Influence of rare earth gadolinium nitrate addition on structural, dielectric, linear and nonlinear optical properties of glycine single crystals

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Influence of rare earth gadolinium nitrate addition on structural, dielectric, linear and nonlinear optical properties of glycine single crystals

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ABSTRACT

In this present work, we have successfully grown γ-glycine single crystals in the presence of gadolinium nitrate as an additive by using slow solvent evaporation method. Powder X-ray Diffraction study confirms γ-polymorph structure and it crystallizes into a hexagonal crystal system with a space group of $P3_1$. UV–Visible transmittance spectra was recorded for the grown crystal to analyse the transparency in visible and near infrared region (NIR). In Kurtz-Perry powder test, the SHG efficiency of grown crystal is found to be 3.125 times higher than reference KDP crystal. The dielectric constant and dielectric loss of gadolinium nitrate added glycine was carried out as a function of frequency and the obtained results were discussed. The photoconductivity study confirms the positive photoconducting nature of grown crystal.

Keywords: A1. Crystal structure; A1. X-ray diffraction; B2. Nonlinear optic materials; B2. Dielectric Materials;

INTRODUCTION

Amino acids based organic materials have a higher NLO efficiency than inorganic materials. Hence, semi organic NLO crystals can be grown with high NLO efficiency and mechanical strength. Last few decades, many attempts and achievements have been made to the research and design of highly efficient non-linear optical (NLO) materials due to widespread applications such as high speed information processing, frequency shifting, optical modulation, optical switching, optical logic, optoelectronics, optical communication and optical data storage [1-3]. Glycine is the simplest, non-essential, optically inactive amino acid and it has no centre of chirality under amino acid category. The presence of carboxylic acid group in the glycine donates its proton to the amino group. Due to these reasons glycine has the structure of $NH_3^+CH_2COO^-$ [4]. A literature survey demonstrates that six distinct polymorphic types of glycine can be grown under various solution conditions: α, β and γ are formed in surrounding condition while δ-, ε- and β^1 are formed in high pressure conditions [5–7]. α-Glycine can be formed due to unconstrained nucleation of pure aqueous glycine. When some amount of selective additive is added to glycine, it will transform to γ-glycine. The slightest stable β-glycine can be formed using blended solvents, for example, methanol or ethanol and water. γ- Glycine is thermodynamically more stable at room temperature. It is formed from acidic (pH 3.40) and fundamental (pH 10.10) solutions [8-10]. In the recent past, growth and characterization of γ-glycine single crystals have been grown using additives such as (i) NaCl [11] (ii) $ZnSO_4$ [12] (iii) $NaNO_3$ [13] (iv) KCl [14] (v) $CdCl_2$ [15] from the aqueous solutions of glycine have been reported by several researchers. In this paper, we report the effect of gadolinium nitrate on nonlinear optical behavior of γ-glycine single crystals by slow evaporation method.

2. Experimental

2.1. Crystal growth