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Hand Held Farming

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Abstract: The advancement of technology rises day by day ever since man learnt to create fire. Agriculture is being practiced by man over hundreds of centuries, the art of cultivation which is being told was on classical way as much as the development in technology towards science and engineering, uproots day by day in all the fields , A long time ago where a room sized machines with copper lines which are laid over hundreds of kilometers for communication, Now a simple hand sized device which we used to call as mobile has become more easy and comfy for the communication, Meanwhile the rising technologies like Nanotechnology , Intelligent Robotics , Three dimensional data storage, Power generation and transmission via smart grids , etc. have taken the ease of work and comfort ability to a great distant wherever and whatever the domain they were applied ,As the art of food production has also seen a lot of mile stones in recent decades. The application engineering Principles towards the statistical agriculture will promote the ease of farming. The process of cultivation takes a year long process right from the land setting (Ploughing) till the harvesting as of a general way and that involves frequent monitoring and protection issues of the field, as well as maintenance of farm with classical methods of crop growth using proper fertilizers, insecticides and pesticides accordingly, this process takes a lot of man-power using the classical methods as the Farm Laboring practice is out dated, the practice of farming on a large scale needs a major labor force and the method also is tedious. Here, In our protocol we establish a sequence of modules that assist the classical method of farming to a modernized way.

Key Words: Ploughing, Shredder, Arduino, sprayer, hover, GSM, Android etc.

1. INTRODUCTION

Hand Held Farming, where the complete monitoring and controlling process of the entire farm to a handed device the “Mobile” ,using this the irrigation of the land is completely taken by care by a mobile as any remote distance (A person can monitor and control his irrigation system of his farm in Sivakasi ,while travelling to Chennai) as the mobile communication takes place via satellites, Also for the security issues , we suggest a smart sensing fence ,which mitigates trespassing and the animal intrusion , a frequent issue in hilly areas , this fence has modernized alarm system that prevents the entry and any level of trespassers. Moreover instead of using a heavy manned land roving vehicles like tractors ,a heavy and remote accesses land roving robot can be used for the purpose of Ploughing and Harvesting ,which is economical, efficient and pollution free as of the use of vehicles, And ,Finally a Farm hover which is a low cost aviation robot used to spray pesticides, insecticides ,fertilizers to a land a very large Scale just by controlling it by a remote, this can also be used for monitoring purpose, All these protocol are low cost and highly efficient in the control and monitoring of classical agricultural method at very affordable rates. This might take the agriculture to a great extent as the ease of work here is great than the classical way.

2. GENERAL OVER VIEW

This project comprises of Four Modules all together and interconnected

- Module -1 : Control and Monitoring of Farm field
  - Manual Mode
  - Automatic mode [5].
- Module -2 : Smart Fencing System
- Module -3: Farm Hover (Pesticide Spraying Robot)
- Module -4 : Land Rover (Ploughing /Harvesting /Fertilizer Spraying Robot).

3. CONTROL AND MONITORING:- (MANUAL MODE)

The control and monitoring of the farm was completely taken down on to a mobile where the major components used are Microcontroller Board (Arduino),GSM Module, Pumps , Moisture sensors , Water level indicators and Rain Sensor.

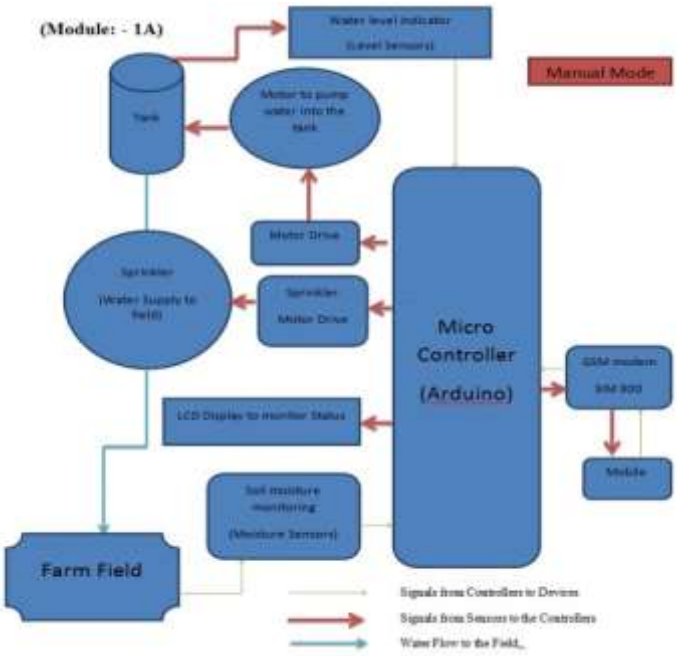

Fig 1.1 (Block diagram of operation)

Here the moisture sensors senses the soil moisture at all times as the farm field is to be wet at all times during early stages of farming, the sensor senses the signal and reports that to the controller , In case of any dry sensations the controllers provokes message to the users mobile via GSM module, User then decides whether to on the motor (Sprinkler motor) or not to, This sequence is given by input message to the controller to on the motor via the GSM module . [3]

Also the main water storage plant, which has a water level indicator, that senses the amount of water in the reserve and reports to the user on the account if the level is much low than the sensible level, here again a message is sent to the user's mobile about the indication and the user can retrieve i.e. on the motor by sending the authenticated signal to the controller via GSM, This module is extended with an ANDROID application for GSM based SMS communication.[6]

4. CONTROL AND MONITORING:- (AUTOMATIC MODE):

Here the moisture sensors senses[6] the soil moisture at all times as the farm field is to be wet at all times during early stages of farming, the sensor senses the signal and reports that to the controller , In Case of any abnormalities on the sensing the sensors sends the signal to the controllers. The controller then sends the signal to the mobile about the condition and automatically turns on the Sprinkler motor to water the field, Also the main water storage plant, which has a water level indicator that senses the amount of water in the reserve and reports to the controller about the condition and the controllers report the user's mobile about the condition and also turns the motor to fill the reserve. [3]

ANDROID APP.

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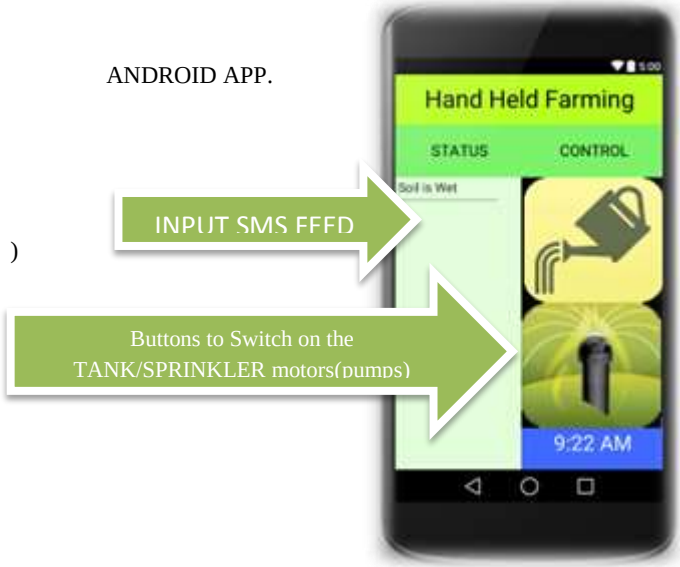


Fig1.2: (Layout of Android app to control/Monitor irrigation)

5. SMART FENCING SYSTEM:

Fencing System ensures the security of the farm with external intrusion from any trespasser and intruding animals (Dogs, Elephants etc.).The major components used in this module are Microcontroller (Arduino), GSM module, Proximity Sensors, Tactile Sensor, Range sensor, Alarm Trigger Systems, Smoke fire Trigger systems. As the proximity and Tactile sensors senses any object to its vicinity, as that's being reported to the controller and that in turn is informed to the user's mobile about the intrusion, and in case of a heavy sensing by the tactile sensors ,the controllers triggers the alarm system and also ignites the smoke fire system , in case of any intrusion of animals .

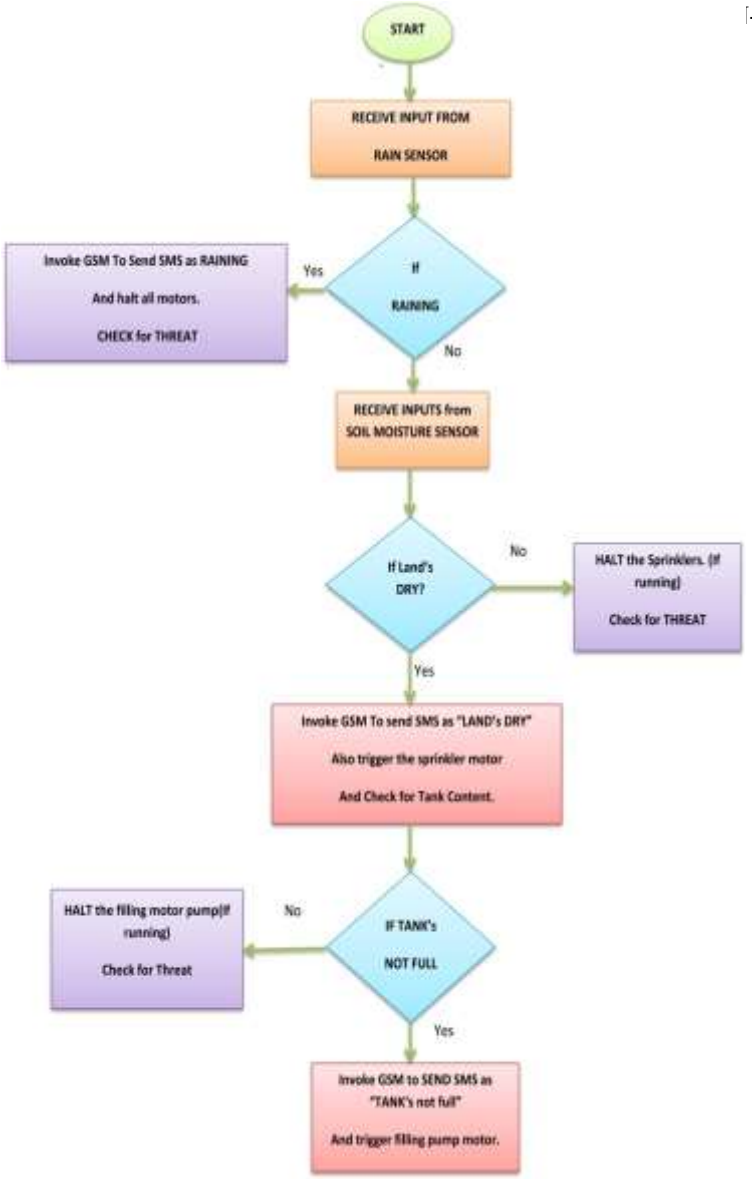


Fig 1.2a (Schematic Flow of Control of irrigation)

Also these Fences has a Range response system that reports the activity while using the module 3 & 4 , Land rover and Farm hovers while working on the field their range and extent of the work is reported by these sensors ,they also sends feed back to the endpoints in the field.

6. FARM HOVER

As far as our smart hand held system of farming is concerned, this module FARM HOVER forms the integral part of our proposal. The following is the main constraint focused, PESTICIDE/FERTILIZER SPRAYING using farm hover via air. Our farm hover module takes the sole responsibility in establishing the above functions in a prejudiced manner. As far as our project is concerned, this module comes with four main components as stated below: Microcontroller chip (ARDUINO UNO R2), Radio frequency RECEIVER and TRANSMITTER , Spray Canister, FARM HOVER with three Motion motors vertical axis motor, horiozontal axis motor, fly wheel motor and the spray pump.

In conjunction to the term micro controller, this component is mainly concerned with the entire controlling of the rover system. ARDUINO UNO R2 invoking ATMEGA 328P Chip is sole responsible for controlling the entire rover. UNO board is predominantly coded towards motion of the land rover. The receiving and transmitting circuits (RFID TRANSMITTER & RECEIVER) are controlled in a programmed sequence so as to ensure efficient rover scheme.

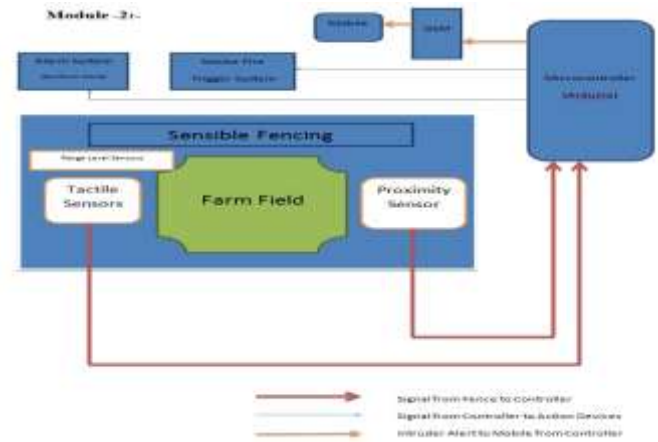


Fig: 1.3 (Block diagram of operation of smart fencing)

Being a transmitter, the RFID transmitter [4] transmits the inputted signals as Radio frequency waves with prescribed frequency range. And the receiver being in this frequency range receives the inputted signals from the transmitter through air as radio frequency, hence forming a wireless loop. This RFID component is highly ensured with transmitting the signal wirelessly.

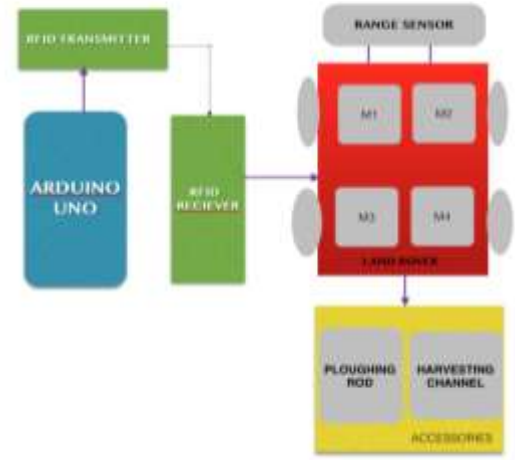
6.1. SPRAY CANNISTER:

As the name implies, this component is highly responsible for spraying fertilisers from air. While the farm hover is in air under flying motion, this spray

canister is excited to spray the fertilisers via air so as to ensure efficient spraying by cause of copter action.

6.2. **HOVER:**

This component is similar to a fly copter or some sort of air drone, controlled manually by remote action through distant ARDUINO encoded RFID transmitter. The construction is similar to a Mini copter

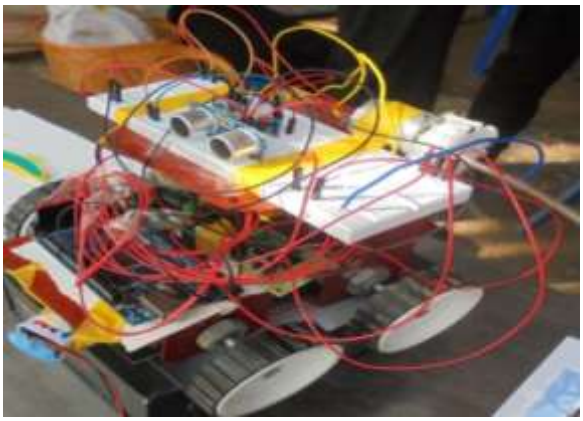


or an Air drone with fertiliser spray canister. The micro controller controls the flying motion of farm hover by controlling three motors as follows

Fig: 1.4: (Block diagram of LAND ROVER)

6.3. **VERTICAL AXIS MOTOR**:

Fig 1.5 (Typical Prototype of LAND ROVER)



This motor ensures the upward movement of the farm hover. Whenever a copter or an air drone flies perpendicularly upwards, there is an up thrust motor Under operation. It consists of a fly wheels which rotates in synchronism with the motor thus resulting in the generation of an upward thrust leading to the initial upward erection of the hover.

6.4. HORIZONTAL AXIS MOTOR:

This motor is responsible for the rotation or left-right motion of the hover and rotates in synchronism with the upthrust motor.

6.5. FLYWHEEL MOTOR:

This is the rear motor which helps in forward pushing of the motor which also rotates in synchronism with the other two motors.

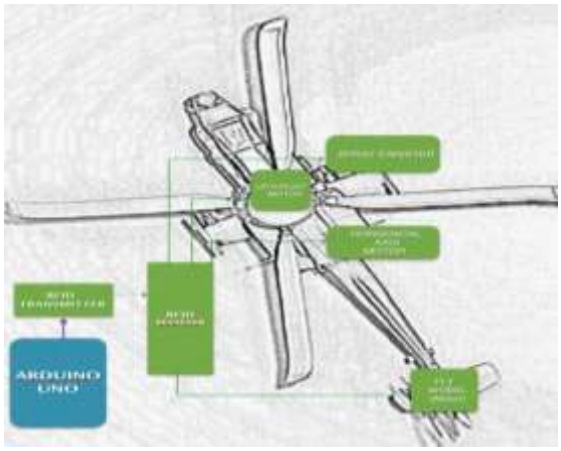


Fig: 1.5 (Block diagram of FARM HOVER)

7. LAND ROVER

Being a smart hand held system of farming, this module LAND ROVER forms the master piece of our proposal. The following are the two main constraints focuses, PLOUGHING the field so as to prepare it for farming, HARVESTING after farming ,Our land rover module takes the sole responsibility in establishing the above two functions in a prejudiced manner. Also with an accessory like a linear pump attached to this UAV the fertilizer can easily be sprayed to the stems of very tough crops like corns etc. As far as our project is concerned, this module is made with four main components as stated below , Microcontroller chip (ARDUINO UNO R2), Radio frequency RECEIVER and TRANSMITTER, Ploughing/harvesting rover with RAMGE SENSOR, Accessories including , Harvesting channel, Ploughing rod and Spraying Pump.

In conjunction to the term micro controller, this component is mainly concerned with the entire controlling of the rover system. ARDUINO UNO R2 invoking ATMEGA 328P Chip is sole responsible for controlling the entire rover. UNO board is predominantly coded towards motion of the land rover. The receiving and transmitting circuits (RFID TRANSMITTER & RECEIVER) are controlled in a programmed sequence so as to ensure efficient rover scheme.

Being a transmitter, the RFID transmitter transmits the inputted signals as Radio frequency waves with prescribed frequency range. And the receiver being in this frequency range receives the inputted signals from the transmitter through air as radio frequency, hence forming a wireless loop. This RFID component is highly ensured with transmitting the signal wirelessly.

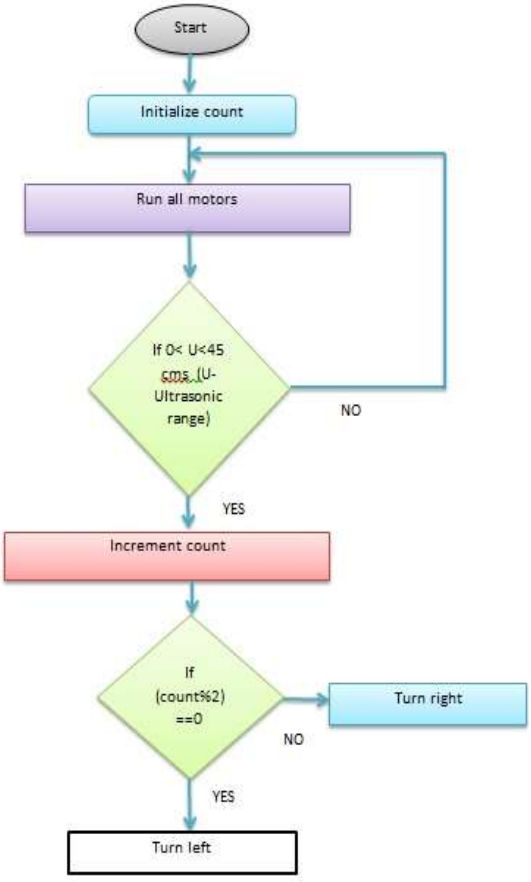


Fig: 1.5a (Schematic Flow for Automatic ploughing)

This component being the heart piece of the rover system comprises of four geared motors as mentioned in block diagram. The Motion of the gear motor is entirely controlled by the remote (either manually or automatically). Further efficient ploughing/harvesting is confined with the range sensor which senses the fencing boundary so as to prevent the rover from damage. The accessories include harvesting channel and ploughing rod which are rear end of the rover at a timely fashion whenever necessary.

8. CONCLUSION:

This idea suggests a best laid improvement of classical agricultural practice with modern technological advancements, As agriculture trends to be the low preferred occupation on this rising technological world ,the use of technology in this manner would definitely cause a strict rise in the GDP (Gross Domestic Product) of the agricultural field, moreover this practice helps to reduce the agricultural labor scarcity , thereby using some robotic based applications to do the basic agricultural amenities like ploughing , harvesting , spraying etc. The Control and monitoring of irrigation system is a best laid method for irrigating and monitoring the land this module can be used even (a person can monitor and control his irrigation system of his farm in Delhi ,while travelling to Mumbai) as the mobile communication takes place via satellites, Also for the security issues , we suggest a smart sensing fence ,which mitigates trespassing and the animal intrusion , a frequent issue in hilly areas , this fence has modernized alarm system that prevents the entry and any level of trespassers. Moreover instead of using a heavy manned land roving vehicles like tractors ,a heavy and remote accesses land roving robot can be used for the purpose of Ploughing and Harvesting ,which is economical, efficient and pollution free as of the use of vehicles, And ,Finally a Farm hover which is a low cost aviation robot used to spray pesticides, insecticides ,fertilizers to a land a very large scale just by controlling it by a remote ,this can also be used for monitoring purpose ,All these protocol are low cost and highly efficient in the control and monitoring of classical agricultural method at very affordable rates. This might take the agriculture to a great extent as the ease of work here is great than the classical way.

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Effect of Rhodamine B Dye on the Thermal, Mechanical, Dielectric, Laser Damage Threshold and Optical Properties of L-Alanine Thiourea (LATU) Single Crystals

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Abstract: Effect of Rhodamine B dye on the growth and properties of L-Alanine Thiourea Bulk single crystals has been reported. The cell parameters and crystallinity of pure and dye admixtured LATU crystals were confirmed by single crystal, powder X-ray diffraction and high resolution X-ray diffraction analyses. The functional groups present in the crystals were confirmed by FTIR analysis. The UV-vis-NIR transmission studies show the optical transparency in the entire visible region of Rhodamine B dye admixtured LATU crystal. The laser damage threshold value significantly enhanced for dye admixtured crystal in comparison with pure LATU crystal. The crystals were further subjected to other important characterizations such as dielectric measurement, micro hardness, thermal and NLO studies. The relative SHG efficiency of Rhodamine B dye admixtured LATU crystal was found to be 1.46 times higher than that of pure LATU crystal.
Keywords: slow evaporation technique, powder X-ray diffraction, dielectric properties, nonlinear optical study.

1. INTRODUCTION

The recent advances in science and technology have brought a great demand of various crystals with numerous applications. A field of multidisciplinary nature in science and technology has been emerged, known as crystal growth, which deals with the crystal growth methods, crystals characterizations and crystal growth theories. Nonlinear optical (NLO) crystals are a key material for the development of laser science and technology because there is almost only this kind of materials that have functions to change frequency of laser beam and modulate it in amplitude and phase. It may be said that lasers could not be used so widely in modern science and technology as they have been today, without NLO crystals. Development of NLO crystals with better linear optical (LO) and NLO properties, wider spectral transmission and phase-matching range in particular is obviously essential for further widening the application field of lasers. That is why many scientists working in the field today are still putting in great effort to search for new NLO crystals, even more than four decades after the invention of the laser. Among organic crystals for nonlinear optics (NLO) applications, amino acids display specific features of interest [1], such as molecular chirality which secures acentric crystallographic structures, absence of strongly conjugated bonds, leading to wide transparency ranges in the visible and UV spectral regions and zwitterionic nature of the molecule, which favours crystal hardness. Further to that, amino acids can be used as chiral auxiliaries for nitro-aromatics and other donor-acceptor molecules with large hyperpolarizability [2]. The growth of large single crystals of amino acids has been little investigated so far, even as regards the simplest acentric member of the family, L-Alanine (CH_3CHNH_2COOH). L-Alanine was first crystallized by BERNAL and later by SIMPSON et al. and DESTRO et al., who refined the structure (a = 6.032 Å, b = 12.343 Å, c = 5.784 Å; $\alpha = \beta = \gamma = 90°$) and assigned it the $P2_12_12_1$ space group [3-5]. In both cases, very small crystals were grown, unsuitable for optical investigations. In the recent years, complex of thiourea NLO crystals have attracted among the researchers [6] due to its flexibility in synthesis of a new complex. Thiourea ligand has both S and N donors; it can be coordinated either through S or N with few amino acid and forms a stable organic complex. Thiourea is an organic matrix modifier due to its large dipole moment and its ability to form hydrogen bonds [7]. A Thiourea crystal finds widespread use as frequency doublers in laser applications and was studied in great detail. Improvement in the quality of the Thiourea crystals and the performance of this crystal-based device can be realized with suitable dopants. To analyse the influence of dye based dopant on the centro symmetric Thiourea molecule, when combined with amino acids yields non-centrosymmetric complexes, which possess in general good nonlinear optical properties [8]. Some of the nonlinear crystals of the amino acid complexes of Thiourea reported are glycine Thiourea [9], and L-Histidine Thiourea [10]. Among these the second harmonic generation efficiency (SHG) of glycine Thiourea crystal was 0.5 times that of KDP and the SHG efficiency of L-Histidine Thiourea crystal 4.1 times that of KDP. Many researchers have worked on dye admixtured potassium dihydrogen phosphate and potassium acid phthalate nonlinear optical crystals in order to improve their nonlinear response [11,12]. Dyeing of crystals is a practice that was developed particularly for quantum optical applications because of the very significant increase in surface area achieved in growing crystals. Rhodamine is a family of related chemical compounds, fluorone dyes. Rhodamine dyes are used extensively in biotechnology applications such as fluorescence microscopy, flow cytometry, fluorescence correlation spectroscopy and Enzyme-Linked Immunosorbent Assay (ELISA). Rhodamine dyes are generally toxic, and are soluble in water, methanol and ethanol. Examples are Rhodamine 6G and Rhodamine B. Rhodamine B dye is used as laser gain medium. It is often used as a tracer dye within water to determine the rate and direction of flow and transport. Rhodamine B is tunable around 610 nm when used as a laser dye. In the present work, a comparative study on the growth, structural, UV-vis-NIR transmission, thermal, dielectric, mechanical, non-linear optical and laser damage threshold studies of pure and Rhodamine B dye admixtured LATU crystals have been reported.

2. EXPERIMENTAL PROCEDURE

L-Alanine Thiourea (LATU) was synthesized by dissolving high purity Thiourea and L-Alanine in the equimolar ratio in aqueous medium. Thiourea was first dissolved in Millipore water and then L-Alanine was added with continuous stirring for about 2 hours using a magnetic stirrer at 50 ˚C. The product was obtained as per the following reaction.

$$H_2N - CS - NH_2 + CH_3CHNH_2COOH \rightarrow H_2N - CS - NH_3^- CH_3CHNH_2COO^+$$

(Thiourea + L-Alanine → L-Alanine Thiourea)

The impurity content of L-Alanine Thiourea (LATU) was minimized by the process of recrystallization. The pH value of the solution was about 7.24. The pH value was adjusted to 3.5 by adding few drops concentrated hydrochloric acid [14]. Then it was filtered using Whatmann filter paper and the filtered solution was kept in a borosil beaker covered with an aluminium foil and the solvent was allowed to evaporate at room temperature. As a result of slow evaporation, after 30 days, colourless and transparent LATU crystal with dimensions of 12×3×3 mm^3 was obtained. The same experimental procedure was adopted for the synthesis of Rhodamine B dye (2 mol%) admixtured LATU salt. The seed crystal with perfect shape and free from macro defects was used for the growth of dye admixtured LATU crystal by slow evaporation method. The photographs of LATU and Rhodamine B dye admixtured LATU (RBLATU) crystals are shown in Figure 1 and Figure 2.

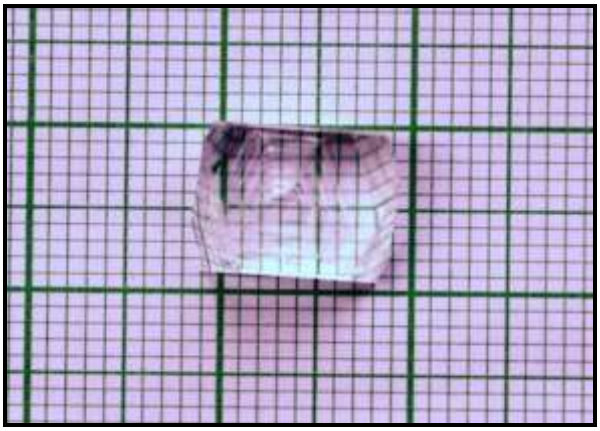

Figure 1. Grown LATU crystal

Figure 2. Grown RBLATU crystal

3. RESULT AND DISCUSSION

3.1 Single crystal XRD analysis

The single crystal XRD analysis of LATU and Rhodamine B dye admixtured LATU (RBLATU) crystals were carried out using MESSRS ENRAF NONIUS CAD4-F, single X-ray diffractometer with MoKα (λ=0.71073 Å) radiation. The lattice parameters of LATU and RBLATU crystals obtained from single crystal XRD analysis are presented in Table 1. The single crystal XRD study reveals that the presence of dopant has not altered the basic structure of the LATU crystal. The lattice parameter values of Rhodamine B dye admixtured crystal may be attributed to the lattice strain in the grown crystals due to the incorporation of the dye dopant.

Table 1. Comparison of lattice parameters of LATU and RBLATU.

S. No.	Crystal name	Axial lengths of unit cell (a, b and c)	Inter axial angles (α, β and γ)	Volume	Crystal system	Space group
01.	LATU	a = 9.6312 Å b = 5.6136 Å c = 9.4142 Å	α= γ =90° β =109.48°	508.98 $Å^3$	Monoclinic	$P2_1$
02.	RBLATU	a = 9.6111 Å b = 5.6351 Å c = 9.4311 Å	α= γ =90° β =109.48°	510.78 $Å^3$	Monoclinic	$P2_1$

3.2 Powder XRD Analysis

The grown crystals of LATU and RBLATU were crushed into fine powder and powder X-ray diffraction analysis has been carried out using Rich Seifert X-ray diffractometer.

Table 2. Miller indices, d-spacing and 2θ-values of L-Alanine Thiourea (LATU) single crystal determined from powder XRD analysis using RexCell software.

S. No.	h	k	l	d(obs) (A°)	d(calc) (A°)	2θ (obs) (deg)	2θ (calc) (deg)
1	2	0	-1	4.59282	4.59479	19.303	19.294
2	1	0	-2	4.28883	4.28477	20.685	20.705
3	1	1	1	3.81913	3.81395	23.263	23.295
4	2	1	0	3.48218	3.48090	25.550	25.560
5	3	0	-1	3.13881	3.13725	28.401	28.415
6	2	1	-2	3.07372	3.07392	29.015	29.014
7	2	1	1	2.93698	2.93525	30.398	30.417
8	1	1	2	2.84657	2.84937	31.388	31.357
9	3	1	-1	2.73649	2.73839	32.685	32.662
10	3	0	1	2.52323	2.52358	35.536	35.531
11	1	2	1	2.46934	2.46928	36.338	36.339
12	0	2	2	2.31055	2.31088	38.933	38.927

The X-axis of graph is 2θ. The Y-axis gives the intensity in arbitrary units. The samples were subjected to intense X-ray of wavelength 1.5406 Å (CuKα) at a scan speed of 1°/minute to obtain lattice parameters. The Miller indices (hkl), d-spacing and diffraction angle (2θ) are summarized for LATU and RBLATU are shown in Table 2 and Table 3 with the help of RexCell program and their powder diffractograms are shown in Figure 3 & Figure 4.

Table 3. Miller indices, d-spacing and 2θ-values of Rhodamine B dye admixtured LATU (RBLATU) single crystal determined from powder XRD analysis using RexCell software.

S. No.	h	k	l	d(obs) (A°)	d(calc) (A°)	2θ (obs) (deg)	2θ (calc) (deg)
1	1	0	0	4.58479	4.58331	19.337	19.343
2	0	1	0	4.43740	4.44123	19.986	19.968
3	0	0	2	4.27836	4.28026	20.737	20.727
4	0	1	-2	3.81086	3.81282	23.314	23.302
5	0	1	1	3.48218	3.47963	25.550	25.569
6	2	0	-3	3.13881	3.13886	28.401	28.401
7	1	-1	-2	3.07372	3.07378	29.015	29.015
8	1	-1	1	2.93698	2.93576	30.398	30.411
9	2	1	-3	2.84657	2.84696	31.388	31.384
10	2	0	-1	2.73649	2.73706	32.685	32.678
11	1	-1	-3	2.52323	2.52354	35.536	35.532
12	2	1	-5	2.46934	2.46885	36.338	36.346
13	1	2	-2	2.31055	2.31040	38.933	38.935

From the X-ray powder diffraction data, the lattice parameters for RBLATU were found to be a = 9.6201 Å, b = 5.6401 Å and c = 9.4249 Å. This is in close agreement with the values obtained from single crystal X-ray diffraction analysis for RBLATU. The change in intensity of peaks as well as addition in number of peaks for RBLATU in the powder X-ray diffraction pattern reveal that the dye doped crystal is slightly distorted compared to the pure LATU. This may be attributed to strains on the lattice by the absorption or substitution of Rhodamine B dye in LATU crystal.

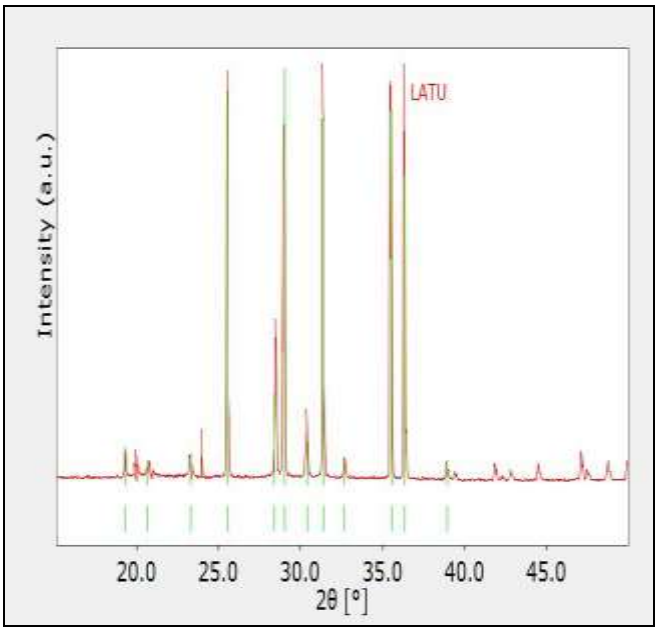

Figure 3. PWXRD spectrum of LATU crystal

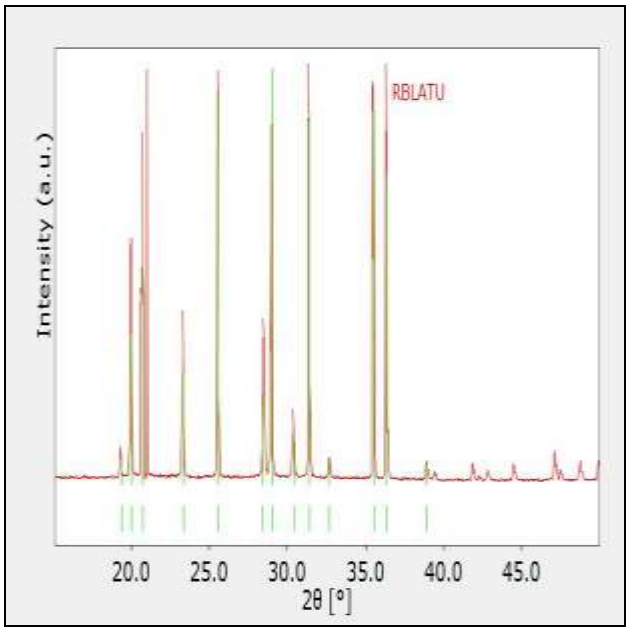

Figure 4. PWXRD spectrum of RBLATU crystal

3.3 High resolution X-ray diffraction studies

The crystalline perfection of the grown crystals were characterized by HRXRD analysis by employing a multicrystal X - ray diffractometer with MoKα_1 radiation designed and developed at National Physical Laboratory (NPL) New Delhi [15] has been used to record high-resolution diffraction curves (DCs). The well-collimated and monochromated MoKα1 beam obtained from the three monochromator Si crystals set in dispersive (+,-,-) configuration has been used as the exploring X-ray beam. The specimen crystal is aligned in the (+,- ,-,+) configuration. Due to dispersive configuration, though the lattice constant of the monochromator crystal(s) and the specimen are different, the unwanted dispersion broadening in the diffraction curve (DC) of the specimen crystal is insignificant. Before recording the diffraction curve, to remove the non-crystallized solute atoms remained on the surface of the crystal and also to ensure the surface planarity, the pure LATU and Rhodamine B dye admixtured LATU crystals were first lapped and chemically etched in a non-referential etchant of water and acetone mixture in 1:2 ratios. Figure 5 and Figure 6 show the high-resolution diffraction curves (DCs) recorded for pure LATU and Rhodamine B dye admixtured LATU crystals using (3 0 0) diffracting planes in symmetrical Bragg geometry by employing the multicrystal X-ray diffractometer with MoKα_1 radiation.

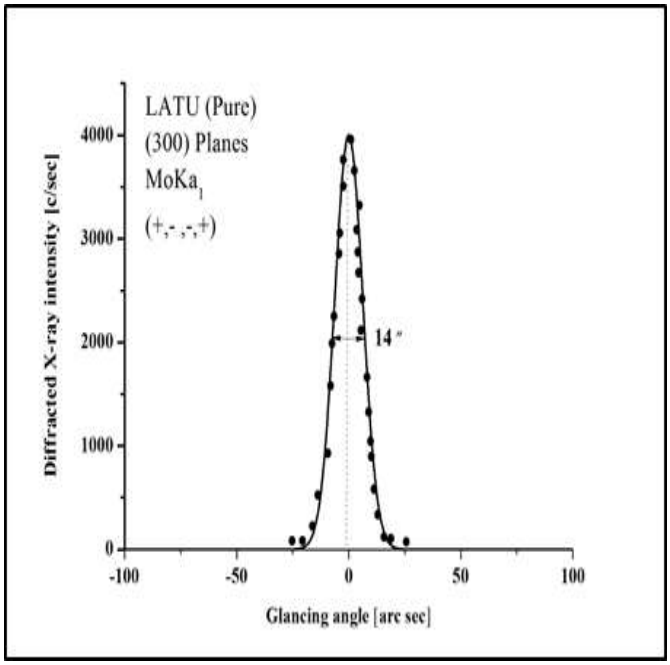

Figure 5. HRXRD curve of pure LATU crystal

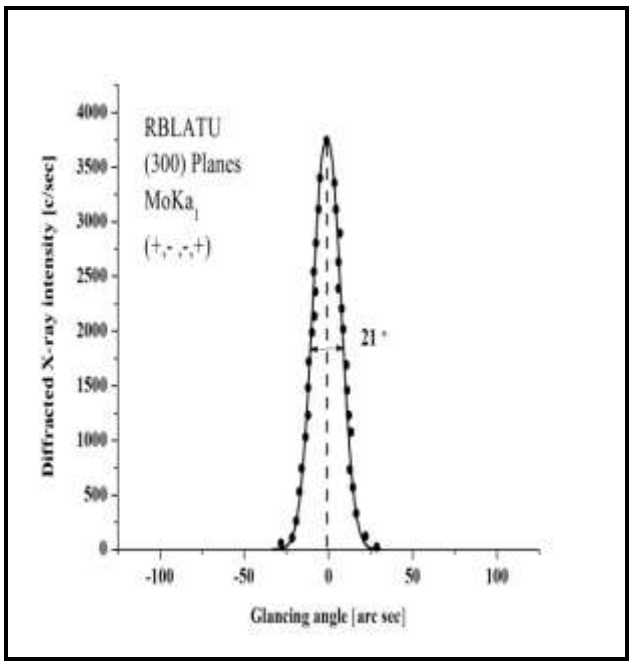

Figure 6. HRXRD curve of RBLATU crystal

The curves are very sharp having full width at half maximum (FWHM) of 14 arc sec for pure LATU and 21 arc sec for Rhodamine B dye admixtured LATU crystals as expected for nearly perfect crystals from the plane wave dynamical theory of X-ray diffraction [16]. The absence of additional peaks and the very sharp DC shows that the crystalline perfection of the specimen crystals is extremely good

without having any internal structural grain boundaries and mosaic nature. The increase in FWHM without having any additional peaks in DC of Rhodamine B dye doped LATU crystal indicates the incorporation of Rhodamine B dye in the crystalline matrix of LATU crystal. In DC of Rhodamine B dye doped LATU crystal, for a particular angular deviation ($\Delta\theta$) of glancing angle (θ) with respect to the Bragg peak position (taken as zero for the sake of convenience), the scattered intensity is much more in the positive direction in comparison to that of the negative direction. This feature or asymmetry in the scattered intensity clearly indicates that the Rhodamine B dopants predominantly occupy the interstitial positions in the lattice and elucidates the ability of accommodation of dopants in the crystalline matrix of the LATU crystal. This can be well understood by the fact that due to incorporation of dopants in the interstitial positions, the lattice around the dopants compresses and the lattice parameter d (interplanar spacing) decreases and leads to give more scattered (also known as diffuse X-ray scattering) intensity at slightly higher Bragg angles(θ_B) as d and $\sin\theta_B$ are inversely proportional to each other in the Bragg equation ($2d \sin\theta_B = n\lambda$; n and λ being the order of reflection and wavelength respectively which are fixed). It may be mentioned here that the variation in lattice parameter is only confined very close to the defect core which gives only the scattered intensity close to the Bragg peak. Long range order could not be expected and hence change in the lattice parameter is also not expected [17]. The HRXRD results confirm an important finding that Rhodamine B dye entrapped in the LATU crystals, but the amount is limited to a critical value and above which the crystals have a tendency to develop structural grain boundaries [18].

3.4 Fourier Transform Infrared Spectroscopy

The mid Fourier transform infrared spectrum of pure and dye doped LATU crystals were recorded at 300 K in the range of 4000–400 cm^{-1} using the KBr pellet technique. The FTIR spectra of pure and dye admixtured LATU crystals are shown in Figure 7 and Figure 8. The incorporation of Rhodamine B dye in LATU crystal has been strongly verified by spectral analysis. The O–H stretching due to water of crystallization arises at frequencies of 3788, 3558 and 3377 cm^{-1} in Rhodamine B dye doped LATU spectrum. The NH_3^+ asymmetric bending and CH_2 stretching vibrations occur at 3175 cm^{-1} and at 2815 cm^{-1}. The asymmetric stretching vibration of CO_2 is observed at 1558 cm^{-1}. In the Rhodamine B dye LATU spectrum, the OH stretching in the high energy region is very much broadened, due to hydrogen bonding. The sharp peak at 2407 cm^{-1} is due to NH_3^+ symmetric stretch out of plane vibration. The peak at 1362 cm^{-1} is due to C=S stretching vibration. The aliphatic C-H stretching mode at 2740 cm^{-1} confirms the presence of Rhodamine B dye in LATU. The narrow bands at 679 and 581 cm^{-1} are observed in Rhodamine B dye added as compared to LATU. The vibration frequencies of L-Alanine Thiourea are compared with Rhodamine B dye admixtured L-Alanine Thiourea in Table 4 to confirm the incorporation of Rhodamine B dye in LATU crystal.

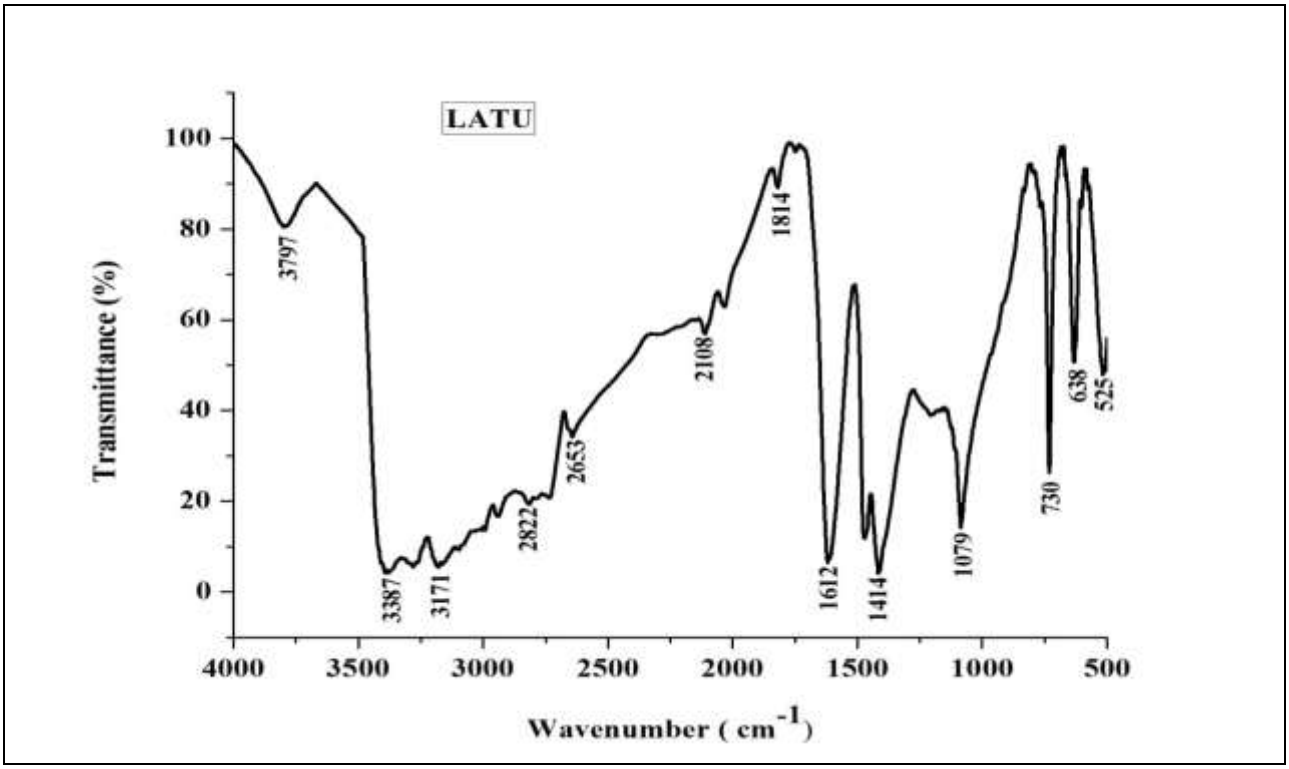

Figure 7. FTIR spectrum of grown L-Alanine Thiourea (LATU) single crystal.

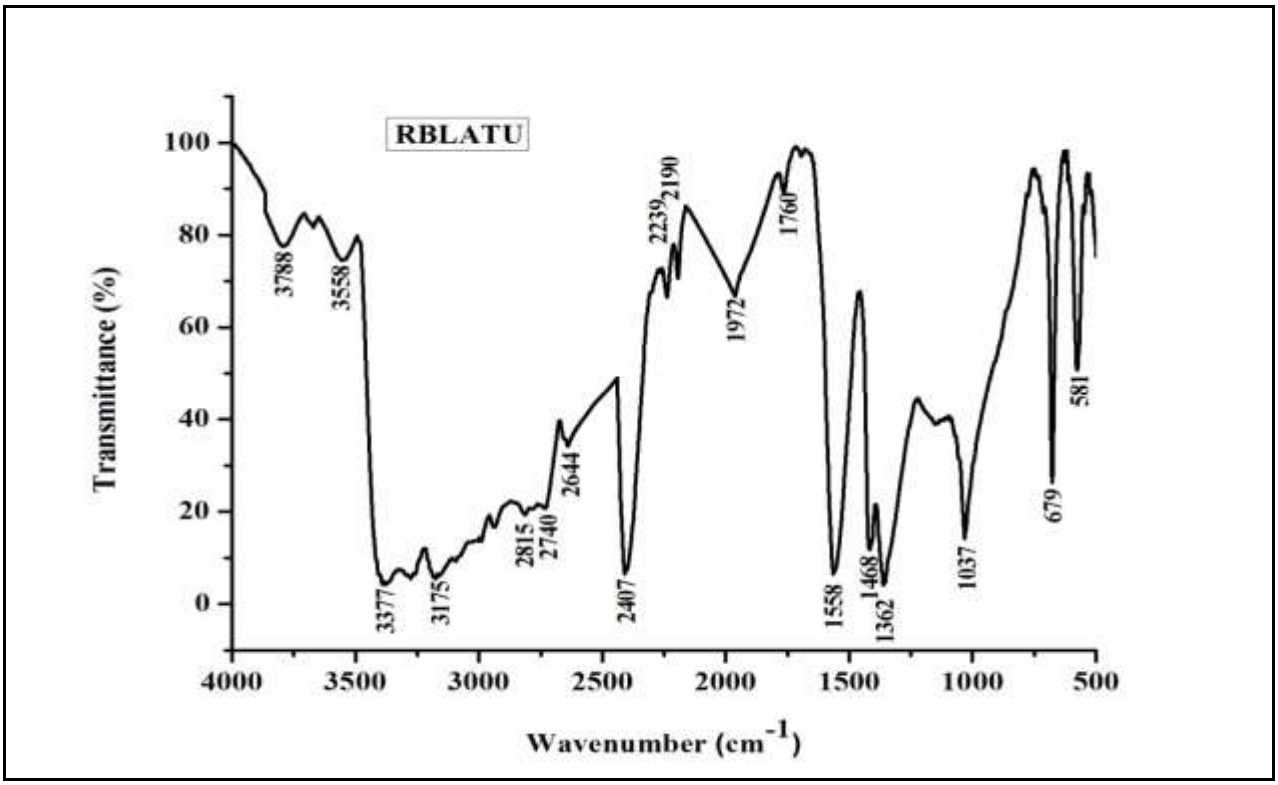

Figure 8. FTIR spectrum of grown Rhodamine B dye admixtured LATU (RBLATU) single crystal.

Table 4. Infrared absorption frequencies (cm^{-1}) of L-Alanine Thiourea (LATU) and Rhodamine B dye LATU (RBLATU) single crystals

S.No.	L-Alanine Thiourea (LATU)	Rhodamine B dye admixtured LATU (RBLATU)	Assignment
1	3797	3788	OH - stretching
2	3171	3175	NH_3^+ symmetric stretching
3	2822	2815	$=CH_2$ stretching
4	-	2740	Aliphatic (C-H) stretch
5	2653	2644	C-H symmetric stretching
6	-	2407	NH_3^+ symmetric stretch out of plane vibrations
7	2108	2190	Over tone region with a combination of symmetric NH_3^+ bending and torsional vibrations
8	1814	1972	C=O absorption
9	1612	1760	Asymmetric bending of NH_3^+ and C=N stretching
10	1414	1468	C= O stretching
11	1079	1037	Symmetrical C-O-C stretching
12	730	679	C-H in plane bending
13	638	581	C=S stretching

3.5 UV-visible spectral study

The UV-visible spectra of pure and Rhodamine B dye admixtured analyses have been carried out using Shimadzu UV-visible spectrophotometer in the wavelength range of 100-1100 nm. Transmission spectra are very important for any NLO material because a nonlinear optical material can be of practical use only if it has wide transparency window [19]. The UV-vis spectra of LATU and RBLATU are shown in Figure 9. In the case of pure LATU, a sharp fall in percent transmittance is occurred at 209 nm. For RB admixtured LATU, the fall in percent transmittance are occurred at 370 nm and 322 nm. It is followed by another percent transmittance at 295 nm. Such variation in percent transmittance is due to electronic excitation of RB dye. It confirms that the addition of RB in the LATU crystal influence the light transmittance of LATU. In the transmission spectrum of Rhodamine B admixtured LATU, the characteristic absorption of Rhodamine B dye are observed at 370, 322 and 295 nm.

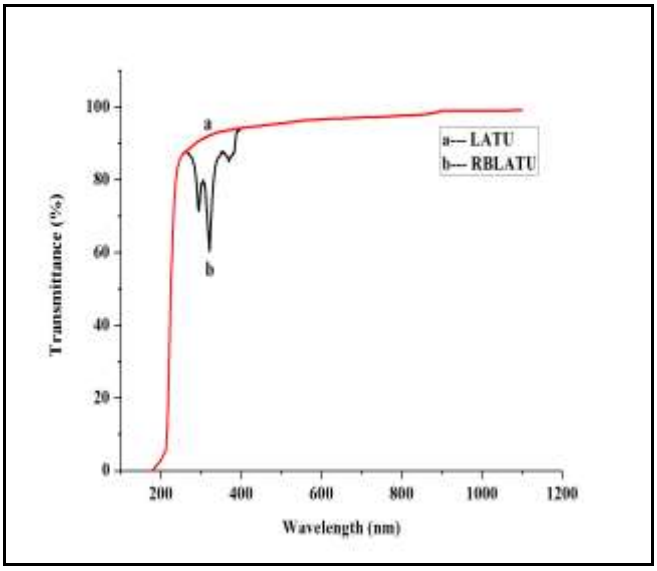

Figure 9. UV-vis-NIR absorption spectra for LATU and RBLATU crystals

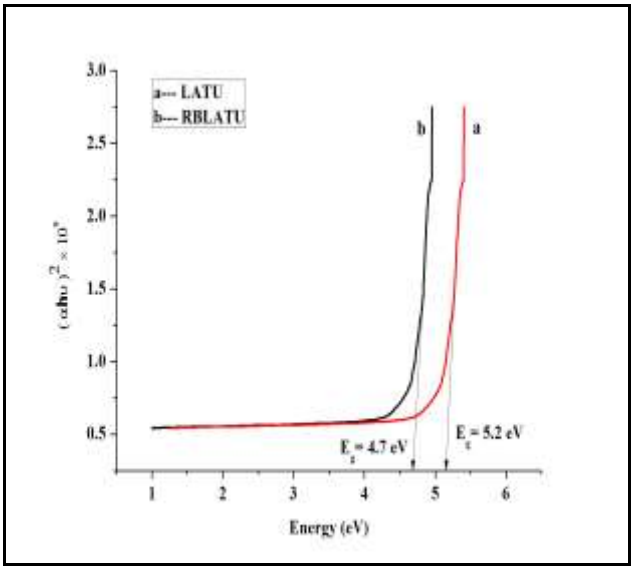

Figure 10. Photon energy vs $(\alpha h\upsilon)^2$ for LATU and RBLATU crystals

3.6 Optical band gap energy (E_g) calculation

The band gap energy of the pure and Rhodamine B dye admixtured LATU crystals were calculated from the Figure 10 by taking Photon energy (hυ) values along X-axis and $(\alpha h\upsilon)^2$ values along Y-axis for LATU and RBLATU crystals. The optical absorption coefficient (α) was calculated using the relation

$$\alpha = (2.3026 * \log (1/T)) / t \quad (1)$$

where T is the transmittance and t is the thickness of the crystal. The band gap energy values were calculated by extrapolation of the linear part of the curve for LATU and RBLATU and found to be 5.2 eV and 4.7 eV respectively. The decrease in band gap energy value of dye admixtured LATU may be due to incorporation of dye in the LATU crystal lattices. The value of band gap energy for RBLATU crystal suggests that the material is dielectric in nature to possess wide transmission range. The large transmission in the entire visible region and lower cut off wavelength enable it to be a potential material for second and third harmonic generation [20].

3.7 Thermo gravimetric analysis (TGA)

Thermo Gravimetric Analysis (TGA) and Differential Thermal Analysis (DTA) were carried out for LATU and RBLATU crystals using TA Q-500 analyser. TGA and DTA curves for pure and Rhodamine B dye admixtured LATU are shown in Figure 11 and Figure 12.

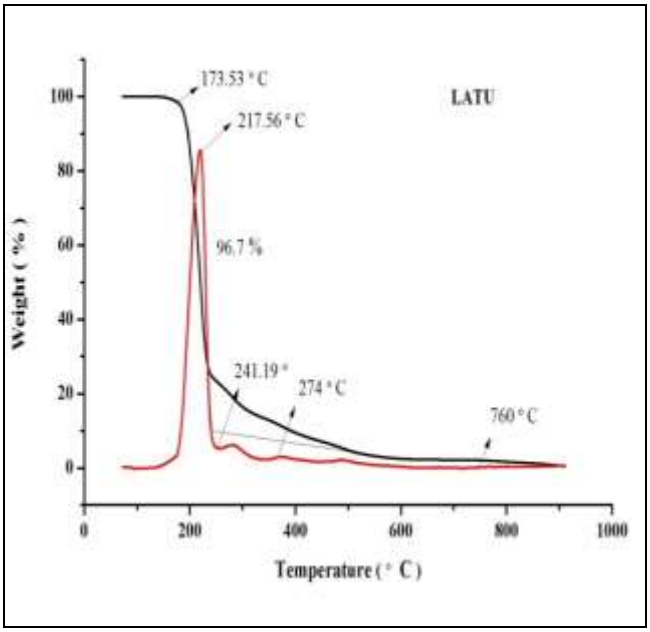

Figure 11. TGA and DTA curves of LATU crystal

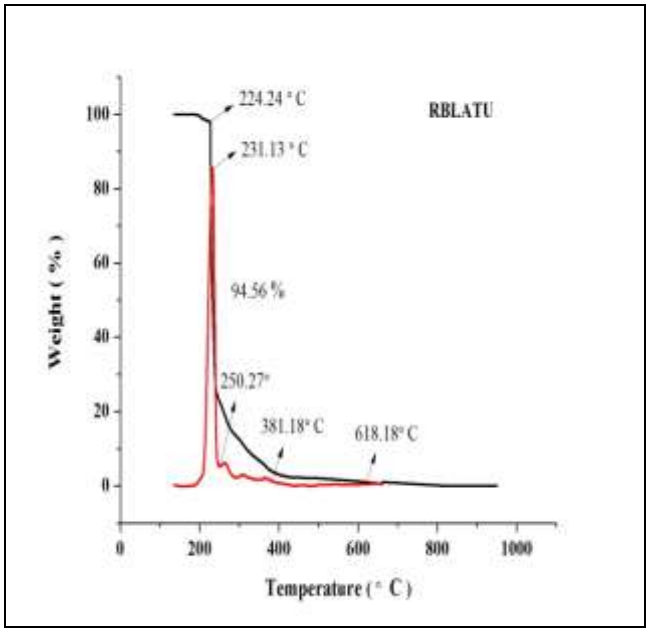

Figure 12. TGA and DTA curves of RBLATU crystal

The powder samples were used for the analysis in the temperature range of 0 ˚C to 1000 ˚C at a heating rate of 10 ˚C/min in the nitrogen atmosphere. In pure LATU, the major weight loss occurs between 173.53 ˚C and 241.19 ˚C. The change in weight loss confirms the decomposition nature of the sample. Differential thermal analysis confirms through a sharp endothermic peak at 217.56 ˚C revealing the major weight loss. Further, degradation of the sample takes place from 274 ˚C to 760 ˚C where the loss of weight is about 5.41% due to liberation of volatile substances like sulfur oxide and amino acid L-Alanine [21]. The weight loss of 2.976% at the end is due to the release of CO molecules. Hence, it is concluded that the grown material is thermally stable up to 173.53 ˚C. In Rhodamine B dye admixtured LATU crystal, the major weight loss occurs between 224.24 ˚C and 250.27 ˚C. The change in weight loss confirms the decomposition nature of the sample. Differential thermal analysis confirms through a sharp endothermic peak at 231.13 ˚C revealing the major weight loss. Further, degradation of the sample takes place from 381.18 ˚C to 618.18 ˚C where the loss of weight is about 1.98 % due to absorption of energy for breaking of bonds during the decomposition of the compound. Hence, it is concluded that the Rhodamine B dye admixtured LATU crystal is suitable for optoelectronics applications up to 224.24 ˚C.

3.8 Dielectric Analysis

The dielectric studies of pure LATU and Rhodamine B dye admixtured LATU crystals were carried out using the HIOKI 3532-50 LCR HITESTER instrument. The capacitance values for LATU and RBLATU crystals were determined for frequencies varying from 50 Hz to 5 MHz at room temperature. The variations of dielectric constant and dielectric loss as a function of log frequency are shown in Figure 13 and Figure 14. It is observed that the dielectric constant of pure LATU is 196 where 308 for Rhodamine B dye admixtured LATU crystal. The high value of dielectric constant at low frequencies may be due to incorporation of Rhodamine B dye in LATU in the grown crystal and better orientation of dipoles in the molecules of the crystals. The low value of dielectric loss indicates that the pure and Rhodamine B dye admixtured LATU crystals have lesser defects, which is a desirable property for NLO applications.

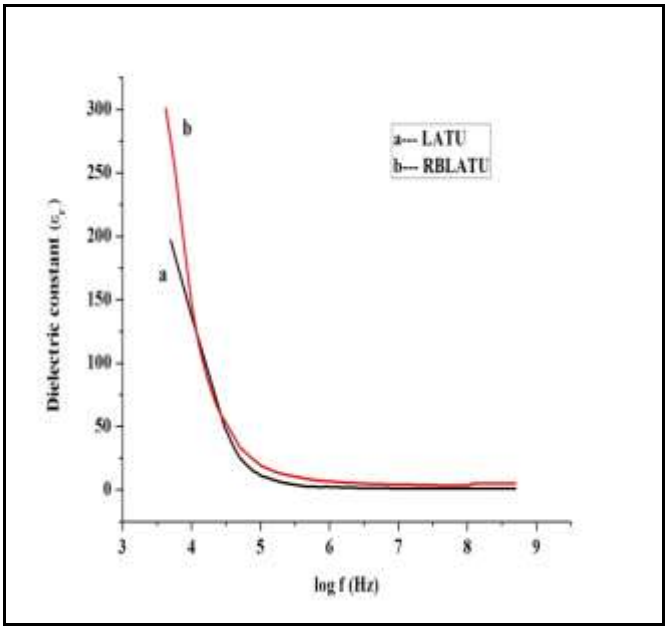

Figure 13. Variation of dielectric constant of pure LATU and RBLATU

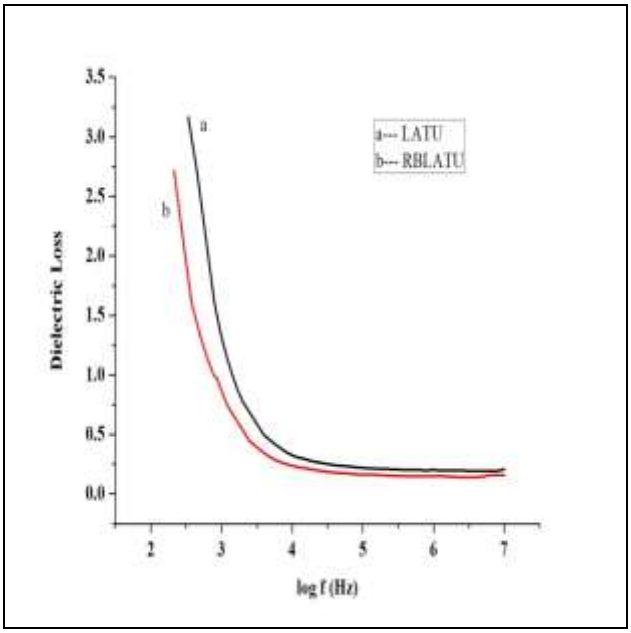

Figure 14. Variation of dielectric loss of pure LATU and RBLATU

3.9 Microhardness Measurements

Microhardness behaviour of pure LATU and RBLATU single crystals were tested by using Shimadzu make-model-HMV-2 fitted with Vickers pyramidal indenter and attached to an incident light microscope. The indentations were made on the flat surface with the load ranging from 25 to 100 g and the indentation time was kept as 10s for all the loads. The Vickers hardness number H_v was calculated from the following expression,

$$H_V = ((1.8544*P)) / d^2 \quad kg / mm^2 \qquad (2)$$

where P is the applied load in kg, d is the diagonal length of the indentation impression in mm and 1.8544 is a constant of a geometrical factor for the diamond pyramid. Vickers hardness number was calculated and a graph has been plotted between the hardness values and the corresponding loads for the crystals as shown in Figure 15. From the results, it is observed that the hardness number decreases with increasing load up to 75 g and attains saturation for further increase in load. Beyond this load cracks were found both in pure LATU and RBLATU single crystals. From the Figure 15, it is observed that the microhardness value of dye admixtured crystal is slightly higher than that of the pure LATU and it is due to the presence of organic Rhodamine B dye molecule in the interstitial sites of pure LATU crystal.

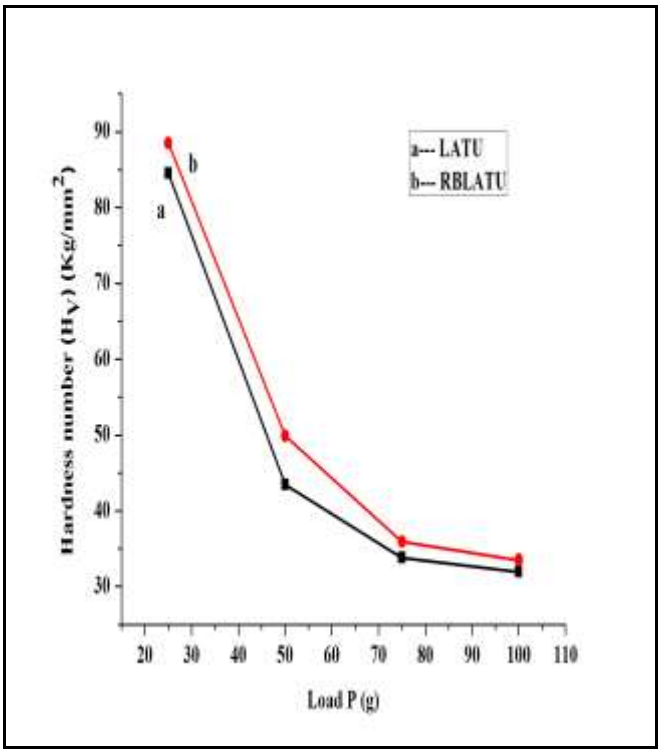

Figure 15. Variation of hardness with applied load for LATU and RBLATU single crystals

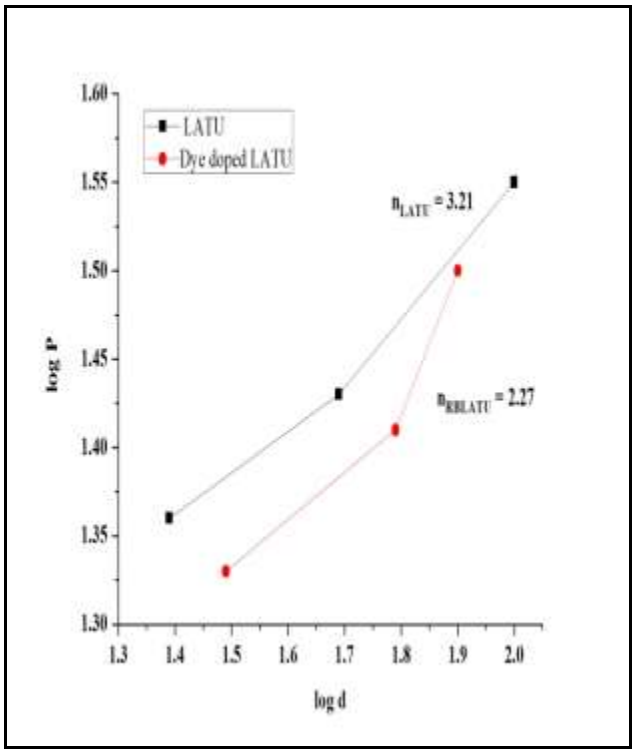

Figure 16. Variation of log (P) with log (d) for LATU and RBLATU single crystals

The Mayer's index number was calculated from the Mayer's law, which relates the applied load(P) and indentation diagonal length(d).

$$P = ad^n \quad (3)$$

where 'a' is the material constant and 'n' is the Mayer's index or work hardening coefficient. The values of the work hardening coefficient (n) were estimated from the plot of log P versus log d drawn by the least square fit method and it is shown in Figure 16.The work hardening coefficients (n) for pure LATU and Rhodamine B dye admixtured LATU crystals were found to be 3.21 and 2.27 respectively. Onitsch [22] pointed out that 'n' lies between 1 and 1.6 for moderately hard materials and it is more than 1.6 for soft materials. The observed values of Mayer's index for LATU and RBLATU are 3.21 and 2.27 and hence they belong to the soft materials category.

3.10 Laser damage threshold studies

The laser damage density is one of the important parameters that decide the applicability of the material for high power laser applications. The laser damage threshold values were measured using a Q-switched Nd-YAG laser source of pulse width 10ns and 10Hz repetition rate operating in TEM00 mode. The energy per pulse of 532nm laser radiation attenuated using appropriate neutral density filters was measured using an energy meter (Coherent EPM 200) which is externally triggered by the Nd:YAG laser. If the material has a low damage threshold, it severely limits its application, though it may have excellent properties like high optical transmittance and high SHG efficiency [23]. For surface damage, the sample was placed at the focus of a plano-convex lens of focal length 30 cm. The (100) plane of pure and dye admixtured crystals was used for the laser damage studies. The surface threshold of the crystal was calculated using the expression:

$$\text{Power density (Pd)} = E / \tau\pi r^2 \quad (4)$$

Where E is the energy (mJ), τ is the pulse width (ns) and r is the radius of the spot (mm). The measured multiple shot (150 pulses) laser damage threshold values of pure and dye admixtured LATU crystals are 9 and 7.3 GW/cm^2 respectively. The decrease in laser damage threshold value of dye admixtured LATU may be due to incorporation of dye in the LATU crystals

3.11 NLO Studies

Nonlinear optical (NLO) property of pure L-Alanine Thiourea (LATU) and Rhodamine B dye admixtured LATU crystals were determined by Kurtz powder technique using the Nd:YAG Q-switched laser beam. The samples of same sizes were illuminated using Q-switched, mode locked Nd:YAG laser with input pulse of 6.2 mJ. The second harmonic signals of 384 mV and 560 mV were obtained for pure and Rhodamine B dye admixtured LATU crystals with reference to KDP (275 mV). Thus, the SHG efficiency of LATU and Rhodamine B dye admixtured LATU crystals was found to be 1.39 and 2.04 times greater than the standard KDP crystal. The relative SHG efficiency of Rhodamine B dye admixtured LATU crystal was found to be 1.46 times higher than that of pure LATU crystal.

4. CONCLUSION

Good quality of LATU and Rhodamine B dye admixtured LATU crystals were grown by slow evaporation method. The unit cell parameters of the crystals obtained from single crystal XRD showed that the LATU and RBLATU crystals belong to monoclinic system with space group $P2_1$. Sharp peaks of powder XRD pattern of the crystals confirm the good crystalline nature of the grown crystals and the incorporation of Rhodamine B dye into LATU crystal lattice. The functional groups of RBLATU crystal were identified by FTIR spectral analysis and they have confirmed the presence of organic additive Rhodamine B dye in LATU crystal. The UV-vis-NIR transmittance spectra showed that the crystals had a wide optical window and the absorption due to Rhodamine B dye in LATU crystal. The addition of Rhodamine B dye in LATU crystal increased the thermal stability of pure LATU crystal. The sharpness of the endothermic peak shows good degree of crystallinity of the crystal. The Vickers micro hardness values were calculated in order to understand the mechanical stability of the crystals. Dielectric studies for the crystal were studied. NLO studies have confirmed that the SHG efficiency value was significantly enhanced due to the presence of Rhodamine B dye in LATU crystal.

5. ACKNOWLEDGMENTS

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Lean Six Sigma Frameworks "An Improvement in Teaching-Learning Process"

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Abstract: Teaching-Learning Process improvement is an important key process area in the education sector for project implementation. Lean Six Sigma approaches have been constantly used for shortening the lead time and the waste from products or services to achieve quality. Lean and Six Sigma techniques are popularize in almost every industries. This paper focuses on how the Lean Six Sigma approach can be valuable for educational institutes to improve the teaching learning process. In this paper the author uses methodology and tools to achieve quality without having any wastes in the student's project implementation processes under the proper guidance of the higher faculties in software engineering.

Keywords: Lean, Six Sigma, Teaching-Learning, DMAIC etc.

1. INTRODUCTION

In education sector, most of the Universities have been facing problem in administrating the new technology due to some human, monetary and physical factors. Teaching-Learning process is a basic element for the Universities. The Teaching-Learning process is just the most imperative exercises in the colleges. An unhealthy teaching process framework means less students being accepted into a college in terms of errors or an incorrect way of providing knowledge to students.

Although significant exertion is generally applied in teaching at higher educational organizations, the conclusions toward the end may not be in-accordance with the effort exerted at the primary place. The nature of the learning outcomes does not exactly measure the positive effort used in teaching. In this research the author tries to investigate teachers experience to teach students of software engineering in large groups and survey the results. Based on the result we implement an intelligent methodology to enhance learning and teaching of software engineering in sufficient large group. First the author present the approach supported by the amalgam of two approaches: Lean and Six Sigma, then we present observation based on the conclusions obtained from examination, group- project coursework took after by discussions on informal assessment of feedback from students and mentors, administration of group project, and a motivation for a reflective instructor/mentor.

Lean Six Sigma provides a methodology through which we can remove the waste associated with the existing process and improve the quality of the process. Improving process in the every department is the primary goal of this paper. Inefficient procedures lead to higher response time, so to make them efficient through development is fierce.

Most of the Universities as well as some other education institutions have on demands for human, technology, physical and money related assets and these imperatives should be managed and processed. Evaluation of this is done at each level of process and the tasks and activity associated with it is considered. All the task and activity which are driving the process have its impact in constructive as well as in unconstructive way. Each and every department of a particular education institution involves many activities like maintaining notes, creating LMS(Learning management system), providing slides on lecture basis, transfer of resources, communicating with the geographically scattered students, reducing the time of teaching process and also to centralize data handling. Our lot of time will be waste in waiting, therefore waiting is simply refers to the waste and it could be defined by the lean six sigma methodology. Recognizing methods, tasks, activities and proposing an enhanced process will prompt a society of constant change. Reduction in cycle time for teaching-learning process has been done in every departments of the university which will direct increase the Student's satisfaction.

2. LITERATURE REVIEW

Teneraa.et.al [1] proposed the project improvement model with the DMAIC cycle and large number of statistical tools. The proposed model used to setting which extend administration forms framework is focused around Project Management Institute (PMI) benchmarks. The model

permitted recognizing organization's principle venture administration issues and related reasons and the determination of the reasons to be initially gone to.

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Porres.et.al [2] proposed that how LSS tools can be used to improve the process. Lean methodology was an exceptionally valuable tool to distinguish each Kaizen in every process, because it gives the fitting tackle to handle this sort of circumstances introduced at the Imaging Office. This system is consistently emulated for each of the three methodologies (Reception, XR and CT) formerly said to make enhancements at all level.

Wang.et.al [3] proposed DMAIC model for quality improvement and quality management. DMAIC model act as logical process cycle, each stage has its activity points and the corresponding tools. DMAIC tool used to reduce the waste and variation associated with equipment maintenance process.

Pamfilie.et.al [4] proposed the lean six sigma approach can be used by any organization and has the purpose to develop strategic business objectives and to highlight the importance of personal improvement. The data obtained from the questionnaire are analyzed through the SPSS statistical package software. To show that associations can acquire individual and authoritative execution by utilizing decently prepared pioneers concentrated on consistent change which uses Lean Six Sigma in driving worker cooperative energy.

Yingchun.et.al [5] proposed Lean Six Sigma methodology can be beneficial for the early notification process used in supplier recovery management. It concentrates on the subtle creation and the key management at the same time. Lean six sigma administration in the supplier recovery administration can bring more practical profit. Lean Six Sigma can be used to demonstrate that how the performance of supplier recovery can be improved practically and effectively.

3. LEAN SOFTWARE DEVELOPMENT IMPROVED QUALITY BY REDUCTION OF WASTES

Lean concept was firstly introduced in 1980's by a research team headed by the Jim Womack, Ph.D., at MIT's International Motor Vehicle Program [4]. Earlier lean methodology was used for the manufacturing industries but now lean can be applied in almost every business and every process. Lean Flow is a method of acting and thinking for entire organization.

The core idea is to amplify client worth while minimizing waste. Basically, lean means making more esteem value clients with fewer assets. A lean association comprehends client value and focuses its key methodologies to constantly expand it. The best objective is to give perfect value to the customer by method for a perfect quality creation process that has zero waste.

To endeavor, Lean flow changes the center of organization from improving separate advances, possessions, and vertical offices to advancing the stream of items and administrations through whole value streams that streams that flow horizontally over assets, technologies and departments to customer. Reducing waste along whole value streams, rather than at isolated focuses, makes forms that need less human exertion, less space, less time to make items, less capital and administrations at significantly less expenses and with much defects, weighed against conventional business frameworks [5][9]. Organizations can answer changing client wishes with high mixture, high caliber, modest, and with amazingly quick throughput times. Additionally, data administration gets to be much less demanding and more exact. Lean Flow specialists have observed that the best achievement can be attained to by systematically looking for out inefficiencies and supplanting them with "leaner", more streamlined procedures. Sources of waste usually infecting generally teaching-learning process include as shown in table1. :

TABLE I: LIST OF 8 WASTES ASSOCIATED WITH THE TEACHING-LEARNING PROCESS

WASTE	DESCRIPTION
DEFECTS	• Lack of standards followed by large groups. • Weak or missing processes
OVERPRODUCTION	• Long set up time for exam, lab and presentation.
WAITING	• Insufficient staffing and absenteeism of either faculty or students participating in particular group project • Inappropriate substitution of lectures • Resource absences • Work absences
NON-UTILIZED TALENT	• Less training provided to students. • Lack of teamwork. • Poor management skills. • Poor communication between teaching staff. • Student present in college but do not participate in practical session completely.

TRANSPORTATION	• Excessive or Un-necessary handling. • Unequal distribution of information. • Less availability of resources such as printer.
INVENTORY	• Incorrect adjustment of workflow among teacher and students.
MOTION	• Shared resources such as printer. • Isolated communication among a particular project team. • Lack of standardize document.
EXCESS PROCESSING	• Excess meeting between group of students and with mentors. • Avoiding institution standard procedures. • Re-handling of work. • Permission seeking.

4. SIX SIGMA STASTICAL METHOD FOR QUALITY IMPROVEMENT

The Six Sigma concept was introduced MOTOROLLA in 1986. Further in 1995 General Electric made this approach central of their business strategy [8]. Six Sigma is typically identified with the number of 3.4 defects for every million opportunities. The word Six Sigma is statistically depends on the basis of the provision of things and service at a rate of 3.4 (DPMO). Individuals frequently view Six Sigma as quality control mechanism; Today Six Sigma is conveying business magnificence, higher client fulfillment, and prevalent benefits by drastically enhancing each procedure in a venture, whether budgetary, operational or creation. Six Sigma has turned into successful methodology of a wide range of businesses, from medicinal services to protection to information transfers to programming. The driving force behind any Six Sigma project originates from its essential center - "acquiring breakthrough enhancements a precise way by managing variation and diminishing deformities". The goal is to stretch and stretch rationally not physically [6] [7].

In today's complex and sophisticated higher education services, the methodology is "pulled" to satisfy the individual needs of the college. In any case regardless of how it is sent, there is a generally speaking structure that drives Six Sigma to progressing execution. Normal Six Sigma characteristics include [12]:

• A methodology of enhancing quality by get-together information, understanding and controlling variety, also enhancing consistency of a university's business forms.

• A formalized Define, Measure, Analyze, Improve, Control (DMAIC) handle that is the outline for Six Sigma changes. (The DMAIC methodology will be depicted in more prominent detail later in this paper.)

• A solid accentuation on quality. Six Sigma undertakings concentrate on exceptional yield zones where the best advantages can be picked up.

• Internal social change, starting with the help from administrator and champions

V.

5. LEAN SIX SIGMA PROCESS IMPROVEMENT MODEL

Lean Six Sigma is really a managerial principle mixing Lean and Six Sigma that effect in the removal of the eight types of wastes / muda (classified as Defects, Overproduction, Waiting, Non-Utilized Skill, Transport, Inventory, Action, Extra-Processing) and an improved convenience of performance. The word Six Sigma is statistically on the basis of the provision of things and service at a rate of 3.4 (DPMO). A mnemonic for the wastes is "DOWNTIME".
A definitive goal of this study is to utilize the Lean Six Sigma approach to remove wastes in the existing process and to enhance the quality. It is planned that this target may be attained by examining the following concerns:

• What was the reason for failure of group projects?

• Were there any regions of disappointment and in what capacity would they be able to be arranged?

• What were the positive results?

• On the off chance that there is any, what are they? Is it true that they are coursework-related, group related, or both?

• Were there any extraordinary perceptions on running group projects?

• Were students quiet with utilizing the product methodology model, demonstrating, and tool?

• Were there normal zones where student performance was comparable in both exam and coursework? In the event that there are any, could the level of student's achievement be connected?

• Was the input feedback during group and practical's session in turn with the results of the above?

Once the results of the above issues have been attained, a case would be planned with recommendations to improve teaching-learning process in computer science engineering. Lean Six

Sigma approach has been used by DMAIC methodology. The methodology followed in this paper stressed on the analysis of process helped with the Lean Six Sigma methodology and LSS tools to recommend a process innovation. Lean Six Sigma methodology is described as follows:

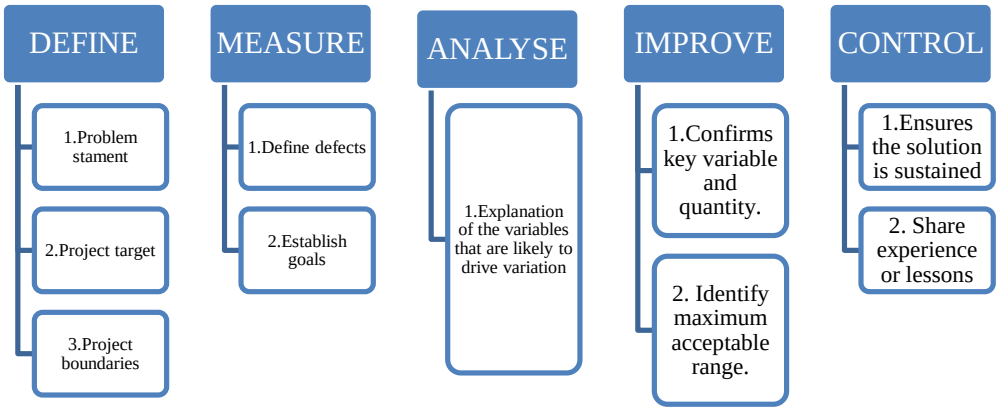

Fig.1. DMAIC Model

A. Define

To attain the goal a survey is conducted within the team members, students and teachers. The first result attained by this methodology was the formal definition from the student's 'point of view' for the objective of the project, project targets and project boundaries.

Project Objective: - Improving the teaching-learning process by achieving the quality without the waste from the student's project and to provide result with enhanced experiences.

Project target: - 97% Project completed on time without incurring any rework and re-handling.

Project Boundaries: Another purpose of this phase was to clearly define what should be extracted and what should not be extracted from the project scope. All the critical points and criteria were identified which could affect the quality such as rewrite data, unavailable data and waiting. As the project advances and more data is gathered in future stages, the issue created in the Define stage was refined [13].

B. Measure

A measure is quantified value or characteristics. In this phase students collected the quantitative and qualitative data to have a clear view on of the current state. Team established a process performance baseline. The size of the project team is considered to be of 11 students and two mentors. The lead time teaching learning process of the project is considered to be of 3 months. A baseline was set, so that the gap between current performance and the required performance could be filled. Four types of possible errors and defects (specified in table.3) were identified within the requirement [13]. All the errors listed, identified and resolved within the development of product. As this phase is little bit complex so it is always better to consider the measure phase along with the define phase. So, that the some of the problem or errors are known to developer at the beginning of this phase.

C. Analysis

In order to check the correctness, questionnaire is used to obtain the data. The questionnaire obtain from the student feedback form is used to identify the root causes of the process failure. This data helped us to understand the gap between teacher and student. The team member will responds to each statement and evaluate each of the statement by using the software measurement scale known as Likert's Scale which have value from 1to 5 where 1 is "below average" and 5 is for "excellent"[1]. Tabulation of this questionnaire is shown below in table II:

TABLE II
Feedback collected for performance measurement and process management

Question	# no. of respondent	Likert Score (1to5)	Mean	σ(std. deviation)
Do you believe that LSS significantly improves the process?	11	1-5	5	0
Do you accept that by executing Lean Six Sigma the association has fundamentally expanded it profit?	11	1-5	3.777778	0.440959
Do you accept that Lean Six Sigma has removes all kind of waste?	11	1-5	3.777778	0.440959
Has Lean Six Sigma been effective in meeting at the objectives/desire of student's project effectively?	11	1-5	4.111111	0.781736
Do you accept that Lean Six Sigma Venture helps in management skills?	11	1-5	3.222222	0.833333
Do you accept that by using Lean Six Sigma satisfaction level and confidence level of student increases?	11	1-5	3.111111	0.927961

In table II, first column represent the question that has been asked to students in the feedback where second column represent the total number of students and teacher responds to the questionnaire. The fourth column of the table represents the average responses of the students and teacher to the individual questions. As we can see
That 7th row of the table has the minimum value which indicates that level of the satisfaction of the students remained a complicated sign. To prove the precision of the result we used a Cronbach's Alpha value analysis using the single Factor [1]. The result is shown in Fig. 2:

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.474747	8	0.434343	0.247696	0.980245	2.042986
Within Groups	157.8182	90	1.753535			
Total	161.2929	98				
alpha	0.752304					

Fig.2. Reliability measure using ANOVA

To prove the relevant result, Cronbach's Alpha value should always be considered to be greater than or equal to 0.7. From the above result value of alpha (α) obtain is 0.752304. So the results shows that answer are significant for evaluated variable.

The Fig. 3 shows main deficiencies of the process failure during the student's project development. This Pareto diagram has been drawn using information collected through the feedback. The level of concern shows that we have rated by using the likert's scale.

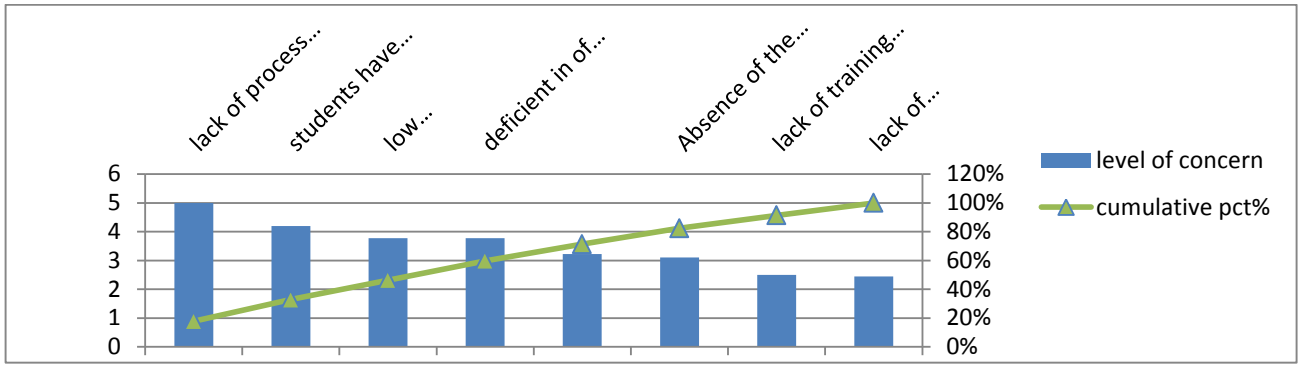

Fig.3. Pareto chart

D. Improve

The motivation behind this step was to recognize, test and actualize an answer for the issue; to some extent. Recognize inventive answers for wipe out the key underlying drivers so as to alter the issues found. As teaching-learning process is iterative process then to control and manage the process PDCA cycle is used in which we iteratively managed the process and control to continuously improving the process. PDCA Cycle helped to come closer to our aim, usually an ideal operation and output [10].

E. Control

Once the change is understood, the objective is to control the enhanced procedures and support the Lean Six Sigma activity. Support quality control information specimens and estimations are booked and dissected to confirm that the procedure change issue characterized in the first stage [13].

The reason for this step was to maintain the benefit. Screen the upgrades to guarantee maintainable achievement. Make a control plan. Redesign report, business process and preparing report as needed. This phase enhanced the confident in the user as at this level were identified and removed. A control plan was prepared and for the entire newly designed task verification [2] [3].

6. CONCLUSIONS

Lean Six Sigma has proven its effectiveness in various application areas. This paper focuses on how Lean Six Sigma can be used to increase efficiency by reducing effort and improving quality. In this paper author tries to reduce the waste associated with the Teaching-Learning Process by using Lean Six Sigma. Various tools and techniques have been used by the students, teachers and experiment shows the fact of Process improvement. The future scope of this paper is to come up with detail implementation of the above said problem with detail data used to improve the various process of education sector using Lean Six Sigma.

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