Structural, optical, dielectric relaxation, complex impedance and modulus spectroscopic studies of pure and glutamic acid doped potassium dihydrogen phosphate

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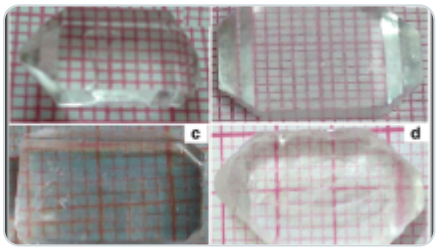
Abstract

The slow evaporation procedure is used to develop KDP crystals with both pure and doped by glutamic acid. The powder XRD patterns reveal single phase, lower lattice strain and enhancement of peak intensity due to doping in KDP. Doping is observed to increase the crystals' nonlinear property, second harmonic generating efficiency. The UV–VIS spectra indicate slight decrement in the transmittance due to doping. The energy band gap is evaluated from Tauc's plot and KM theory and slight reduction is observed on doping. The refractive index of pure and doped KDP crystals within visible region is observed to vary between 1.52 to 1.64. The dielectric constant and loss have shown normal behavior with respect to applied frequency of electric field at room temperature. The complex impedance and modulus plots show single semicircle for pure and

doped KDP due to grain contribution only and exhibits non-Debye type relaxation. The Jonscher's power law is applied to ac conductivity data and ideal long-range pathways and diffusion limited hopping mechanism is confirmed.



Dielectric relaxation, protonic defect, conductivity mechanisms, complex impedance and...

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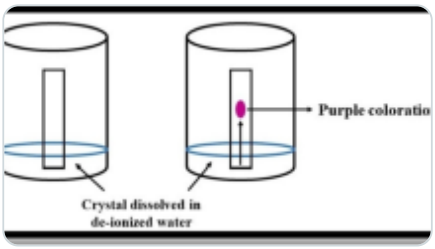

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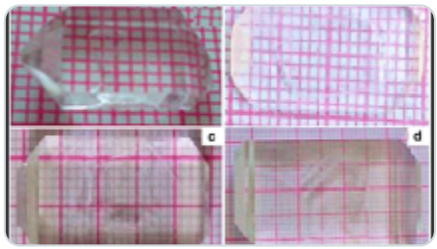

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References

[1] A Mahadik, P H Soni and C F Desai *Physica B Condensed Matter* 527 61 (2017)

ADS Google Scholar

[2] A Mahadik, P H Soni, K Chaudhari and A Mithani *Optik* 262 169223 (2022)

ADS Google Scholar

[3] A Mahadik, A Mithani, K Chaudhari and P H Soni *J. Mater. Sci.: Mater. Electron.* 33 25551 (2022)

Google Scholar

[4] J H Joshi, G M Joshi, M J Joshi and H O Jethva *J. Chem.* 42 17227 (2018)

Google Scholar

[5] J Podder and S Ramalingom *Res. Technol.* 36 549 (2001)

Google Scholar

[6] V R Raghorte, G C Wakde, N S Meshram and K G Rewatkar *Results in Chemistry* 2 100074 (2020)

Google Scholar

[7] N Hirayama, K Shirahata, Y Ohashi and Y Sasada *BCSJ* 53 30 (1980)

Google Scholar

[8] F Akhtar and J Podder *Journal of Crystallization Process and Technology* 1 55 (2011)

Google Scholar

[9] B S Kumar and K R Babu *IJPAP* 46(2) [Febuary 2008] (2008)

[10] N Pattanaboonmee, P Ramasamy and P Manyum *Procedia Engineering* 32 1019 (2012)

Google Scholar

[11] N C Halder and C N J Wagner *Acta Cryst.* 20 312 (1966)

Google Scholar

[12] V Bhuvaneswari and N S Rajeswari *Optik* 288 171192 (2023)

ADS Google Scholar

[13] V Krishnakumar and R Nagalakshmi *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy* 61 499 (2005)

ADS Google Scholar

[14] V Venkataramanan, S Maheswaran, J N Sherwood and H L Bhat *Journal of Crystal Growth* 179 605 (1997)

ADS Google Scholar

[15] J H Joshi, K P Dixit, K D Parikh, H O Jethva, D K Kanchan, S Kalainathan and M J Joshi *J. Mater. Sci.: Mater. Electron.* 29 5837 (2018)

Google Scholar

[16] J Tauc and A Menth *Journal of Non-Crystalline Solids* 8–10 569 (1972)

ADS Google Scholar

[17] S K Sen, T C Paul, M S Manir, S Dutta, M N Hossain and J Podder *J. Mater. Sci. Mater. Electron.* 30 14355 (2019)

Google Scholar

[18] M Parthasarathy, M Anantharaja and R Gopalakrishnan *Journal of Crystal Growth* 340 118 (2012)

ADS Google Scholar

[19] P Jayaprakash, M P Mohamed and M L Caroline *Journal of Molecular Structure* 1134 67 (2017)

ADS Google Scholar

[20] R Rajkumar and P Praveen *Appl. Phys. A* 124 382 (2018)

ADS Google Scholar

[21] T C S Girisun and S Dhanuskodi *Cryst. Res. Technol.* 44 1297 (2009)

Google Scholar

[22] J C Anderson *Dielectrics* (London: Chapman & Hall) (1964)

Google Scholar

[23] E E Shaisha, Sh F El-Desouki, I Shaltout and A A Bahgat *Journal of Materials Sciences and Technology* 22 701 (2006)

Google Scholar

[24] U Ahmadu, S Tomas, S A Jonah and A O Musa *Mater. Lett.* 4 185 (2013)

Google Scholar

[25] B D Hatton, K Landskron, W J Hunks, M R Bennett, D Shukaris, D D Perovic and G A Ozin *Materials Today* 9 22 (2006)

Google Scholar

[26] M P Dasari, K Sambasiva Rao, P Murali Krishna and G Gopala Krishna *Acta Phys. Pol. A* 119 387 (2011)

ADS Google Scholar

[27] J H Joshi, D K Kanchan, H O Jethva, M J Joshi and K D Parikh *Ionics* 24 1995 (2018)

Google Scholar

[28] L B Harris and G J Vella *Journal of Applied Physics* 37 4294 (1966)

ADS Google Scholar

[29] R M Hill and A K Jonscher *Journal of Non-Crystalline Solids* 32 53 (1979)

ADS Google Scholar

[30] A G Hunt *Philosophical Magazine B* 81 875 (2001)

ADS Google Scholar

[31] K A Mauritz *Macromolecules* 22 4483 (1989)

ADS Google Scholar

[32] S R Elliott and A P Owens *Philosophical Magazine B* 60 777 (1989)

ADS Google Scholar

[33] E Barsoukov and J R Macdonald (eds) *Impedance Spectroscopy: Theory, Experiment, and Applications, Third Edition* (Wiley) (2018)

[34] A A Saif, Z A Z Jamal, Z Sauli and P Poopalan *Materials Science* 17 186 (2011)

Google Scholar

[35] W Wieczorek, J Płocharski, S Głowinkowski and Z Pajak *Solid State Ionics* 28–30 1014 (1988)

Google Scholar

[36] P Ganguly and A K Jha *Bull. Mater. Sci.* 34 907 (2011)

Google Scholar

[37] D K Pradhan, R N P Choudhary, C Rinaldi and R S Katiyar *Journal of Applied Physics* 106 024102 (2009)

ADS Google Scholar

[38] M J Haun, E Furman, S J Jang and L E Cross *Ferroelectrics* 99 13 (1989)

ADS Google Scholar

[39] I Grinberg and V Cooper *Rev. B* 69 144118 (2004)

Google Scholar

[40] P Kour, P Kumar, S K Sinha and M Kar *J. Mater. Sci.: Mater. Electron.* 26 1304 (2015)

Google Scholar

[41] F Yakuphanoglu *Physica B: Condensed Matter* 393 139 (2007)

ADS Google Scholar

[42] A Dutta, T P Sinha, P Jena and S Adak *Journal of Non-Crystalline Solids* 354 3952 (2008)

ADS Google Scholar

[43] S B Aziz, Z H Z Abidin and A K Arof *Express Polym. Lett.* 4 300 (2010)

Google Scholar

[44] L N Patro and K Hariharan *Materials Chemistry and Physics* 116 81 (2009)

Google Scholar

[45] P G R Achary, S Behera, R N P Choudhary and S K Parida *J. Mater. Sci.: Mater. Electron.* 32 5738 (2021)

Google Scholar

[46] N Channa, M Khalid, A D Chandio, G Mustafa, M S Akhtar, J K Khan, J Ahmad and K A Kalhoro *J. Mater. Sci.: Mater. Electron.* 31 1661 (2020)

Google Scholar

[47] R K Parida, D K Pattanayak and B N Parida *J. Mater. Sci.: Mater. Electron.* 28 16689 (2017)

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