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The Investigation on The Consequence of Succinic Acid Doped Solitary Adp Crystal

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ABSTRACT

As Yet, succinic doped ADP have not been found, this scrutiny gives a report on succinic acid were successfully doped on Ammonium dehydrogenate phosphate (NH_4HPO_4, ADP) was furnished by FT-IR reveals development in crystalline with ambient temperature through slow cooling method. So far, this crystal has not been produced by using this method. UV visible spectroscopy explain that the inclusion of succinic acid in ADP. The influence of metal do pant succinct acid creates the imperfection in ADP. Micro hardness studies show crystalline mechanical stability. The fluorescence studies of succinic doped ADP crystal confirmed the violet color emission in the visible region. This prognosticate do pant is very helpful to increase the rate of crystal growth and excellent transparency crystal quality.

KEYWORDS: Slow cooling, Ambient temperature, Micro hardness, Fluorescence

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1. INTRODUCTION

The demand for crystalline material for industrial application has continued to rise over the past few decades.[1] In the emerging technologies, crystal growth plays a crucial role in the field such as electronic industry, photonic industry and fiber optic communications. The single crystal development shows that the chemical bond philosophy includes crystals morphology, growth rate and crystal defects all these are related to the unit of development. Nether most, ADP crystal has been extensively employed for various applications including frequency conversion of Nd-laser radiation by third or fourth harmonic generation owning to its large-scale application in the field of non-linear optical (NLO), high transmittance, high laser damage threshold (LDT), piezo-electric material, as a monochromatic for X-ray fluorescence analysis.[2] There is demand in power consumption and need of energy in emerging technologies, regular power sources such as coal and other fossil fuels are decreasing low-end unable to meet future energy needs of the world. So nuclear energy is the right alternative method. ADP is proving as a firm candidate in inertial confinement fusion.[3] The third harmonic generation performance contain novelty, this was formalized and all samples have exceeded 50% efficiency. ADP crystal in the optical field has a broader focus on its absolute properties.[4] The axiom's chemical bonding and the nature of the ADP is predicted to be a tetragonal bipyramid.[5] Further, ADP crystal has better homogeneity and less production costs than KDP crystal.

ADP crystal has increased interesting due to the various applications, the fact that the contours of the habit are different effects of both habitual and crystal characteristics. Many reports are available in the literature as a result of various organic and inorganic additives supplements of ADP. In some cases, the alternation of the metal is done against the lattice and prevents growth. On the other hand, alternative circuits lead to free energy reduction increases the rate of crystalline growth. Anion/cation partial dopant is advantageous in the crystallization project, resulting in a disruption to the physical properties of the resulting structures. An important step in clarifying the fundamental mechanism of crystalline growth was driven by particles and the atomic and nuclear clarity of objects at all stages of crystalline growth. Amidst the prevalent studied carboxylic acid like malonic acid and, glutaric acid, butanedioic acid ($C_4H_6O_4$) can be used as the forerunners of multifarious industrially momentous chemicals like adipic acid, 1,4-butanediol, tetrahydrofuran, N-methyl pyrrolidine, 2-pyrrolidine, succinate salts. Succinic acid is desired to employ it for matrix in infrared (IR) MALDI analytical methods and high electron mobility transistor fabrication (HEMT).[6] Succinic acid has received widespread heed due to its metabolite, ergo it is formed by plants, animals and microorganism. Wherefore, flourishing a high functional, low cost succinic crystal is of becoming a delving attention. Because of their interesting biological properties it is used as a biodegradable solvents, a food additive, a flavouring agent, and a supplement to pharmaceuticals, antibiotics, food and pharmaceutical products, surfactants and detergents, plastics, clothing fibers and vitamins, surfactant, a detergent extender, a foaming agent and an ion chelator.

The repercussion of doping rely on the dopant concentration inclusive of quasi multiplicative defective factors: complex structure of the host material, size and concentration of domains, strain in crystal, peak shift, growth orientation, variation in peak intensity, strength of bonding, grain size, grain boundaries, retarding/driving forces and crystallite alignment.[7] The present scope is to review the usefulness of succinic acid as well as their defective oriented approaches. Betwixt assorted synthesis succinic acid doped ADP crystal were prepared by slow cooling method is an auspicious approach to Maintain high consistency and quality follow the solidarity well and reach.

2. EXPERIMENTAL

2.1 *Growth procedure*

The bulk succinic doped ADP crystals were grown by one of the simplest slow cooling technique. 30g of pure ADP is dissolved in 50ml of distilled water, saturated pure ADP solution is prepared and the solution is allowed to stirred using magnetic stirrer for two hours to reach the settlement homogenous solution. On the other hand, for 1.1809 g of succinic acid is dissolved in 50ml of distilled water after attaining the homogenous state succinic solution is added drop by drop on the ADP solution. After two hours the saturated solution is filtered using Whatman filter paper. The solution beaker was covered with microscopic lid and placed in a dust free environment. After forty five days, good quality and transparent crystal from the solution was prepared. **Figure 1** shows the succinic doped ADP crystal.

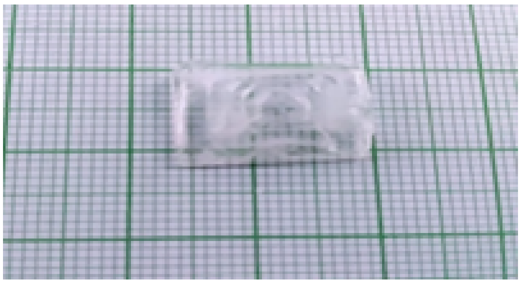

Figure 1. Succinic acid doped ADP crystal

3. RESULT AND DISCUSSION

3.1 Optical band gap study

The optical property of transmittance of the samples was examined using Lambda 35 UV Visible spectrophotometer. The transmittance and absorbance plot of the samples are shown in **Figure 2a & 2b**. The transmittance of the sample is 98%. The excellent transmission value of the crystal is due to the incorporation of succinic nanoparticles. This will show the higher frequency in the range of

200nm-800nm. The crystalline absorption is not the cause of the peaks of the spectrum. This peak is associated with certain features of molecular stabilization that are assigned to the absorption of the di-carboxyl group in ADP. The existence of separate electron pairs of O atom in the group of carboxylic succinic acid promotes an electron-intracellular isotope (n-π*) enthusiastic state.[8]

This crystal showed good broadcast from the entire UV-visible area. Good optical quality and well-defined electronic structured single crystals are mainly used for many technical optical devices. These crystals are found to be highly spread in the UV region and in the complete immigrant areas. UV in the suction edge Falls into the zone, which refers to the delocalized electron for charge transfer. Succinic doped UV cut wavelength to ADP crystals is 265nm. A wide range of transparency (98%) can be used for developing cryptography on opto-electronic devices.[9]

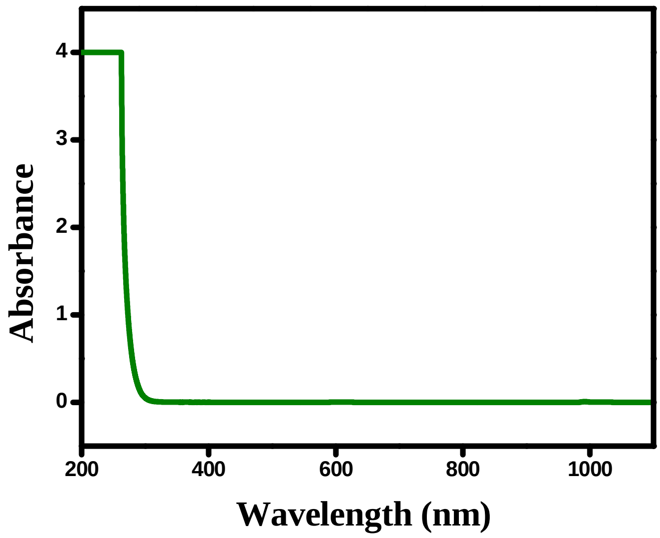

Figure 2a. Absorbance Plot of Succinic Acid Doped ADP

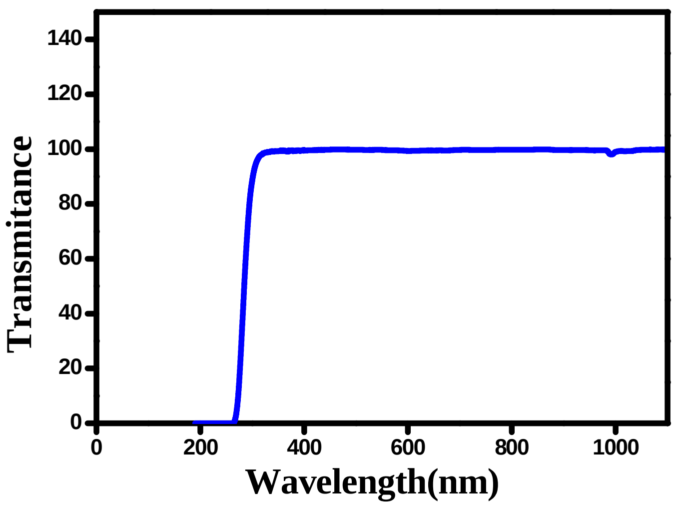

Figure 2b. Transmittance Plot of Succinic Acid Doped ADP

3.2 FTIR Spectrum Analysis

This study was done by recording the spectrum in the range 4000 – 400 cm^{-1} using spectrum RX I. The FT-IR spectra of succinic doped ADP crystal revealed a high peak at 3220 cm^{-1}, 1629 cm^{-1} affirming the presence of ADP and succinic acid as shown in **Figure 3**. The incorporation of succinic acid in ADP has been firmly verified. From the figures, various absorption peaks are furnished by FTIR spectra of the developed crystals are reserved for their associated functional groups and are listed in **Table 1**.

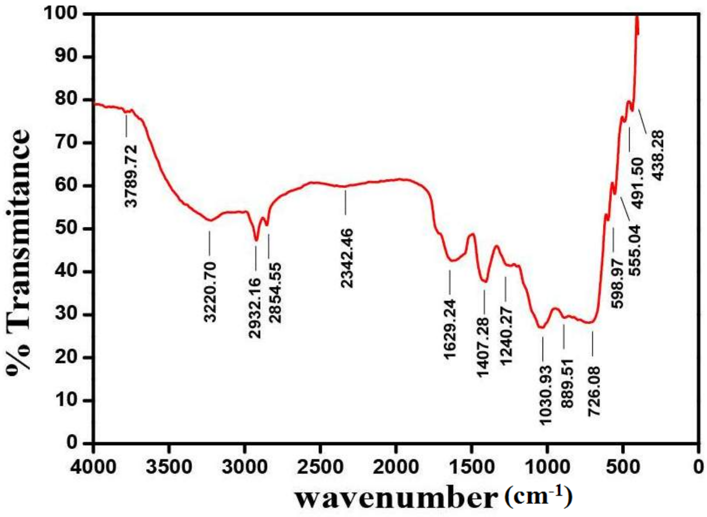

Figure 3. FTIR spectrum of succinic acid doped ADP crystal

Table 1. Functional group assignments for succinic acid doped ADP crystal

Wavenumber (cm^{-1})	Functional group assignment for ADP	Functional group assignment for succinic acid
3789.72	only alkenes and aromatic show C-H stretch slightly higher than 3000 cm^{-1}	
3220.70	Asymmetric stretching mode at NH^{3+}, O-H stretching of hydrogen bonded carboxyl group	
2932.16		C-H stretching
2854.55		C-H stretching
2342.46	P-H stretching	
1629.24		C=O stretching
1407.28	Bending vibration of Ammonia(NH_4)	
1240.27	Combination of asymmetric bending vibration of PO_4 with lattice	
1030.93		C-O stretching
889.51		C-H bending
726.08		C-H bending
598.97		-OH-P-OH bending
554.04	PO_4 bending vibration	
491.50	PO_4 bending vibration	
438.28		C=O bending

3.3 Mechanical Strength Analysis

Vickers micro hardness test was analysed using HMV 2T. For the standard indentation test 25 to 100 g loads were applied to the developed crystal using a Vickers diamond pyramid indenter attached to an incident radiation microscope. The Vickers microhardness number (H_V) was estimated from the relationship H_v = 1.8544(P/d2) Kg/mm^2, where P is the applied load in g and d is the diagonal length of the impression in mm.[10] **Figure 4a** reveals the value of hardness increases with increasing load which indicates LHS is exhibiting Normal Indentation Size effect (ISE). The value of “n” is estimated to be 0.04067 from the **Figure 4b**. According to Meyer's index the obtained n value clearly shows that the grown crystal is hard material. The **Figure 4c** shows the plot between d_n vs load (p) and the value of material constant k_1 is calculated from the slope of the graph, the value was found to be 4.327 kg/mm.

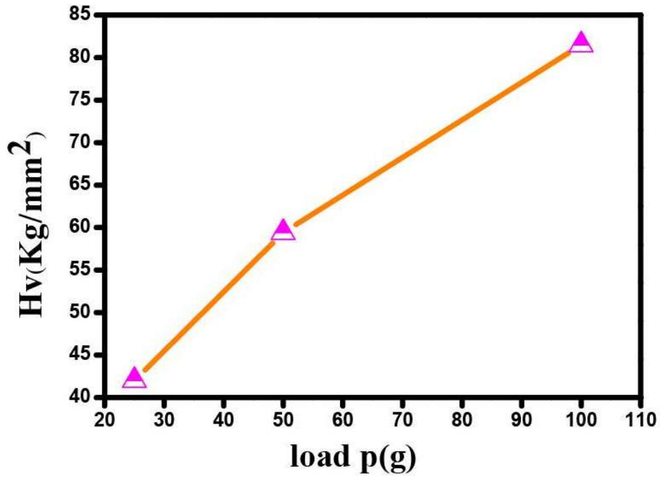

Figure 4a. Variation of hardness number with load for succinic acid doped ADP crystal

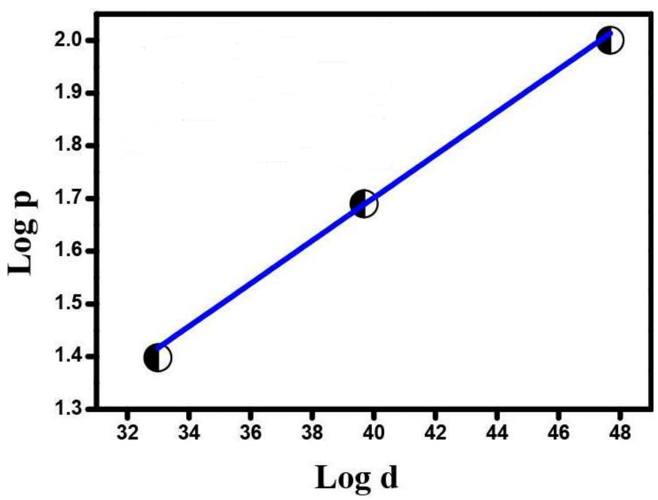

Figure 4b. log P Vs log d for succinic acid doped ADP crystal

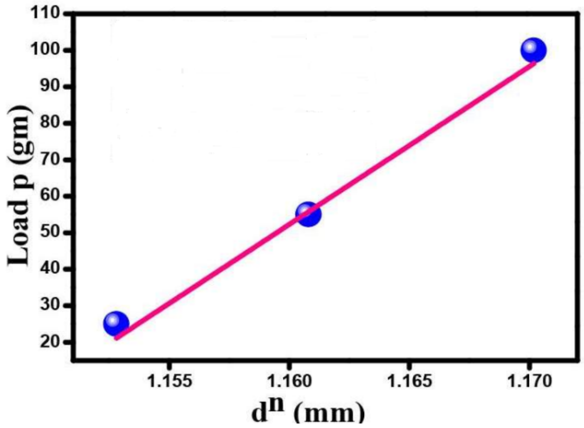

Figure 4c. d^n Vs load p for succinic acid doped ADP crystal

3.3.1 Yield strength:

Yield strength was calculated using this formula,[11]

$$\sigma_y = \frac{H_v}{3} \quad \text{-------------} \ (1)$$

The values of yield strength are listed in the **Table 2**.

3.3.2 Elastic stiffness constant (C_{11}):

By using the Wooster's empirical relation elastic stiffness constant for different loads for a range of 25 to 100 can be calculated. This proves that the binding force and tightness of the bond between adjacent atoms are really strong. **Figure 4d** shows the plot between H_v versus C_{11}.

$$C_{11} = H_v^{(7/4)} \quad \text{-------------} \ (2)$$

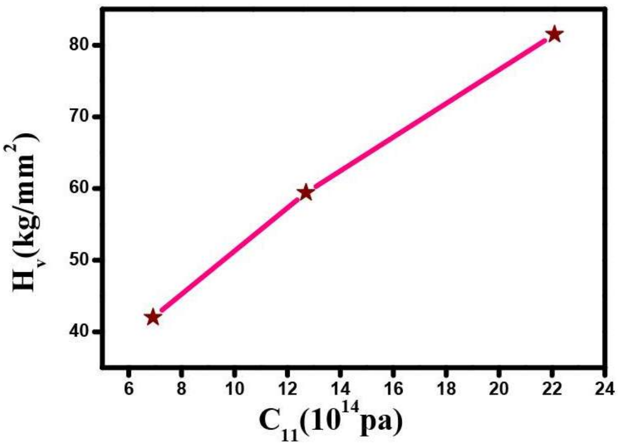

Figure 4d. C_{11} Vs H_v for succinic acid doped ADP crystal

Table 2. H_v, Elastic stiffness constant, yield strength and H_k values of succinic doped ADP crystal

Load p(gm)	H_v (kg/mm^2)	C_{11} x10^{14}(Pa)	Yield strength (MPa)	H_k (kg/mm)^2
25	42.5	6.92	14	0.3266
50	59.4	12.70	19.8	0.4562
100	81.5	22.10	27.16	0.6260

3.3.3 Fracture mechanism:

Internal decay and fracture properties Crack-launch reflects the indentation load.The crack in a crystal determines the fracture hardness "K_c", which tells how much fracture stress is applied under uniform loading. Fracture hardness is an important parameter for selecting materials for use where the load is high Range or yield point. The value of the fracture hardness depends on the type of crack structure.[12] Resistance to fracture refers to the hardness of an object and the fracture hardness Kc determines how much fracture stress is applied under uniform loading and is provided by formula

$$k_c = \frac{P}{\beta_0 c^{3/2}} \qquad \text{---------------} \ (3)$$

Where p, is the applied load c, is the crack length measured from the center of indentation mark to crack end, β_0 is the numerical constant that depends upon the indenter geometry. For a Vickers indenter, $\beta 0$ is equal to7.The calculated value of c/a is 2.14 and k_c is 2.697 MN $m^{-3/2}$c/a indicated the type of crack is palmquist.

3.3.4 Brittleness index:

Brittleness is a crucial property that alter the mechanical behavior of an object and provides an idea of how a fracture can be induced in a material without any valuable deformation.[13] The Brittleness index (B_i) of Succinic doped ADP crystal was calculated for different loads by the equation,

$$B_i = \frac{H_v}{k_C} \qquad \text{-----------} \quad (4)$$

The calculated value of B_i is 2.2024 $Nm^{-3/2}$.

3.3.5 Knoop mechanism:

According to Hays and Kendall's law,[14] the applied load "P" is thought to be partially after effect by the small effect pressure "W" is the minimum used load to cause a plastic deformation. According to the Small resistance pressure "W"

$$W = k_1 d^n - k_2 d^2 \qquad \text{-----------}(5)$$

For different load, the **Figure 4e** shows a plot of d^n versus d^2. Using least square fitting method, slope and intercepts are giving the value of K_2/K_1 and W/K_1. The K_1value is obtained from the figure

4c. By using the equation we calculate the value of K1, K2 and W are listed in the **Table 3**.

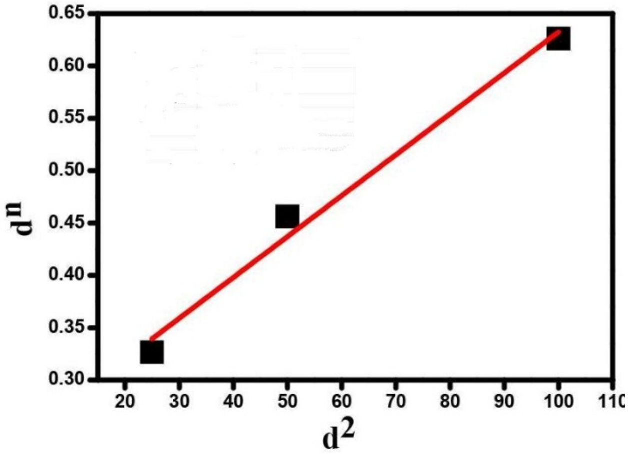

Figure 4e. d^2 Vs d^n for succinic acid doped ADP crystal

3.3.6 Young's modulus:

To prove the elasticity of this crystal the E value are provided in the **Table 3**. From the observed knoop micro hardness measurement the value of young's modulus (E) of the crystal was determined by the relation,

$$E = \frac{0.45H_k}{[0.1406 - b/a]} \qquad \text{------------ (6)}$$

Where H_k is Knoop micro hardness values of specific load, and b and a are the shorter and longer Knoop indentation diagonal. The calculated young's modulus is 0.67826×10^{10} Nm^{-2}.

Table 3. Calculated Vickers Hardness parameter

Parameter	Value
Work hardening co-efficient (n)	0.04067
Material constant (k_1)	4.327kg/mm
K_2	3.222 kg/mm
Resistance pressure (W)	5.02 g
Fracture toughness K_c	2.697 MN $m^{-3/2}$
Type of crack	Palmquist
Young's modulus (E)	0.67826×10^{10} Nm^{-2}
Brittleness index (β_i)	2.2024 $Nm^{-3/2}$
Brittleness number	2
Character of impression	One crack not coinciding with the continuation of the diagonal of the impression; Two cracks in adjacent corners of the impression.
Optical absorption	98%
Energy band gap	3.7 eV

3.4 Fluorescence studies

Fluorescence provides important information about quality, electronic states and inherent contaminants of growing crystals. The doped succinic doped ADP crystal was photographed with an energy wavelength of 260 nm this reveals the emission of violet color shown in **Figure 5** and in the range of 350-800 nm. The quality of the measured succinic doped ADP crystal indicates that it is exceptionally good Fluorescence spectroscopy is a fast, sensitive method for classifying molecular situations and events.[15] Additionally, calculated Energy band gap value for succinic doped ADP crystal is 3.7 eV and E_g is calculated using this formula,

$$E_g = \frac{h_c}{\lambda e} \quad \text{-------------(7)}$$

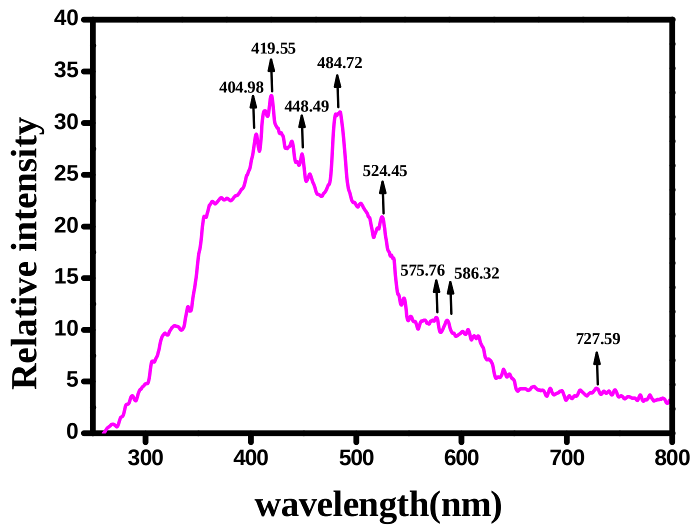

Figure 5. Fluorescence study of succinic acid doped ADP crystal

4. CONCLUSION

In conclusion, the present work may furnish a report on the inclusion of succinic doped ADP crystal. Among the various techniques, have been used to fabricate succinic doped ADP crystal, this paper presents an easy technique to produce succinic doped ADP crystal for the first time by slow cooling method at room temperature. In the meantime, detailed investigation was made in the development of micro hardness mechanical analysis. In this way, the mechanism of separate crystals were briefly explained. Due to all of these properties, the crystals could be a reliable source of non-linear optical application.

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