

Sex (SEX): it is a dummy variable that assumes a value of "1" if the head of the household is male, "0" if they are female. Several studies have shown that sex affects asset accumulation. In Sub-Sahara Africa, women own fewer assets than men (LeBeau et al., 2004). In urban SSA, women's ability to accumulate assets is governed by family and community norms, which historically have favoured men to women's disadvantage. Gedela (2012) found that male-headed households save more than female-headed households. The expected effect of sex on female-headed households was negative.

Market distance (DISTMKT): Here it is assumed to capture the effect of walking distance to the main market centre from home measured in kilometres. Better access to roads expands output markets besides because as farmers locate far from the market, there is limited access to input and output markets and

market information. Moreover, distance to market leads to higher transaction cost, which reduces the benefits accrue to the households. More importantly, the long distance from the market likely discourages the households from participating in market-oriented production that increases their income and is possible to save in financial institutions (Essa et al., 2012). The expected effect on saving was negative.

Distance from Financial institutions (DISTFIN): it is a continuous variable measured in kilometres. Households near financial institutions have a location advantage and can contact quickly and have more access to information than those who live more distant locations. Chemonics International (2007) identified distance as a significant barrier to formal financial saving and other rural areas' markets. As households are far from formal financial institutions, the expected effect on saving was negative.

Annual Income (ANINC): it is a continuous variable and operationalized as the total annual earnings of a family from sale of agricultural produce, off-farm and non-farm activities. Income level shows that when households' income level increases, the saving rate will also increase by some presents. Abdelkhale et al. (2009) indicated that income strongly affects the saving level of the household. The expected effect of this variable on urban household saving was positive.

Annual Expenditure (ANEXP): it is a continuous variable which was measured in Birr. It affects urban households from saving negatively. The more the households spend, their saving reduces. Rehman et al. (2010) indicated that expenditure significantly and inversely affecting household saving. The expected effect of expenditure on urban household saving was negative.

Access to Credit (ACCRT): it is a dummy variable that assumes a value of "1" if the household is credit users and "0" otherwise. Some financial institutions like Omo Micro Finance Institution put saving as the primary principle for credit access from their institution. Therefore, this principle helps urban households to improve their saving status. Households with better access to credit tend to save more than households who do not access credit service.

Interest Rate (IR): The percentage of the balance in a deposit account that the savers receive as income from their deposit. It was measured by the sample households earning as interest from their deposit in a year. The interest could encourage or discourage households, which could influence their willingness to save in financial institutions. In most cases, when the interest rate obtained from saving increases, savers are encouraged to save, which has an expected positive effect on households' savings.

Transactional Costs (TC): Transactional costs are the costs that cover a wide range of informational cost, transportation costs, and consumption costs. It is a continuous variable measured in Birr that the savers spent money while they deposit money informal financial institutions at a time. When the transactional cost is high urban households saving will be reduced. Therefore, the expected effect of this variable on urban household saving was negative.

Table 2: Explanatory Variables and their Expected Sign

Types of Variables	Description of the Variables	Measurement	Expected sign
SAVING	Probability of Saving	Dummy (1= saving, 0 = not-saving)	**Dependant**
AG	Age of the household head	Continuous variable measured in years	-
SEX	Sex of the household head	Dummy(1=male,0=female)	+
FS	Family size of the households	Continuous variable measured in the number	-
MRS	Marital status of household	Dummy(1=married,0=unmarried+ divorced + widowed)	-
EDU	Education of household head	Continuous variable measured in years of schooling	-
DISTFIN	Distance from financial institutions	Continuous measured in KM	-
ANINC	Annual Income	Continuous measured in Birr	+
ANEXP	Annual expenditure	Continuous measured in Birr	-
DISTMKT	Market distance	Continuous measured in KM	-
CRD	Household access to credit	Dummy(1, if the household access credit, 0 otherwise)	+
IR	**Interest rate**	Continuous variable measured in Birr	+
TC	Transaction Cost	Continuous variable measured in Birr	-

RESULTS AND DISCUSSION

This chapter deals with the results of descriptive statistics and logit regression results of the determinants of households saving. The analysis was done in light of the objectives of the study. Section 4.1 deals with descriptive analysis, and section 4.2 presents the results of the econometric analysis.

DESCRIPTIVE ANALYSIS

Table 3: Age distribution of the respondents

Age	Number of Respondents	Percentage
20-29	51	21.25
30-64	161	67.08
>64	28	11.67
Total	**240**	**100**

As the above Table 4.1 indicates, the 51(21.25%) of respondents were under age category 20-29; the 161(67.08%) of respondents were age category 30-64, and 28 (11.67%) of the respondents were age greater than 64. According to table 4.1, most of the respondents were under age category 30 to 64, and their response to saving is highest than the rest of the age category. The adult age can work more hours, and they are more producers rather than the oldest age.

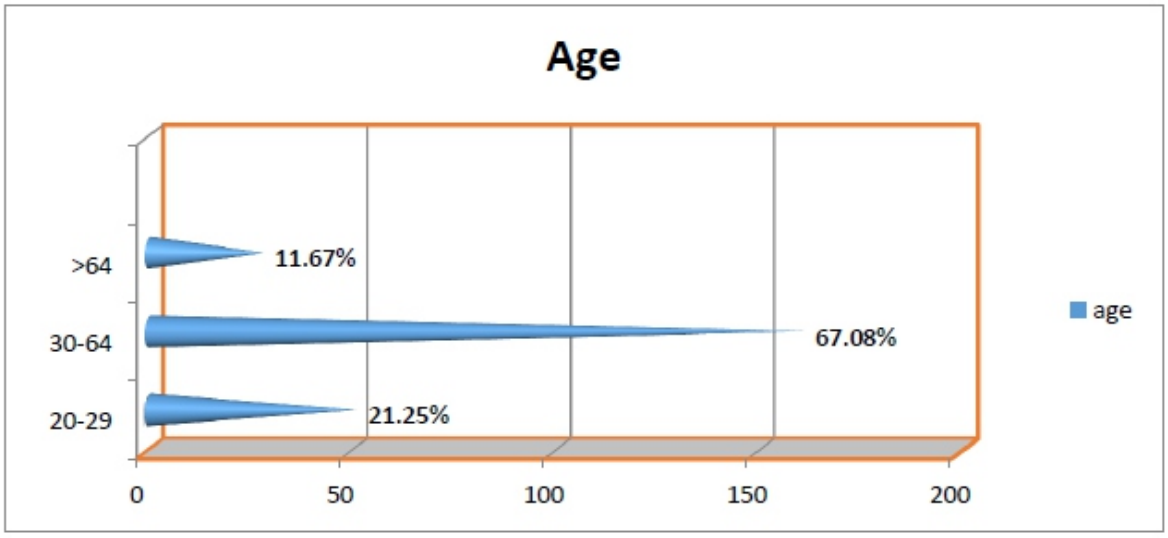

Figure 2: Graph showing the Age Category of the respondents

4.1.2 Education level of respondents

Education level plays a significant role in determining the saving level of households by improving income; by increasing the knowledge of how to use the new technology, how to participate in different income-generating activities, family planning, and improved management of resources. All those are lead to good productivity of the household and can enhance the income level directly related to saving. Due to the lack of access to education, the more significant number of the respondents becomes fewer savers due to poor management of resources, low-income family planning low awareness of the technology. They do not have more knowledge on how to improve the living quality.

Table 4: The distribution of the respondent's on Education level

Education level	Sample unit	Percentage
Illiterate	19	7.91
Grade 1-8	31	12.91
Grade 9-12	79	32.91
Diploma and above	111	46.27
Total	**240**	**100**

Source: own survey 2018

As the above Table 4.2 shows, 19 (7.91%) of the respondents were illiterate, 31(12.91%) of the respondents were completed primary education, 79 (32.91%) of the respondents were completed secondary education and 111 (46.27%) of the respondents' education level diploma and above

According to the table 4.2, the majority of the more significant number of the respondents were educated diploma, and above the level at the same time, their response to saving is highest than other education categories, when we see the illiterate household's response to saving is low due to low awareness to

lifestyle, living quality, inadequate understanding of how to minimize and how to improve the life quality and increase income and saving by involving in other income-generating activities.

Family size of the respondents

Family size is one of the factors determining the saving level in the study area. Out of 240 households, 32.92% had family size 0 to 3, 58.75% with family size 4 to 6 and the remaining 8.33% family size greater than 6. As the finding shows, households with large family save less than households with a lower number. Households with large family number resulted due to lack of awareness of family planning in the study area. A possible interpretation for the finding is for large family size; it is challenging to feed a large family size by one household head. As a result, their consumption level is greater than saving. Typically, large family size has a significant relationship with lower saving, an increase in the household size; the demand for household consumption increases and at the same time, saving decreases.

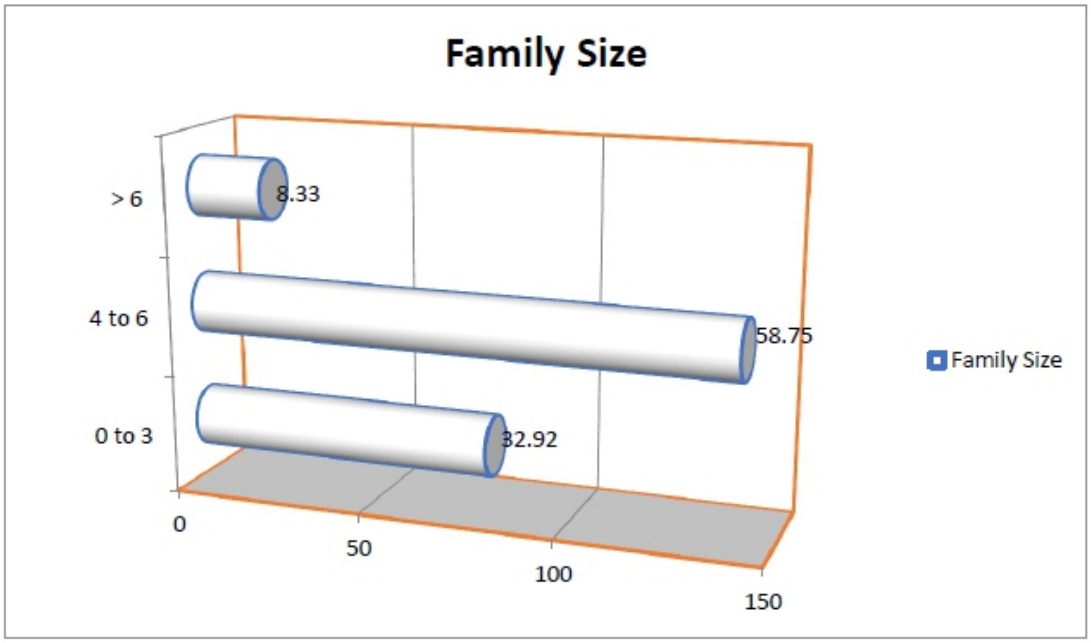

Figure 3 : Diagram showing the Family size of the respondents

Table 5.: Distribution of the respondents on Family size

No. of Family members	Number of Respondents	Percentage
0-3	79	32.92
4-6	141	58.75
Above 6	20	8.33
Total	**240**	**100**

Source: own survey 2019

The above table 4.3 shows that 32.92 per cent of respondents have 0 to 3 families in the household, 58.75% respondents have 4-6 families in the household, and 8.33% have above 6members in the household.

According to Table 4.3, most respondents have a large family size 4 to 6 in the household. They are covered by the greater number of the less saviour respondents than households having family size 0 to 3. Contrary to this, households with family size greater than 6 responded that their response to saving is the lowest.

Econometric Analysis

Model Specification

Before regression of the model, the researcher tasted model specification test, and model specification error can occur when one or more relevant variables are omitted from the model or one or more irrelevant variables are included in the model. It can substantially affect the estimate of regression coefficients. Moreover, in this study, the model specification error was checked by the link test, the test of hat and hatsq were 0.000 and 0.546, respectively. Therefore, it shows that the link test has failed to reject the hypothesis that the model is specified correctly. Accordingly, it seems to us that we don't have a specification error.

In addition to the basic descriptive statistics, the logistic regression model was employed to identify factors affecting household saving in the study area. The variables included in the model were tested for the existence of multi-co linearity if any. Contingency coefficient and variance inflation factor were used for multi-collinearity test of discrete and continuous variables, respectively.

Contingency coefficient value ranges between 0 and 1. A rule of thumb variable with a contingency coefficient below 0.75 shows a weak association and value above indicates a strong association of variables. The contingency coefficient for the discrete variables included in the model was less than 0.75, suggesting multi-collinearity to be a serious concern. As a standard practice, continuous variable having variance inflation factor of less than 10 are believed to have no multi-collinearity, and those with VIF of above 10 are subjected to the problem and should be excluded from the model (Gujarati, 2004)
0

To identify the significant factors affecting household saving in Sodo town, the dependent variable, Probability of saving was regressed against various explanatory variables. The regression table revealed that the binary logistic model managed to predict 71 per cent of the responses correctly.

Apart from per cent correct predictions, the model Chi-Square with "n" degrees of freedom and Hosmer and Lemeshow's are used to test the goodness-of-fit test. Accordingly, p-values associated the Chi-Square with 13 degrees of freedom. The value of .0000 indicates that the model is statistically significant, that shows the model fit the data well.

Another commonly used test of model fit is the Hosmer and Lemesshow's goodness-of-fit test. The Hosmer-Lemesshowgoodiness-of-fit statistic is computed as the Pearson chi-square from the contingency table of observed frequencies and expected frequencies. Like a two-way table test, a good fit as measured by Hosmer and Lemeshow's test yields a large p-value. Therefore in this study, the test result shows that p=1 suggests that the model was correctly fitted with the data. Robust logistic regression was used to control for heteroscedasticity in binary outcome models. Heteroscedasticity in binary outcome models will affect both the "Betas" and their standard errors (Wooldridge, 2001).In this particular study, both regression, i.e. earlier regression and robust logistic regression, have the same result. None of the coefficients changed, but the standard errors and Z values are a little different. Had

there been more heteroscedasticity in these data, would have probably seen the more significant change. Therefore this model is free from heteroscedasticity problem.

Estimation of Factors Affecting Urban Households' Savings in the study area

The binary logit model was used to estimate factors affecting urban households' savings in the study area. The estimation result of the model was presented in the following table:

Logistic regression Number of observation = 240
LR chi2(12) = 136.89
Prob> chi2 = 0.0000
Log likelihood = -97.213547
Pseudo R2 = 0.7119

Table 6 : Binary Logit Model Regression Result

Saving	Co-eff.	Std. Err.	Z	P > z	Odds Ratio
FS	-.604129	.1448078	-4.17	0.000***	0.546550
HHEDU	.7316566	.1655316	4.42	0.000***	2.078521
AGE	-.0100575	.0190163	-0.53	0.597	.9899929
MRS	.0372378	.3777425	0.10	0.921	1.03794
DFIS	-.3167906	.4166227	-0.76	0.447	.7284832
DISMKT	-.9584343	.5764184	-1.66	0.096*	0.383492
SEX	.8065306	.3966268	2.03	0.042**	2.224012
ANEXP	1.331987	1.13332	1.18	0.240	3.78856
IR	-.7229611	.413186	-1.75	0.080*	.485313
TC	-1.366819	.4308968	-3.17	0.002***	.2549165
CREDIT	2.541986	.5187734	4.90	0.000***	12.70488
ANINC	1.453662	.5352693	2.72	0.007***	4.278754

NB: * Significant at 1%, ** Significant at 5% and * Significant at 10%**
Source: Survey result using STATA

In logistic regression analyses, the variables positively related to the probability of saving are family size, household education, marital status, sex, annual expenditure, credit, and annual income. The variables that are negatively correlated with the probability of saving are family size, age, distance from the financial institution, distance from market, interest rate and transaction cost.

In the table above out of 12 explanatory variables, 8 of the variables are household education level, distance from the market, sex, interest rate, transaction cost, credit access, and annual income have a significant effect on the urban households saving at the significance level at 1 per cent, 5 per cent and 10 per cent. The negative values of explanatory variables in the table above indicate that when the unit change in the independent variable leads to a decrease in the probability of saving.

Households Family Size and probability of Saving

The household size was found negative in this finding, and the Coefficient is statistically different from zero at 1percent significance level. Holding all other variables constant at their mean values, it was

expected that household family size increase by a unit, odds ratio in favour of probability households saving decrease by about 0.54. This is attributed because when family size with a current high fertility rate, less employment opportunity, weak work habits, and family members become unemployed and have a low payment rate. Therefore, additional household member shares the limited resources that lead the household to save less.

Households Education level and the probability of Saving

Household head education level is one of the factors affecting saving level in this study. The result shows that the variable statistically significant at 1 per cent and positively related as it was expected. Holding other the model variables at their mean value, increasing education by one unit (one more grade) leads to an odds ratio favouring the probability of saving increase at about 2.07. The possible explanation for this result is education level of the households enhance the capacity to capture technology, and it may help to use improved inputs for its income generation practices and at the same time when income increases peoples saving also increases.

Distance from the market and the probability of Saving

The survey results revealed that the variable under consideration is negatively related and significant at less than 10% with a probability of saving. Holding other things constant, a unit increases in hours spent to distance from the nearest market odds ratio favouring the household's likelihood to save decrease by about 0.38. The possible explanation is that access to markets allows the household to be involved in other income-generating activities to enhance saving. It will also enable selling their assets/what they have/ with the fair price.

Sex and probability of Saving

In this study, sex was one of the factors determining the households saving level. The variable is positively related and statistically different from zero at less than 5% level as it was expected. Holding other variables constant at their mean level, when a unit increases in interest rate odds ratio favouring probability saving increase by a factor of 2.22. The possible explanation for this finding is when the household is headed by male engagement in different activities, increasing their saving level.

Interest rate and the probability of Saving

In this study, the annual interest rate was one of the factors determining the households saving level. The variable is positively related and statistically different from zero at less than 10% level as it was expected. Holding other variables constant at their mean level, when a unit increases in interest rate odds ratio favouring probability saving increase at about 2.06. The possible explanation for this finding is when the interest rate for saving increases people's motivation to consume and increase their saving level.

Transactional costs and the probability of Saving

In this study, the transactional costs are considered as one of the determinants of saving level. The finding of this study shows that transaction cost was negatively related, and the coefficient of the variable is statistically different from zero at 1 per cent. Holding other variables constant at their mean level, when a unit increases transaction cost odds ratio favouring the probability of saving decrease at about 0.2549. The finding was because when the transactional cost is high urban households saving will be reduced.

Credit access and the probability of Saving level

One of the model variables in this study is access to credit to households. The variable is positively related and statistically different from zero at the 1 per cent level as it was hypothesised. Holding other variables constant at their mean value, when access to credit change from no access to access odds ratio favouring the probability of saving increases at about 12.70. The result was due to the fact that access to credit can increase an opportunity to invest and participate in a different income-generating activity which can enhance income and saving level at the same time.

Annual income and probability of Saving

The household's annual income was positively related, and the variable is significantly different from zero at 1 per cent level. Other things remain constant when the household's annual income increases by a unit the odds ratio in favor of the probability of saving increase at about 4.27. This is due to the fact that when income rises, peoples saving increase.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary and Conclusion

The study was conducted to identify factors affecting urban households saving in Sodo town. Data for the research was collected from 240 urban households from four villages. To attain the study's stated objectives, we have used different data analysis methods, i.e. descriptive analysis and econometric analysis to identify independent variables' effect on the independent variable. With descriptive percentages, graphs, charts and tables were presented factors affecting household saving.

The result shows that 51(21.25%) of respondents were under age category 20-29; the 161(67.08%) of respondents were age category 30-64, and 28(11.67%) of the respondents were age greater than 64. According to table 4.1, most of the respondents were under age category 30 to 64, and their response to saving is highest than the rest of the age category.

Out of 240 households, 32.92% were with family size 0 to 3, 58.75% household's family size 4 to 6 and the remaining 8.33% household's family size greater than 6. Typically, large family size has a significant relationship with lower saving, an increase in the household size; the demand for household consumption increases and at the same time, saving decreases.

The finding of this study shows 19(7.91%) of the respondents were illiterate, 31(12.91%) of the respondents were completed primary education, 79(32.91%)of the respondents were completed secondary education and 111(46.27%) of the respondents' education level diploma and above. The majority of the respondents have an educated diploma and above level while their response to saving is highest than other education categories.

In logistic regression analyses, the variables positively related to the probability of saving are household head age, sex, marital status, household education, credit, annual income and interest rate. The variables that are negatively correlated with the probability of saving are family size, distance from the financial institution, distance from market, annual expenditure, and transaction cost.

From 12 explanatory variables, 8 of the variables: family size of the household, distance from the market, annual expenditure, transaction cost, household education level, credit access, annual income

and interest rate have a significant effect on the rural households saving at the significance level at 1 per cent, 5 per cent and 10 per cent.

Recommendations

As a result, the following policy recommendations were made.

- Family planning and related measures should be taken to limit household family size.
- Access to education is positively correlated with household saving in the study area. It helps people be capacitated and empower human capital and gives more significant opportunities to earn income t his, in turn, increases saving. Therefore the government should expand education services.
- Access to credit is also positively correlated with household saving in the study area. It helps households improve their participation in different activities, increase productivity, create the job, and smooth consumption flows. Still, with a prior saving used as a prerequisite to qualify for credit in the form of group lending hinders credit access to households with lower income in the area. However, respondents find group lending inconvenient to access credit from MFI since they are rejected from the group by better offs on the one hand and the prerequisite saving requirement on the other. Therefore, accommodative credit policy should be employed; meaning that MFIs and other development agencies need to introduce credit policies targeting poorest of the poor.
- Market access improves households' probability of households saving and can enhance households' ability to be involved in investment activities; hence, efforts should intensify to create some sort of market in the households' vicinities and improve road and other infrastructure facilities to established markets.

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Conflict of Interests

There was no conflict of interest among all the authors. The manuscript has been prepared with the suggestions of all the authors.

Technical Terms

These words in Ethiopia has special meaning.

Kebele means Village

Woreda means District

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