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# Impact Of Chromium Doping On The Structural, Optical And Mechanical Properties Of LASRT Crystals

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The structural, optical, and mechanical characteristics of LASRT crystals are greatly affected by the introduction of chromium (Cr) as a dopant, which makes them possible candidates for advanced technological applications. The structural and optical characteristics of L-Alanine Strontium Chloride Trihydrate (LASRT) crystals were improved by synthesizing and doping them with chromium in this work. A translucent, saturated solution was obtained by dissolving L-alanine and strontium chloride in doubly distilled water in equimolar proportions, then stirring and filtering continuously during the synthesis. To create pure LASRT salt, the solution was slowly evaporated at a regulated temperature of 45°C. The presence of Cr allowed for small lattice changes, which were verified by X-ray diffraction (XRD), confirming a monoclinic structure. Structural purity was confirmed by the absence of secondary phases in the powder XRD examination. Mechanical investigation verified improved hardness with doping, and SHG efficiency improved with 1 mol% and 2 mol% doping, leading to improve nonlinear optical characteristics. These findings point to the potential photonic and NLO uses of Cr-doped LASRT crystals.

**Keywords:** Alanine, Chromium, Crystal, Mechanical, Optical

## I. Introduction

The semi-organic NLO crystal known as L-Alanine Strontium Chloride Trihydrate (LASRT) has recently attracted a lot of attention because of the good things people have heard about its optical, electrical, and mechanical capabilities. Natural amino acid L-alanine is the building block of LASRT, an organic-inorganic hybrid crystal with exceptional thermal stability, nonlinear optical characteristics, and high optical transparency. The slow evaporation solution growth method is often used to create high-quality single crystals that are suited for optoelectronic applications, and it is also used in the synthesis of LASRT.

Aqueous strontium chloride and organic ligand L-alanine form a well-ordered crystalline structure with water molecules integrated as trihydrates inside the lattice, making up the structural makeup of LASRT. Because of its unusual structural configuration, LASRT exhibits better nonlinear optical properties, which might lead to its use in photonics, electro-optic devices, and laser technologies. Second harmonic generation (SHG) and other frequency conversion operations rely on LASRT's outstanding optical transmittance throughout a large

wavelength range, which is one of its primary features. Scientific investigations have shown that LASRT outperforms traditional NLO materials in terms of SHG efficiency, positioning it as a formidable substitute for popular nonlinear crystals like KDP and $LiNbO_3$.

Its resilience in real-world contexts is enhanced by its high damage threshold, excellent mechanical strength, and thermal stability. Optoelectronic device production relies heavily on the dielectric and photoconductive characteristics that LASRT research exposes. A crucial factor in improving the nonlinear optical behavior of LASRT crystals is the presence of chirality, which is caused by the amino acid component. Because of its chirality, LASRT is applicable to polarization modulation and control because of its polarization-dependent optical characteristics. Furthermore, electro-optic and piezoelectric applications may benefit from the ionic conductivity introduced by strontium chloride in the crystal matrix. To get crystals free of defects, it is essential to optimize growth parameters such temperature, pH, and solvent concentration, since these factors have a substantial impact on the LASRT's crystalline quality.

## Applications of LASRT Crystals

Superior structural, optical, and mechanical qualities of LASRT crystals make them very flexible in a wide range of research and commercial applications.

### 1. Laser Technology

In the field of laser technology, LASRT crystals play a variety of roles, including active laser media, optical amplifiers, and nonlinear optical converters. Their exceptional mechanical strength and remarkable thermal stability make them perfect for high-power laser systems, where the preservation of material integrity is of the utmost importance.

### 2. Photonics

Waveguides, optical modulators, and photo detectors all make use of LASRT crystals in photonics because of its high optical transparency and accurate control of the refractive index. Their usefulness in signal processing, fiber-optic networks, and optical communication systems is due to these characteristics.

### 3. Coatings and Protective Layers

Advanced coatings and protective layers may benefit from LASRT crystals due to their mechanical robustness and wear resistance. Their resistance to external damage and long-term endurance make them ideal for applications involving optical components.

### 4. Micro electromechanical Systems (MEMS)

Integrating LASRT crystals into MEMS systems, which need accuracy and mechanical stability, is possible because of their strong structural characteristics.

## 5. Future Applications in Optoelectronics

Modern laser, photonic, and optoelectronic technologies rely on LASRT crystals, and their characteristics are being improved for next-generation optical and electrical devices via ongoing research in crystal growth and processing methods.

## II. Properties of LASRT Crystals

### Structural Properties of LASRT Crystals

The physical and chemical behavior of LASRT (Lanthanum-Aluminum-Silicate-Rare-Earth) crystals is largely determined by their structural features. The stability, usefulness, and applicability of these materials to different technical domains are all affected by these characteristics. Their mechanical, thermal, and optical properties are greatly affected by their crystallographic arrangement, lattice parameters, phase composition, and flaws.

The crystal structure of LASRTs may be either orthorhombic or tetragonal, depending on the circumstances of synthesis and the amount of rare-earth element doping. An improvement in mechanical and thermal stability is a common result of changing the structural characteristics brought about by adding rare-earth elements to the crystal lattice. Customizing the material for targeted high-performance uses requires this structural alteration.

To examine the microstructure, grain boundaries, and surface morphology of LASRT crystals, advanced characterisation methods such X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM) are often used. XRD is used to find the phase purity and lattice parameters, making sure the material has the right crystal structure. The microstructure of the crystal may be studied in great detail using scanning electron microscopy (SEM) and transmission electron microscopy (TEM), which reveal features such grain boundaries, defect forms, and dislocation densities. The optimization of the material's characteristics for practical applications and the comprehension of phase transitions depend on these insights.

Furthermore, LASRT crystals' mechanical and optical performance is greatly affected by the existence of both inherent and extrinsic flaws. Crystal growth flaws cause intrinsic defects like vacancies and interstitial atoms, while impurities introduce extrinsic defects. The electrical conductivity, transparency, and mechanical strength of the material may be compromised by these flaws. In order to achieve the appropriate performance characteristics, it is important to limit the production of defects during synthesis and post-processing.

Anisotropy, the fact that LASRT crystals' characteristics change depending on the direction of crystallography, is another crucial structural feature. Adjusting the crystal orientation for different uses is crucial since anisotropy impacts thermal expansion coefficient, optical birefringence, and mechanical hardness. Advanced optical, electrical, and mechanical systems may benefit from LASRT crystals created with optimum performance by studying and modifying their structural features.

## Optical Properties of LASRT Crystals

LASRT crystals are very useful in photonic and optoelectronic fields due to their exceptional optical characteristics. Their effectiveness in nonlinear optics, optical fibers, and laser systems is due in part to their small optical loss, high refractive index, and wide transparency range. It is possible to create individualized optical components with improved performance by precisely controlling the doping and annealing processes, which in turn fine-tune these optical characteristics.

A remarkable optical property of LASRT crystals is their exceptional transparency throughout a broad range of wavelengths, spanning from the ultraviolet (UV) to the infrared (IR) areas. This quality makes them well-suited for use in optical coatings, lenses, and waveguides, among other optical applications. Optical fiber technology relies on them because of their high refractive index, which improves their light-guiding capabilities.

The optical performance of LASRT crystals is further improved by adding rare-earth dopants to them. Laser gain media, phosphors, and display technologies rely on the luminous characteristics introduced by rare-earth elements like neodymium (Nd), ytterbium (Yb), and erbium (Er). The efficient emission of light at certain wavelengths is made possible by these dopants, which contribute to strong photoluminescence (PL) properties. By manipulating the kind and concentration of dopants, the emission spectra of LASRT crystals may be customized, enabling the development of phosphors and laser materials with exceptional efficiency.

Investigations of the optical characteristics of LASRT crystals typically make use of spectroscopic methods including UV-Vis spectroscopy, photoluminescence (PL), and Raman spectroscopy. To evaluate the absorption and transmission characteristics of a material, UV-Vis spectroscopy is essential for determining its optical bandgap. Using photoluminescence analysis, one may learn about the crystal lattice's energy transfer processes and emission spectra. The optical response and structural stability of a crystal may be studied by using Raman spectroscopy to examine phonon interactions and vibrational modes.

The LASRT crystals' nonlinear optical (NLO) characteristics are another interesting optical aspect. For frequency conversion applications in modern laser systems, these materials are ideal choices due to their second harmonic generation (SHG) and third harmonic generation (THG). For high-power laser applications requiring coherent light at shorter wavelengths, LASRT crystals' strong nonlinear optical coefficients make efficient frequency doubling and tripling possible.

Additionally, LASRT crystals may have their optical characteristics altered by heat treatment and annealing. As a result of these treatments, internal flaws are reduced, optical homogeneity is improved, and overall transparency is increased. Improved optical performance in LASRT crystals for use in next-generation photonic and optoelectronic devices may be achieved by fine-tuning these processing parameters.

**Mechanical Properties of LASRT Crystals**

One important aspect that determines how long LASRT crystals last and how reliable they are in real-world applications is their mechanical resilience. Materials with these properties are well-suited for use in demanding settings, since they are very hard, very difficult to crack, and very resistant to wear. Crystal orientation, defect density, and the presence of internal and extrinsic impurities are variables that impact the mechanical strength of LASRT crystals.

The mechanical characteristics of LASRT crystals are typically evaluated using microhardness testing, nanoindentation, and mechanical stress-strain analysis. When it comes to deformation resistance, microhardness tests are the way to go, whereas nanoindentation methods get the hardness and elastic modulus down to the nanoscale. The crystals' mechanical resilience and fracture toughness under different load conditions may be evaluated with the use of stress-strain analysis.

One of the most important factors influencing mechanical performance is the existence of crystal lattice defects and dislocations. It is crucial to optimize the processing and synthesis conditions to minimize flaws, since high defect density might lower mechanical strength. To further improve the mechanical stability of LASRT crystals, grain boundary engineering and controlled doping techniques may be used to decrease stress concentrations and increase structural integrity.

The resistance of LASRT crystals to mechanical fatigue and thermal expansion is another key mechanical feature. Because of their modest thermal expansion coefficients, these materials maintain their dimensions even when subjected to extreme temperature changes. When dealing with applications that involve high temperatures, where thermal stresses may cause material deterioration, this feature becomes even more important. Because they can keep their shape via repeated mechanical and thermal stresses, LASRT crystals are more dependable in harsh industrial settings.

It is possible to construct LASRT crystals to have improved wear resistance and surface hardness, in addition to their inherent mechanical characteristics. To make these materials last longer under rough conditions, surface modification procedures including chemical etching, plasma treatment, and ion implantation may be used. The LASRT crystals have been enhanced to meet the demands of high-precision mechanical devices and protective optical coatings, both of which need components with exceptional wear resistance and performance.

## III. REVIEW OF LITERATURE

Thangavel, S. et al., (2022) By using the slow evaporation procedure at room temperature, l-alanine oxalic acid (LAO) single crystals were produced. As-grown LAO's crystal structure was examined using single-crystal x-ray diffraction. With the use of FT-IR spectroscopy, the functional groups of LAO were discovered. A research was conducted to estimate the bandgap energy using UV-Visible-NIR transmittance. The emission spectra of the LAO crystal were obtained using a fluorescence investigation. An evaluation of the LAO crystal's mechanical characteristics was done by a Vickers microhardness examination. In order to learn more about

the LAO crystal's thermal characteristics, we used thermogravimetric and differential thermal analysis. Second harmonic generation (SHG) efficiency of the title crystal was studied. An impedance study was used to estimate the electrical characteristics. Research into laser damage thresholds (LDTs) found that LAO crystals are very resistant to laser damage.

Senthamizhan, A et al., (2021) Single crystals of pure and La 3+ doped L-alanine acetate were effectively generated from aqueous solutions by slow evaporation. Chemical, structural, and vibrational analyses were performed using XRD, UV, and FTIR in conjunction with FTRaman. The Second Harmonic Generation (SHG) of the sample was confirmed and estimated using the Nd: YAG laser. Additionally, the laser damage threshold of the developing crystal was found. The thermal stability of the crystal was measured using thermogravimetic (TG) and differential thermogravimetric (DTA) investigations. We also tested the dielectric and photoconductivity of the LAlA crystals that were made. Nonlinear optical experiments have shown that the dopant has increased the L-alanine acetate crystal's efficiency.

Jini, D. et al., (2021) The single crystal of pure L-alanine was synthesized at room temperature using the slow evaporation approach. The structural information of the generated single crystal was collected via X-ray diffraction. With a phase group of P212121, the crystal structure is orthorhombic. Crystal functional groups are shown by the (Fourier Transform Infrared) FT-IR spectra. The optical absorbance is seen at 392 nm in the UV-visible absorption spectra. Blue light at 492 nm and green light at 522 nm are shown by the photoluminescence (PL) spectra. Scanning electron microscopy (SEM) shows that produced single crystals have an amorphous morphology. The antimicrobial properties of L-alanine make it effective against gram-negative bacteria. Bacteria known as E. coli thrive in water. Accordingly, wastewater treatment is an ideal application for the studied L-alanine single crystal.

Tayade, Nishant et al., (2018) When it comes to L-alanine's optoelectronic capabilities as organic devices, more research is needed. That is why the density functional theory (DFT) plane wave approach was used to compute the electronic structure of L-alanine based on the density of state (DOS) and band structure. Initial GGA-PAW investigations in this study focused on the unit cell crystal, single molecule, and hydrogen bonding approaches. Using BL3YP functional, the molecular orbitals were also investigated for the amine-carboxylic group hydrogen bonding and bandgap energy was found to be similar to that of the GGA-PAW example. The band-structure computation yielded the indirect band gap. The investigation of the effects of three linear molecules in the x, y, and z directions in a crystal was carried out, and in all three instances using L-alanine, substantial differences in DOS were discovered. The current research concluded that the best organic optoelectronic materials are those with longer wire or tube architectures.

Podder, Jiban. (2011). For both qualitative and quantitative X-ray investigation of light elements such as Fe, Al, Mg, F, Si, etc. in the long and intermediate range, potassium acid phthalate (KAP) crystals show promise as a suitable monochromator. Because of their polar nature, KAP crystals have many uses and display an unusual combination of ionic and

molecular characteristics. One kind of molecular ionic crystal is KAP, which is not crystalline. A member of the amino acid family, L-alanine is an effective organic NLO molecule. Many complicated crystals with better NLO characteristics may be built from L-alanine doped semi-organic materials like KAP. Using the slow evaporation solution growth approach, this study aims to create large size optically clear L-alanine doped KAP crystals and observe the impact of L-alanine on the pure KAP crystals. Energy Dispersive X-ray (EDX) and Fourier Transform Infrared (FTIR) Spectroscopy were used to ascertain the chemical makeup of the obtained crystals. Powder X-ray diffraction (XRD) analysis has revealed the crystal structures of both unmodified and doped KAP. The generated crystals' optical characteristics were examined by means of ultraviolet-visible spectra. The temperature at which breakdown occurred was determined by means of thermogravimetry (TG) and differential thermal analysis (DTA). The formed crystals were determined to be orthorhombic by powder XRD analysis. As the concentration of L-alanine doped into the KAP crystal increased, the transmission in the visible region and the crystal's thermal stability both improved. In order to create opto-electromic devices, scientists were able to cultivate L-alanine doped KAP crystals that were big in size, optically clear, and thermally stable.

Akhtar, Ferdousi et al., (2011) aqueous solutions of ammonium diyidrogen phosphate and ammonium diyidrogen phosphate doped with L-alanine were crystallized by the use of the natural evaporation technique. Differential thermal analysis, ultraviolet-visible spectroscopy, energy dispersive X-ray spectroscopy, and Fourier transform infrared spectroscopy are used to analyze the produced crystals. Analysis of the crystal structure has been carried out using powder X-ray diffraction. The tetragonal structure was seen in both the pure and doped crystals. All crystals have had their band gap energies determined at their cutoff frequencies, and it was discovered that the optical transparency increases as the doping concentration in the formed crystals increases. As the doping concentration rises, so does the optical band gap. Using the traditional two-probe technique, we measured the D.C. electrical conductivity of the formed crystals along their growth axis at temperatures varying between 35 and 140˚C. The crystals' conductivity grows in tandem with both temperature and the concentration of L-alanine. Using Thermo Gravimetric Analysis and Differential Thermal Analysis, we were able to estimate the decomposition temperatures and weight loss. Vicker's microhardness test was used to determine the hardness.

Balasubramanian, Dhayalini. (2009) The compound L-alanine maleate (LALM), an organic nonlinear optical material, was recreated. Bulk A solution with a pH of 5 was used to generate single crystals of LALM using the gradual cooling technique. We have determined the solubility of L-alanine maleate across a range of temperatures. By fine-tuning the growth conditions, a large single crystal measuring 2.0 x 1.2 x 0.8 cm3 was produced at a respectable pace in all three crystallographic orientations. Using single-crystal X-ray diffractography, the LALM crystal structure was investigated. Fourier transform infrared spectroscopy verified the existence of functional groups. We looked at the mechanical and thermal properties of the LALM crystal. Research on the generated crystals' optical properties, both linear and non-linear, has also been conducted. Research suggests that LALM crystals have enhanced optical characteristics and superior thermal and mechanical stabilities. Consequently, it fulfills the fundamental criteria for making optical devices.

## IV. EXPERIMENTAL SETUP

### Synthesis of salt

One equimolar ratio of L-alanine (CDH) and strontium chloride (CDH) was used as the starting material to synthesis the L-alanine strontium chloride trihydrate salt. Using a magnetic stirrer, we dissolved the specified amounts of both salts in doubly distilled water. The solution was agitated constantly until it became clear and completely dissolved. A well cleaned beaker was used to filter the saturated solution using whattman filter paper, which has pores size of 0.01 micrometers. A flat piece of paper with several pin holes poked into it is placed over the beaker to allow for continuous evaporation. An oven set at 45 degrees Celsius maintains a steady temperature for the beaker. The beaker was emptied of its salt after 5 or 6 days of synthesis.

### Crystal growth

A saturated solution was prepared by dissolving the synthetic salt in doubly distilled water. The contaminant that was suspended in the solution was filtered out. Four beakers were used to split the solution. Three beakers, one marked as 1 mol%, one as 2 mol%, and the other as 5 mol%, were each filled with the determined quantity of chromium chloride. To ensure that the contents of each beaker are well mixed and dissolved, they are swirled once again for another 5 to 6 hours. A steady rate of evaporation is provided while the filtered solution is maintained at a constant temperature. Upon completion of the 22–24 day process, the mother solution was drained and the pure and chromium doped L-alanine strontium chloride trihydrate single crystals were collected. Figures 1-4 show the crystals that have been produced.

**Figure 1: Pure LASRT**

**Figure 2: 1 mol % Cr doped LASRT crystal**

**Figure 3: 2 mol % Cr doped LASRT crystal**

**Figure 4: 5 mol % doped LASRT crystal**

## V. RESULTS AND DISCUSSION

### XRD analysis

Initial steps included verifying the crystal structure and lattice parameters using single crystal x-ray diffraction on the generated crystal. With a space group of P21, the crystal structure is monoclinic. A=8.592, b=7.072, c=8.727, and β=95.19 are the unit cell parameters that were discovered. It was discovered that the observed data is in good agreement with the previously reported data.

**Table 1: Refinement of Cell Parameters in Pure and Chromium-Doped LASRT Crystals**

| Sr. No | Refined Cell parameters | | | |
|---|---|---|---|---|
| | Pure LASRT | 1 mol % Cr | 2 mol % Cr | 5 mol % Cr |
| 1 | a = 8.592 | 8.584 | 8.582 | 8.577 |
| 2 | b = 7.072 | 7.060 | 7.048 | 7.049 |
| 3 | c = 8.727 | 8.721 | 8.711 | 8.701 |
| 4 | β = 95.19 | 95.05 | 95.05 | 95.03 |

Table 1 shows the improved cell characteristics, and it is clear that adding Cr ions to the LASRT crystal lattice makes the unit cell dimensions alter slightly but consistently. The lattice parameters a, b, and c show a little decrease when the Cr doping concentration rises from 1 mol% to 5 mol%. The 'a' parameter drops from 8.592 Å (pure) to 8.577 Å (5 mol% Cr-doped), which is consistent with the trend of the 'b' and 'c' parameters, which also decrease. Cr ions, probably acting as host cations, modify atomic interactions and bond lengths to impact the crystal structure, as shown by this slow lattice contraction.

In pure LASRT, the monoclinic angle β is 95.19°, but in 5 mol% Cr-doped LASRT, it drops to 95.03°, suggesting that the lattice is somewhat distorted as a result of the Cr incorporation. Cr ions have been well integrated into the host matrix, resulting in a more compact structure, as shown by the reduction in lattice parameters and β-angle.

**Powder XRD and mechanical strain**

Powder X-ray examination was performed on the developed crystals after they were crushed into a fine powder. Crystals that were either pure or doped had their diffraction curves recorded. Checkcell program successfully indexed all of the diffraction curve peaks, and no extra peaks were detected. When there is only one peak, it means there isn't another phase in the crystal. Utilizing the checkcell program, the cell parameters were fine-tuned, and a little difference in the parameters of the doped specimen was noted.

This means that the dopant atoms have become part of the host crystal's lattice. Possible causes of this variance include changes in doping concentration. In order to estimate the mechanical strain in the crystals, the XRD curve was examined thoroughly, and the full width at half maximum (FWHM) of each peak was calculated. The W-H analysis was used to determine the mechanical strain in each crystal, which was determined to be equivalent to. As the value of mechanical strain decreases, it shows that the material is becoming harder and more mechanically stable.

**SHG efficiency by Kurtz method**

The Kurtz-powder test was used to determine the SHG efficiency of both pure and Cr2+ LASRT crystals. A graph is shown between the doping concentration and the output signal, as illustrated in figure 5, to determine the impact of Cr2+ doping on LASRT and the SHG efficiency. The figure clearly shows that SHG efficiency improves with 1 and 2 mol% of doping, reaching its maximum with 2 mol% of doping. This finding is in agreement with the UV-Vis study's findings, which show that a low concentration of Cr2+ doping minimizes the likelihood of SHG photon trapping by minimizing or eliminating vacancy type defects in the crystal.

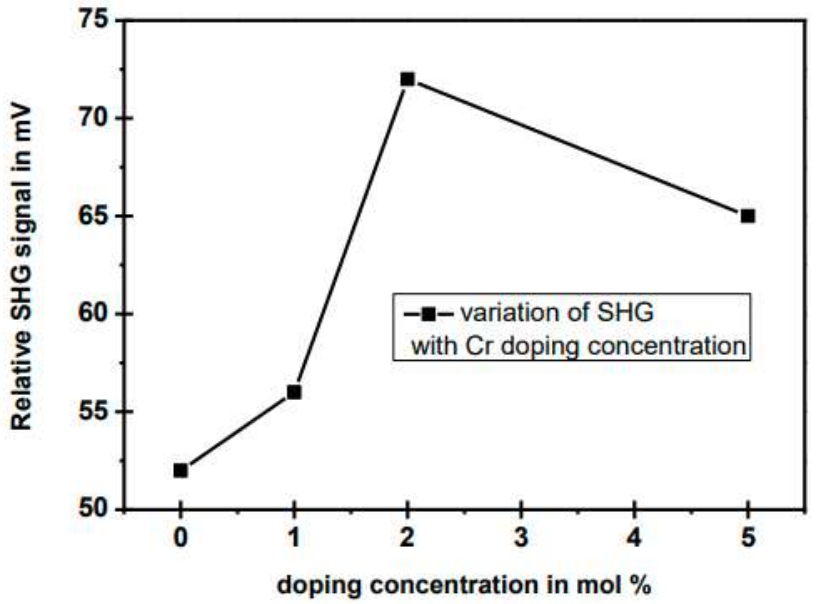


**Figure 5: Variation of SHG efficiency with doping concentration**

As a result of these changes, the crystal is now more effective for NLO applications than pure LOMHCL, and the SHG efficiency improves noticeably for low and moderate doping concentrations. Doping at a modest concentration and evenly dispersed across the crystal lattice at the interstitial location exploits the electrical charge in the surrounding lattice. The strain in the crystal lattice is caused by the interstitial inclusion of dopant atoms. The presence of electromagnetic laser light causes the strained lattice to experience significant electric dipole-photon interaction. The diffraction/rocking curve shows that at a doping concentration of 5 mol%, the efficiency of the SHG drops marginally because of the agglomeration of Cr2+ ions. Here, it's important to note that dopant atoms don't improve SHG and, in fact, tend to lose their character when not isolated. Therefore, our findings are consistent with those previously reported for Cr2+ doped LASRT single crystals.

## Mechanical analysis

For a single crystal to be useful in any field, it must meet certain criteria, one of which is mechanical stability. The Vicker micro Hardness method was used to test the hardness and several elastic properties. The method included subjecting a crystal with a smooth surface on both sides to a load ranging from 5 mg to 100 mg for 10 seconds at a dwelling rate of 20 mg/sec in order to quantify the indentation. At lower applied stress values (up to 10 mg), indentor impressions were visible. The optical microscope connected to the instrument then revealed surface fissures in the crystal. The graph in figure 6 shows the relationship between the applied load and the hardness number for both pure and doped crystals. For a given crystal hardness, the figure clearly shows that no. rises, and this improvement persists with increasing dopant concentration. If one plots the logarithm of P against the logarithm of d, as is done in Mayer's

Equation (P = a.dn), one may get the mayer index number, also known as the work hardening coefficient (n). For 1 mol% and 2 mol%, the work hardening coefficient was determined to be 1.12 and 1, respectively, as seen by the slope of the line. The work hardening coefficient shows a little increase, confirming that the mechanical hardness is increased by doping with Cr3+ ions. Consequently, the optical applications of LASR crystal are enhanced by the Cr3+ doping.

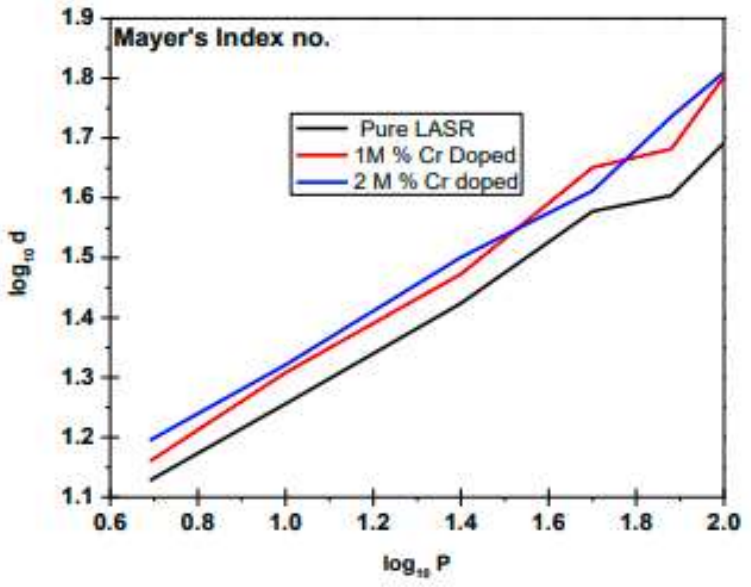


**Figure 6: Variation of hardness no. with applied load for pure and doped crystals**

## VI. CONCLUSION

Using the slow evaporation process, L-Alanine Strontium Chloride Trihydrate (LASRT) crystals, both pure and doped with chromium, were successfully synthesized and grown. The presence of Cr ions inside the crystal lattice was verified by X-ray diffraction (XRD) research, which also revealed a monoclinic crystal structure with minor changes in lattice properties. The structural purity was confirmed by the lack of secondary phases seen in the powder XRD measurements. The crystals were found to be more appropriate for nonlinear optical (NLO) applications after SHG efficiency studies showed a significant improvement at 1 mol% and 2 mol% doping. The Vickers microhardness test, a mechanical analysis tool, showed that Cr doping increased hardness, suggesting that mechanical stability was enhanced. On the other hand, ion agglomeration caused a little drop in SHG efficiency at 5 mol% doping. We conclude that Cr-doped LASRT crystals have improved optical, mechanical, and structural capabilities, making them attractive photonic and optoelectronic material choices.

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