Growth and Study of L-Tyrosine Based Single Crystal for Photonic Applications: A Review

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Abstract - In the recent days the amino acid plays a vital role in the manufacturing of opto-electronic devices. The no essential amino acid named as L-Tyrosine ($C_9H_{11}NO_3$) used in the growth of non-linear single crystal. A single crystal of L-Tyrosine doped with either phenolic compound or aromatic compound will be grown at constant atmospheric temperature using slow solvent evaporation technique. The addition of either phenolic compound or aromatic compound replaces hydroxyl element from tyrosine which changes the physical and chemical properties for NLO and optical applications.

Key Words: *Tyrosine, L-Tyrosine, Amino acids, Photonics NLO*

1. INTRODUCTION

Photonic crystals (PCs) are highly ordered materials that possess a periodically modulated dielectric constant, with the properties of confining and controlling the propagation of light owing to the existence of photonic band gap, a band of frequencies in which light propagation in the photonic crystal is forbidden. Therefore, photonic crystals are also known as photonic band gap materials. Photonic crystals have been the subject of numerous investigations since the original work of Yablonoviteh (1987) and John (1987). Because of their unique characteristics, the potential applications of photonic crystals are highly prospective, ranging from gas sensing to optical filters, photonic papers, inkless printing, and reflective flat displays. According to variations in the refractive index and period in space, there are one-dimensional (1D), two-dimensional (2D), and three-dimensional (3D) photonic crystals. In particular, 3D photonic crystals have permittivity modulation along all three directions. If the 3D PCs possesses a sufficiently high refractive index ratio, suitable periodicity, and a dielectric filling ratio, a full band gap might be formed. Thus, light with a specific frequency will be forbidden within three directions of photonic crystals, which facilitates control of the spontaneous emission and propagation of light. Thus, 3D photonic crystals are considered to be a one of the most potential materials. To study and characterize these photonic crystals is hot topic in recent times. Several reports are available on the photonic crystals and very limited articles found in 3D photonic materials **[1].** Among other uses, photonic-crystal fibres, or two-dimensional photonic crystals, are employed in fiber-optic communication. Three-dimensional crystals have the potential to become more effective solar cells and be employed in optical computers in the future **[2].**

2. REVIEW OF THE LITERATURE

In the literature, very limited articles are available regarding the L-Tyrosine based photonic crystals and I have presented here some important articles and its synopsis.

M. Anis et.al. (2023) has studied the L- Tyrosine photonic device applications. The transmittance of the prepared crystal is around 90%. The wide optical band gap energy 3.76 eV with in the wavelength range 350-640nm. This result as certain that the grown crystal can be used in photonics and optoelectronic applications. The PL analysis conform the maximum emission at 402 nm. Looking at the results, Tyrozine is proven to be vital dopant for optimizing the optical traits of ZTS crystal and Ty-ZTS crystal with such linear–nonlinear optical traits may be suitable for a wide range of optical applications **[3].**

V. Bhuvaneswari et.al. (2023) have reported the study of tyrosine, glutamic acid and tryptophan amino acids for optical applications. They did XRD analysis, FTIR analysis, UV-Vis spectrum and thermal analysis to analyze the various parameters of prepared crystal **[4].**

Pavithra Verthikere Ravi et.al. (2022) have studied characteristic property of tyrosine. She studied UV-Vis spectrum, Spectro fluoro photometer, FTIR spectroscopy, High-Resolution Transmission Electron Microscope, XRD, Laser Raman analysis. She found the absorption wavelength of sample is 409 nm and emission wavelength is 494 nm. The calculated wavelength of the prepared crystal is 3.15 eV **[5].**

R. Vivekanandhan et.al. (2021) has investigated the L-Tyrosine Barium Chloride Single Crystal for Photonic applications using slow evaporation technique. Single crystal X-ray diffraction analysis shows the grown crystal crystallized in orthorhombic system with space group P. FTIR showed the orientation of discrete functional group in the grown crystal. The optical absorption studies show the material has largish optical transparency in the total visible region. The band gap energy values were also determined by using the optical studies with Eg = 6.34 eV. The electrical behavior of the crystal was studied by dielectric method.

The hardness values of crystal were estimated by Vickers micro hardness tester and other such properties show the suitableness of the L-Tyrosine Barium Chloride crystal for photonic and optoelectronic applications **[6].**

Manju Kumari et.al. (2020) has reported previously about optoelectronic application of L-Tyrosine. The prepared crystal is subjected to characterize by XRD, NLO study, FTIR, HXRD, UV-Vis Spectroscopy, Photoluminescence, derivative thermogravimetry (DTG) and other studies. They stated that, L-tyrosine is a very good material for optoelectronic device application from the characterizations **[7].**

Ilango E et.al. (2020) were analyzed the L-Tyrosine Zinc Acetate Single Crystals for photonic applications. The grown crystals LTZA were characterized using single crystal XRD and confirmed by powder XRD. Using FT-IR spectroscopy the functional groups and the modes of vibrations of LTZA were identified. The UV-Vis- NIR transmittance spectrum shows that good transmittance in the visible region with the lower cutoff wavelength at 235 nm. The energy band gap value is 5.289eV. The thermal, mechanical, dielectric studies also performed for grown crystal **[8].**

The similar works and some importance research gaps (coloured) are in Table-1.

In this table, P refers Studies Performed and NP refers Studies Not Performed

3. METHODOLOGY

The method of gradual solvent evaporation will be used to prepare the single crystal of L-tyrosine, same as it is for other dimensional amino acid photonic crystals. For example, single crystal L-tyrosine is produced as a solution by adding appropriate derivatives for potential optoelectronic applications, as reported in the literature. The mixture is stored in a beaker with a tight lid. The developed crystal obtained after 15–30 days. After grown the crystal, we expect the following change in the L-Tyrosine. The possible replacements of element/ compounds are shown in Fig 1.

In addition, the sample will characterize using advanced methods such as NMR, FTIR, UV-Vis-NIR Spectroscopy, XRD, and dielectric studies. In order to improve the outcomes, we employ a few more pertinent strategies. The methods will be carried out in a laboratory environment, and the synthesized crystals' investigations and characterizations will be further examined therein and in external labs such as NIT's, IIT's, IISc, CSIR labs…etc.

Year	Name of The Journal	Studies				
		XRD	FTIR	UV- Vis	NLO	Dielectric
2023	Optik - International Journal For Light And Electron Optics	P	P	P	NP	NP
2023	Journal of Nonlinear Optical Physics & Materials **[9]**	P	P	P	NP	NP
2022	Materials Advances	P	NP	P	NP	NP
2022	Diamond & Related Materials	P	P	NP	NP	NP
2021	Research Square	P	P	P	NP	P
2020	J Mater Sci: Mater Electron	P	P	P	NP	NP
2020	Nanomedicine & Nanotechnology Open Access	P	P	P	NP	P
2020	Optik - International Journal for Light and Electron Optics 220 **[10]**	P	NP	P	P	P
2013	Optik **[11]**	NP	NP	P	NP	NP
2012	Optoelectronics and Advanced Materials–Rapid **[12]**	P	P	P	P	NP
2010	Journal of Crystal Growth Communications **[13]**	P	P	P	P	NP

Table -1: Sample Table format

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 01 | Jan - 2025 SJIF Rating: 8.448 ISSN: 2582-3930

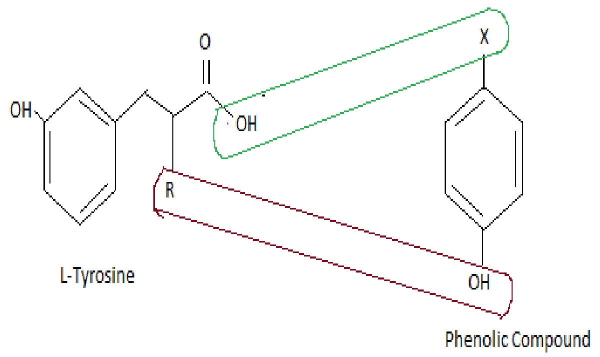

Fig-1. The possible exchanges between L- Tyrosine and Phenolic Compound

4. EXPECTED OUTCOME

The goal of the current study is to generate highly significant articles and reviews. Nevertheless, research on 1D, 2D and 3D crystals may produce some novel findings. From an application standpoint, I have focused on a few particular cutting edge applications for 1D and 2D crystals, covering light detection, telecommunication, information processing, photovoltaics, metrology, spectroscopy, holography, and medical applications. For 3D crystals, I have targeted applications for molecular imprint sensors. For instance, dielectric and NLO investigations will be conducted on the produced single crystal of L-Tyrosine. In order to reduce both the dielectric constant and dielectric loss, several derivative material ratios will be tested. Generally speaking, a greater dielectric constant corresponds to a higher refractive index. When adding derivatives, we anticipate a dielectric constant value of less than two at lower frequencies.

5. CONCLUSION

We aims to grow single crystal of phenolic element combined with L-Tyrosine which gives good results due to replacement of hydroxyl position in L-Tyrosine by X element / compound from phenolic compound or R position in L-Tyrosine by hydroxyl compound from phenolic compound.

ACKNOWLEDGEMENT

I am expressing our deepest gratitude and appreciation for the assistance and support received throughout the completion of this research paper. I want to take this opportunity to acknowledge the contributions of the individuals and institutions who have played a significant role in successfully completing this review paper.

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BIOGRAPHIES (Optional not mandatory)

I am a Ph.D., Research Scholar also working as as Assistant Professor in the Department of Physics at Dhanalakshmi Srinivasan Engineering College (A), Perambalur with 13 years of teaching experience. I have little experience in research.