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Surface Etching Study of Semiorganic Zinc Bromide Doped L-Arginine Monohydrate NLO Crystal

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ABSTRACT

The current study employed etching studies for surface analysis. The etch patterns observed on the surface of the semi-organic zinc bromide-doped L-arginine monohydrate crystals were scrutinized to explore the growth behavior, and structural imperfections associated with the crystal were recorded for 50 seconds.
Keywords : Surface Analysis, Etching, Slow Evaporation Solution Technique.

I. Introduction

In today's fast-paced and vigilant era, a wide range of reliable nonlinear optical (NLO) materials are being developed for the photonics industry. These materials are used to create optical components for various technological devices, including frequency doubling, telecommunications, optical switching, optical modulation, laser stabilization systems, and more [1–3]. The nonlinear optical coefficients of organic NLO materials are significantly higher than those of inorganic materials. However, their application is limited due to their inadequate mechanical and thermal properties and low laser damage threshold. The inorganic NLO materials have impressive mechanical and thermal characteristics but exhibit relatively limited optical nonlinearities because they lack extended electron delocalization. The inorganic NLO materials have exceptional mechanical and thermal properties but have relatively modest optical nonlinearities due to the limited π-electron delocalization. Considering these issues, a new class of materials has been created from organic and inorganic compounds known as semi-organic materials [4–7]. The concrete form of all amino acids (except glycine) mostly has a centrosymmetric space group, a significant criterion for NLO applications. Researchers reported crystals, i.e., L-arginine acetate, L-arginine phosphate, L-arginine diphosphate, L-arginine hydrochloride, etc., with wide NLO applications. Researchers have paid attention to the synthesized other L-arginine salts, especially in enhancing linear and nonlinear optical properties. Many scientists have also reported the growth of L-arginine amino acids, measuring various physical properties, such as dielectric, thermal expansion, elastic, and mechanical properties [8–13]. The present article reports

an etching study of zinc bromide-doped L-arginine crystals.

II. Experimental

L-arginine monohydrate was dissolved in double-distilled water, and a small amount of zinc bromide was added to the solution (analytical grade, SD-fine chemicals, India). The solution was thoroughly purified to obtain high-quality zinc bromide-doped L-arginine single crystals. The purification process involved repeated recrystallization of the synthesized material. The solution was then filtered using membrane filter paper in a rinsed beaker. The filtered solution was allowed to slowly evaporate in a bath with a constant temperature accurate to ±0.01 °C. Optically transparent thin crystals were harvested within 2 weeks. Etch patterns were studied, and it was observed that fast etchants behave like water. An etching study of zinc bromide-doped L-arginine crystals was conducted under a LYZER, India, microscope for this analysis.

III. Result and Discussion

The etching study shows surface purity, growth habit, and crystal structural defects. For the present analysis, the plane face of the crystal was selected, as shown in Figure – 1. Then, the crystal was etched with water for 50 seconds.

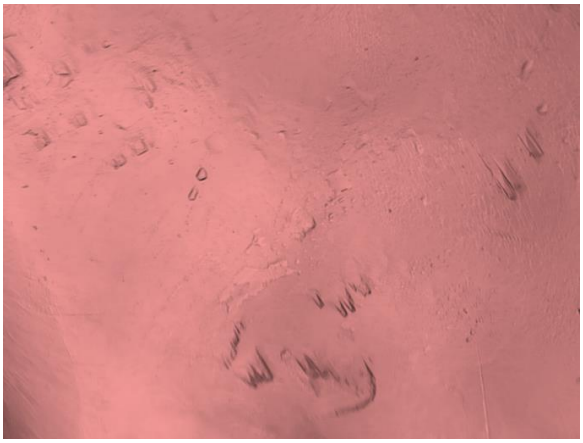

Figure 1. Surface of zinc bromide doped L-arginine monohydrate crystal before etching

In Figure - 1, zinc bromide doped L-arginine monohydrate crystal shows a plane surface with few irregularly shaped defects, which might have appeared due to solvent vacuoles in the crystal. The resulting micrograph after 50 seconds was recorded. The etch patterns of zinc bromide-doped L-arginine monohydrate crystals are shown in Figure 2. Analysis of the etching reveals that the crystal has a step-growth habit throughout the surface. Zinc bromide-doped L-arginine monohydrate crystal's primarily occupied plane surface defines its high purity. Hillocks, striations, and regular rectangular-shaped line patterns were observed after the etching time of 50 seconds.

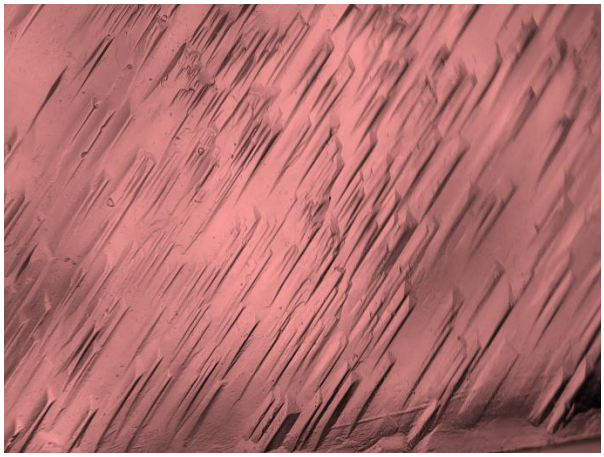

Figure 2. Etch pattern of zinc bromide doped L-arginine monohydrate crystal after 50 s

IV. Conclusion

Hillocks, striations, and rectangular-shaped regular line patterns were observed after a 40-second etching. The absence of large micro-pits and step growth habit in crystal up to 40 seconds indicates its good crystalline nature with minimum defect. These conclusions are significant as they contribute to our understanding of crystal growth behavior and structural imperfections.

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