




# Dr. Binay Kumar

Crystal Lab, Department of Physics & Astrophysics,  
University of Delhi, Delhi-110007 (INDIA)



Title	DR.	First Name	BINAY	Last Name	KUMAR	Photograph
Designation		Associate Professor				
Department		Physics & Astrophysics				
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Education						
Subject	Institution		Year	Details		
Ph. D.	University of Delhi		1992	Thesis topic: Polytypism of vapour grown dendritic single crystals of both undoped and doped cadmium iodide		
M. Sc.	Bhagalpur University		1986	Subjects: Physics		
B. Sc. (H)	Bhagalpur University		1983	Subjects: Physics, Chemistry Mathematics		
Career Profile						
Organization / Institution	Designation		Duration	Role		
University of Delhi	Associate Professor		1 Jan 2006-Till date	Teaching & Research		
University of Delhi	Reader		June 2001-31 Dec 2005	Teaching & Research		
University of Delhi	Lecturer (& Senior Sc)		Jan1993-June 2001	Teaching & Research		
University of Delhi	Research Associate		Aug.1992-Jan 1993	Teaching & Research		
<b>Research Interests / Specialization: Crystal Growth, Nanoparticles, Piezo-/Ferroelectricity, Characterization, Devices</b> <b>Ph.D. Supervised: 12 (+1 under submission)</b> <b>Ph.D. under progress: 6</b> <b>Papers in Referred International Journals: ~110</b> <b>Major Projects: 6 (DST, DRDO, UGC)</b> <b>Talk in National/International conferences: ~ 40</b>						

## Research Work of DR. BINAY KUMAR (2010 onwards)

Dr. Binay Kumar is the group leader of Crystal Lab in the Department of Physics & Astrophysics, University of Delhi, in which research work for the growth of single crystals of technologically important materials like high performance piezoelectric (e.g. lead based PZN-PT, PMN-PT; lead free BNKT, NKLN; organic TGS; LiNbO<sub>3</sub>, etc.), high T<sub>c</sub> superconductors (e.g. Bi-2212 system), ZnO & multiferroic BFO nano structure, MX<sub>2</sub> compounds, Organic & Semi-organic NLO materials and their characterization are being undertaken. Enhancement of crystallographic and material properties by various pre- and post- growth treatments and doping to make these crystals more suitable for application is one of the targets of our research work. Single crystals are grown by flux, solution, vapor, Cz, traveling zone etc. techniques while the characterization include techniques like XRD, SEM, TEM, AFM, TGA, Dielectric (conductivity, etc.) Piezometry (d<sub>33</sub>), Ferroelectric (P-E loop, etc), UV-Vis, FTIR etc, etc.

Since 2010, five major projects have been undertaken; eleven students have completed Ph.D. while nearly 77 papers have been published in refereed International Journals.

### LIST OF PUBLICATIONS OF DR. BINAY KUMAR (DURING 2010 - July 2016)

In Indexed/ Peer Reviewed Journals

Year	Title	Journal	Author
(77) 2016	New geometrical modeling to study the crystal morphology	Crystal Growth & Design (2016) (in Press) ISSN: 1528-7483 DOI: 10.1021/acs.cgd.6b00665 I.F. 4.4	Harsh Yadav, , Nidhi Sinha and Binay Kumar
(76) 2016	Modified low temperature Czochralski growth of xylenol orange doped benzophenone single crystal for fabricating dual band patch antenna	Journal of Crystal Growth 450 (2016) 74–80 ISSN: 0022-0248 I.F. 1.48 DOI: 10.1016/j.jcrysgro.2016.06.035	Harsh Yadav, Nidhi Sinha and Binay Kumar
(75) 2016	Synthesis of 0.64Pb(Mg <sub>1/3</sub> Nb <sub>2/3</sub> )O <sub>3</sub> –0.36PbTiO <sub>3</sub> ceramic near Morphotropic Phase Boundary for high performance piezoelectric, ferroelectric and pyroelectric applications	Journal of Asian Ceramic Societies 2016 (in Press) DOI: 10.1016/j.jascer.2016.06.004	Abid Hussain, Nidhi Sinha, Sonia Bhandari, Harsh Yadav, Abhilash Joseph and Binay Kumar

<b>(74) 2016</b>	Effect of crystal violet dye on the structural, optical, mechanical and piezoelectric properties of ADP single crystal	Materials Research Bulletin, 83 2016, 77–87 I.F. 2.43	Sahil Goel, Nidhi Sinha, Harsh Yadav and Binay Kumar
<b>(73) 2016</b>	Growth, morphology, structure and characterization of L-histidinium dihydrogen arsenate orthoarsenic acid (LHAS) single crystal	Acta Crystallographica Section B. 2016, Volume 72, (Part 4) Page xxx (in Press) article GW5042 I.F. 2.89	Nidhi Tyagi, Nidhi Sinha, Harsh Yadav and Binay Kumar
<b>(72) 2016</b>	Growth, structural, dielectric, ferroelectric and mechanical properties of L-prolinium tartrate single crystal	Journal of Materials Science, 51(2016), 7614-7623 I.F. 2.37 DOI:10.1007/s10853-016-0040-3	Sonu Kumar , Nidhi Sinha, Harsh Yadav and Binay Kumar
<b>(71) 2016</b>	Growth, crystal structure, Hirshfeld surface, dielectric and mechanical properties of a new organic single crystal: ‘Bis glycine’ squarate	RSC Adv., 2016, 6, 24565 DOI: 10.1039/c5ra18983g I.F. 3.8	Nidhi Tyagi, Nidhi Sinha, Harsh Yadav and Binay Kumar
<b>(70) 2016</b>	Flexible High Performance Lead-Free Na <sub>0.47</sub> K <sub>0.47</sub> Li <sub>0.06</sub> NbO <sub>3</sub> Microcubes-Structures Based Piezoelectric Energy Harvester	ACS Appl. Mater. Interfaces, 2016, 8 (3), pp 1766–1773 DOI: 10.1021/acsami.5b09485 I.F. 6.7	MK Gupta, Sang- Woo Kim, and Binay Kumar
<b>(69) 2016</b>	Growth of NBT–BT single crystals by flux method and their structural, morphological and electrical characterizations	Journal of Crystal Growth 441 (2016) 64–70 I.F. 1.48	S R Kanuru, K. Baskar, R. Dhanasekaran, and Binay Kumar
<b>(68) 2015</b>	Remarkable Enhancement in dielectric, piezoelectric, ferroelectric and SHG Properties by iron doping in sodium para-nitrophenolate dihydrate single crystals	Materials Letters (2015) Ms. No. MLBLUE-D-15- 05110R1 I.F. 2.5	Jyoti Dalal and Binay Kumar
<b>(67) 2015</b>	Enhanced microstructure and electrical properties of Mn-modified Bi <sub>0.5</sub> (Na <sub>0.65</sub> K <sub>0.35</sub> ) <sub>0.5</sub> TiO <sub>3</sub> ferroelectric ceramics	Ceramics International (2015) CERI_CERI-D-15-05956 DOI:10.1016/j.ceramint.2015.1 1.104 I.F. 2.6	Sonia Bhandari, Nidhi Sinha and Binay Kumar
<b>(66) 2015</b>	“Influence of metal ion doping on dielectric, ionic conductivity and piezoelectric properties of flux grown KTP crystals”	Int. J. of Applied Engineering Research, 10 297-301(2015)  ISSN 0973-4562	M. Rathnakumari, J. Rajeev Gandhi, P. Muralimanohar , K. Sathyamoorthy, R. Parasuramana, P. Sureshkumar and Binay Kumar

<b>(65) 2015</b>	Enhancement of Optical, Piezoelectric, and Mechanical Properties in Crystal Violet Dye-Doped Benzophenone Crystals Grown by Czochralski Technique	Crystal Growth and Design 15, 4908–4917 (2015) DOI: 10.1021/acs.cgd.5b00792 ISSN: 1528-7483 I.F. 4.9	Harsh Yadav, Nidhi Sinha, Nidhi Tyagi, and Binay Kumar
<b>(64) 2015</b>	Study the influence of Nd and Co/Cr co-substitutions on structural, electrical and magnetic properties of BiFeO <sub>3</sub> nanoparticles	Ceramics International 42(2016)1782–1790 DOI: 10.1016/j.ceramint.2015.09.141 I.F. 2.6	Sanjay Godara, Nidhi Sinha and Binay Kumar
<b>(63) 2015</b>	Bulk crystal growth, optical, mechanical and ferroelectric properties of new semiorganic nonlinear optical and piezoelectric Lithium nitrate monohydrate oxalate single crystal	Optical Materials (2015) DOI:10.1016/j.optmat.2015.11.033 I.F.: 2.0	Jyoti Dalal and Binay Kumar
<b>(62) 2015</b>	Performance of crystal violet doped triglycine sulfate single crystals for optical and communication applications	CrystEngComm, 17, 5757–5767 (2015) DOI: 10.1039/C5CE00703H ISSN 1466-8033 I.F. 4.0	Nidhi Sinha, S. Bhandari, H. Yadav, G. Ray, S. Godara, N.Tyagi, J. Dalal, S. Kumar, and Binay Kumar
<b>(61) 2015</b>	Structural, electrical, ferroelectric and mechanical properties with Hirshfeld surface analysis of novel NLO semiorganic sodium p-nitrophenolate dihydrate piezoelectric single crystal	RSC Advances (2015) 5, 57735 - 57748 DOI: 10.1039/C5RA10501C ISSN 2046-2069 I.F. 3.8	Jyoti Dalal, Nidhi Sinha, Harsh Yadav and Binay Kumar
<b>(60) 2015</b>	Enhancement in semiconducting and optical properties in doped anthracene micro crystals	Physica B 470-471 (2015) 15–20 I.F. 1.2	Nidhi Sinha, G. Ray, S. Godara, H. Yadav, S. Bhandari and Binay Kumar
<b>(59) 2015</b>	Effect of Ba–Nb co-doping on the structural, dielectric, magnetic and ferroelectric properties of BiFeO <sub>3</sub> nanoparticles	Ceramic International 41, 6912-6919 (2015) I.F. 2.6	Sanjay Godara and Binay Kumar
<b>(58) 2015</b>	Enhanced dielectric and electric properties of Ta-doped ferroelectric 0.50(Na <sub>0.5</sub> Bi <sub>0.5</sub> )TiO <sub>3</sub> - 0.50(K <sub>0.5</sub> Bi <sub>0.5</sub> )TiO <sub>3</sub> lead-free ceramics Ceramics International	Ceramic International 41 (2015) 10237-10242 I.F.2.6	Krishan Kumar, Nidhi Sinha, Sonia Bhandari and Binay Kumar
<b>(57) 2015</b>	Achieving high piezoelectricity and fatigue free hysteresis in lead free relaxor ferroelectric ceramic 0.94[Na <sub>0.5</sub> K <sub>0.5</sub> NbO <sub>3</sub> ]-0.06LiSbO <sub>3</sub>	Materials Chemistry and Physics 159, 107-113 (2015) DOI: 10.1016/j.matchemphys.2015.03.059 I.F. 2.4	Geeta Ray, Nidhi Sinha, Sonia Bhandari and Binay Kumar

<b>(56) 2015</b>	Pyroelectric properties and conduction mechanism in solution grown glycine sodium nitrate single crystal	Physica B 462 (2015) 18–24 I.F.: 1.2	Nidhi Tyagi , NidhiSinha , HarshYadav , and Binay Kumar
<b>(55) 2015</b>	Lead Free Relaxor Ferroelectric $\text{Na}_{0.47}\text{K}_{0.47}\text{Li}_{0.06}\text{Nb}_{0.94}\text{Sb}_{0.06}\text{O}_3$ Crystals for Opto-Electronic Applications	Crystal Growth and Design 15, 1852-1860 (2015) ISSN: 1528-7483 I.F. 4.9	Geeta Ray, Nidhi Sinha, Budhendra Singh, Igor Bdikin, and Binay Kumar
<b>(54) 2015</b>	Growth and characterization of new semiorganic nonlinear optical and piezoelectric Lithium sulfate monohydrate oxalate single crystals	Materials Research Bulletin 64 194–199, (2015) I.F. 2.43	Harsh, Nidhi Sinha and Binay Kumar
<b>(53) 2015</b>	Effect of structural modification by MnO <sub>2</sub> addition on the electrical properties of lead free flux grown $(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$ – $(\text{K}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$ single crystals	Crystal Growth and Design 15, 867–874, (2015) ISSN: 1528-7483 I.F. 4.9	Sonia Bhandari and Binay Kumar
<b>(52) 2015</b>	Observation of non linear optical and photoluminescence properties in ferroelectric $0.94[\text{Na}_{0.5}\text{K}_{0.5}\text{NbO}_3]$ - $0.06\text{LiNbO}_3$ single crystals	Materials Letters 143, 105–107, (2015) DOI: 10.1016/j.matlet.2014.12.088 I.F. 2.5	Geeta Ray and Binay Kumar
<b>(51) 2014</b>	Excellent piezo-/pyro-/ferroelectric performance of $\text{Na}_{0.47}\text{K}_{0.47}\text{Li}_{0.06}\text{NbO}_3$ lead free ceramic near polymorphic phase transition , editorial reference number: has been accepted for publication in.	Scripta Materialia 99, 77–80, (2015) DOI: 10.1016/j.scriptamat.2014.11.033 I.F. 2.8	Geeta Ray, Nidhi Sinha, Sonia Bhandari and Binay Kumar
<b>(50) 2014</b>	Growth and characterization of piezoelectric benzil single crystals and its application in microstrip patch antenna	CrystEngComm (2014), 16 10700- 10710 ISSN 1466-8033 I.F. 4.0	Harsh, Nidhi Sinha and Binay Kumar
<b>(49) 2014</b>	Enhanced electric and magnetic properties in Ce-Cr co-doped Bismuth ferrite nanostructure	Materials Letters 136, 441–444 (2014) I.F. 2.5	Sanjay Godara, Nidhi Sinha and Binay Kumar
<b>(48) 2014</b>	Combined structural, electrical, magnetic and optical characterization of bismuth ferrite nanoparticles synthesized by auto-combustion route	J Asian Ceramic Society, 2, (2014) 416-421 DOI: 10.1016/j.jascer.2014.09.001	Sanjay Godara, Nidhi Sinha Geeta Ray and Binay Kumar
<b>(47) 2014</b>	Enhanced piezoelectric output voltage and Ohmic behavior in Cr-doped ZnO nanorods	Materials Research Bulletin 54 (2014)267-271 I.F. 1.9	Nidhi Sinha, Geeta Ray, Sanjay Godara, Manoj K. Gupta and Binay Kumar
<b>(46) 2014</b>	Flux growth and effect of cobalt doping on dielectric, conductivity and relaxation behaviour of $0.91\text{Pb}[\text{Zn}_{1/3}\text{Nb}_{2/3}]\text{O}_3$ – $0.09\text{PbTiO}_3$ crystals	CrystEngComm 16, 1935-42 (2014) ISSN 1466-8033 I.F. 4.0	B.K. Singh, Igor Bdikin, Ajay Kaushal and Binay Kumar
<b>(45) 2014</b>	Structural, Optical and Dielectric studies of novel non-linear Bisglycine Lithium Nitrate piezoelectric single crystal	Optical Materials (2014) 37, 457- 63 I.F. 1.9	Jyoti Dalal, Nidhi Sinha and Binay Kumar

<b>(44) 2014</b>	Processing and properties of ferroelectric $\text{Bi}_{0.5}(\text{Na}_{0.65}\text{K}_{0.35})_{0.5}\text{TiO}_3$ ceramics under the effect of different sintering temperature	Scripta Materialia (2014) 89, 61-64 IF 2.8	Sonia Bhandari, Nidhi Sinha, Geeta Ray and Binay Kumar
<b>(43) 2014</b>	Flux growth of $0.94[\text{Na}_{0.5}\text{K}_{0.5}\text{NbO}_3]-0.06\text{LiNbO}_3$ piezo-/ferroelectric crystals for long duration and high temperature applications	CrystEngComm, 16, 7004– 7012 (2014) ISSN 1466-8033 I.F. 4.0	Geeta Ray, Nidhi Sinha, Sonia Bhandari, B. K. Singh, Igor Bdikin and Binay Kumar
<b>(42) 2014</b>	Synthesis and enhanced properties of Cerium doped ZnO nanorods	Ceramic International 40 12337–12342 (2014); IF 1.9	N. Sinha, G. Ray, S. Bhandari, S. Godara and Binay Kumar
<b>(41) 2014</b>	Flux growth of lead free $(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3 - (\text{K}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$ ferroelectric single crystals and its characterization	CrystEngComm, 16 (21), 4459 – 4466 (2014) ISSN 1466-8033 I.F 4.0	S. Bhandari, N. Sinha, G. Ray and Binay Kumar
<b>(40)2014</b>	Synthesis and characterization of multiferroic BFO nanoparticles by auto combustion route with various complexing agents	Int. J. of Chem. Tech Research (2014) 6, 2083	Sanjay Godara, Nidhi Sinha and Binay Kumar
<b>(39) 2014</b>	Enhanced optical, dielectric and piezoelectric behaviour in dye doped zinc tris-thioureasulphate (ZTS) single crystals	Chemical Physics Letters 591 (2014) 10–15 ; ISSN: 0009-2614; IF: 2.1	S. Bhandari, N. Sinha, G. Ray and Binay Kumar
<b>(38) 2014</b>	Evidence of Sustained Ferroelectricity in Glycine Sodium Nitrate Single Crystal	Current Applied Physics 14 (2014) 156-160; ISSN: 1567-1739; IF: 1.8	N. Tyagi, N. Sinha and Binay Kumar
<b>(37)2013</b>	Environment friendly novel piezoelectric $0.94 [\text{Na}_{0.8}\text{K}_{0.2}\text{NbO}_3]_{0.06} \text{LiNbO}_3$ ternary ceramic for high temperature dielectric and ferroelectric applications	Materials Chemistry and Physics 142 (2013) 619-625; ISSN: 0254-0584; IF: 2.4	G Ray, N Sinha and Binay Kumar
<b>(36) 2013</b>	Influence of Dopants on Vickers Microhardness of Ferroelectric Glycine Phosphate Single Crystals	Proc Indian Natn Sci Acad 79 (2013) 423-426 ISSN: 0073-6600; IF: 0.3	K. Senthil kumar, S. Moorthy Babu and Binay Kumar
<b>(35) 2013</b>	“Crystal growth, optical, mechanical and electrical properties of Inorganic material: Sodium tetra borate decahydrate”	Materials Research Bulletin 48 (2013) 1632–1636; ISSN: 0025-5408; IF 2.14	Neeti Goel, Nidhi Sinha and Binay Kumar
<b>(34) 2013</b>	Effect of rare earth ions on the properties of glycine phosphate single crystals	Journal of Crystal Growth, 362, 343-348 (2013) ISSN: 0022-0248; IF: 1.6	K. Senthil kumar, Moorthy Babu, G. Bhagavannarayana and Binay Kumar
<b>(33)2013</b>	Structural, Dielectric, Piezoelectric and Ferroelectric Characterization of NBT-BT Lead-Free Piezoelectric Ceramics	Materials Science and Engineering 43 (2013) , 012010; ISSN: 0921-5093; IF: 2.3	SS Sundari, B Kumar, R Dhanasekaran and Binay Kumar



<b>(32) 2013</b>	“Enhanced Optical, NLO, dielectric and thermal properties of novel sodium hydrogen phthalate single crystals doped with Zinc”	Optical Materials 35 (2013) 479–486; ISSN:0925-3467; IF: 1.9	Neeti Goel, Nidhi Sinha and Binay Kumar
<b>(31)2013</b>	Growth and properties of sodium tetraborate decahydrate single crystals	Materials Research Bulletin 48 (2013) 1632–1636	Neeti Goel , Nidhi Sinha , Binay Kumar
<b>(30) 2012</b>	“Effect of SHI Irradiation on NBT-BT Ceramics: Transformation of Relaxor Ferroelectric to Ferroelectric Nature”	Applied Surface Science 265 (2013) 296-301 ISSN: 0169-4332; IF: 2.1	S. Shanmuga Sundari, K. Ashokan, R. Dhanasekaran and Binay Kumar
<b>(29) 2012</b>	Improvement in Structural, Dielectric, Ferroelectric and Mechanical Properties in Metal Ions Doped Glycine Phosphite Single Crystals	Ferroelectrics,437,126-136 (2012); ISSN: 0015-0193 IF: 0.42	K. Senthil kumar, Moorthy Babu, G. Bhagavannarayana and Binay Kumar
<b>(28) 2012</b>	Remarkable Enhancement in optical and thermal properties of sodium hydrogen phthalate crystals due to Fe <sup>3+</sup> doping”	Journal of Crystal Growth 361(2012)44–50 ISSN: 0022-0248; IF: 1.6	Neeti Goel and Binay Kumar
<b>(27) 2012</b>	“Dielectric studies and band gap tuning of ferroelectric Cr-doped ZnONanorods”	Journal of Applied Physics 112, 014303 (2012); ISSN:0021-8979; IF: 2.3	Manoj K. Gupta, Nidhi Sinha and Binay Kumar
<b>(26) 2012</b>	Synthesis, dielectric and relaxation behavior of lead free NBT–BT ceramics	Ceramics International 39 (2013) 555–561 ISSN: 0272-8842; IF: 1.9	S. Sundari, R. Dhanasekarana, and Binay Kumar
<b>(25) 2012</b>	“Enhancement in ferroelectric, pyroelectric and photoluminescence properties in dye doped TGS crystals”	Journal of Solid State Chemistry 190 (2012) 180-185.; ISSN: 0022-4596; IF: 2.3	Nidhi Sinha, Neeti Goel, B.K. Singh, M.K. Gupta and Binay Kumar
<b>(24) 2012</b>	“Crystalline perfection, Raman, UV-VIS-NIR and prism coupler investigations on Cz-grown pure and Zn-doped LiNbO <sub>3</sub> single crystals”	CrystEngComm,2012,14,3297 ISSN. 1466-8033; IF: 3.8	S. K. Kushwaha. K. K. Maurya, N. Vijayan, R. Bhatt, S. Ganesa- moorthy and G.Bhagavannarayana. and Binay Kumar
<b>(23)2012</b>	“A comparative study of ferroelectric triglycine sulfate (TGS) crystals grown by conventional slow evaporation and unidirectional method”	Materials Research and Bulletin,47 (2012)1587-1597.ISSN: 0025-5408; IF 2.14	M. Senthil Pandian, P. Ramasamy and Binay Kumar
<b>(22)2012</b>	“Effect of Nb-doping on dielectric, ferroelectric and conduction behavior of lead free Bi <sub>0.5</sub> (Na <sub>0.5</sub> K <sub>0.5</sub> ) <sub>0.5</sub> TiO <sub>3</sub> ceramic	Ceramics International 38 (2012) 1157–1165; ISSN: 0272-8842; IF: 1.9	Krishan Kumar and Binay Kumar

<b>(21)2012</b>	“Optical and dielectric studies of solution grown glyciniun maleate single crystal”	Optics Communications 285 (2012) 659–664. ISSN: 0030-4018; IF: 1.3	N. Singh, B.K. Singh, M.K. Gupta and Binay Kumar
<b>(20)2011</b>	'High Tc Ferroelectricity in V-Doped ZnO'	Journal of Materials Chemistry, 2011, 21, 14559-14562; ISSN: 0959-9428; IF: 6.0	Manoj K. Gupta and Binay Kumar
<b>(19)2011</b>	Enhancement in dielectric and ferroelectric properties of lead free $\text{Bi}_{0.5}(\text{Na}_{0.5}\text{K}_{0.5})_{0.5}\text{TiO}_3$ ceramics by Sb-doping	Ceramic International 37 (2011), 2997-3004 ISSN: 0272-8842; IF: 1.9	K. Kumar, B. K. Singh, M. K. Gupta, N. Sinha and Binay Kumar
<b>(18)2011</b>	Effect of rare earth ions on the properties of glycine phosphite single crystals	Journal of Crystal Growth 362 (2011) 343-348 ; ISSN: 0022-0248; IF: 1.6	K Senthil kumar, S MoorthyBabu, B Kumar, G Bhagavannarayana
<b>(17) 2011</b>	Effect of zinc chloride on structural, optical and dielectric behavior of solution grown anthracene crystal	Physica B 406 (2011) 3206–3209. ISSN: 0921-4526; IF: 1.3	Nidhi Sinha, Manoj K. Gupta , Neeti Goel and Binay Kumar
<b>(16) 2011</b>	p- type K -doped ZnO Nano rods for opto-electronic applications	Journal of Applied Physics 109, 083532 (2011). ISSN:0021-8979; IF: 2.3	Manoj K. Gupta, Nidhi Sinha and Binay Kumar
<b>(15) 2011</b>	Enhanced ferroelectric, dielectric and optical behaviour in Li-doped ZnO nanorods.	Journal of Alloys and Compound 509 (2011) L208–L212;ISSN: 0925-8388; IF: 2.3	Manoj K. Gupta and Binay Kumar
<b>(14) 2011</b>	Structural, optical and dielectric studies of Glyciniun trifluoro acetate single crystal.	Physica B: Condensed Matter, 406 (2011) 2152–2157. ISSN: 0921-4526; IF: 1.3	Neelam Singh and Binay Kumar
<b>(13) 2011</b>	Investigation of glassy behaviour of flux grown $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$ crystal.	Physica B: Condensed Matter, 406 (2011) 941–945. ISSN: 0921-4526; IF: 1.3	B.K. Singh and Binay Kumar
<b>(12) 2011</b>	Enhancement in crystalline perfection and optical properties of benzophenone single crystals: the remarkable effect of a liquid crystal	J. Appl. Cryst. (2011). 44, 839–845 ISSN: 0021-8898; IF: 3.4	S. K. Kushwaha, N. Vijayan, K. K. Maurya, A. Kumar, K. Somayajulu, G. Bhagavannarayana and Binay Kumar
<b>(11) 2011</b>	Growth and characterization of new semi organic L-proline strontium chloride monohydrate single crystals.	Physica B: Condensed Matter 406 (2011) 63. ISSN: 0921-4526; IF: 1.3	Manoj K. Gupta, Nidhi Sinha and Binay Kumar
<b>(10)2010</b>	Effect of electric field on dielectric, ac conduction and ferroelectric behavior of flux-grown $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}\text{O}_3$ single crystals	Physica Status Solidi (a) 207 (11), 2564-2569 ISSN: 1862-6319; IF: 1.5	BK Singh, K Kumar, MK Gupta and Binay Kumar



(9) 2010	Synthesis of K-doped p-type ZnO nanorods along (100) for ferroelectric and dielectric applications.	Materials Letters, 64 (2010)1825-28. ISSN: 0167-577X; IF: 2.5	Manoj K Gupta, Nidhi Sinha, B.K. Singh and Binay Kumar
(8) 2010	Structural, Dielectric, Optical and Ferroelectric property of Urea Succinic Acid Crystals grown in aqueous solution containing Maleic Acid	Journal of Physics and Chemistry of Solids 71(2010) 1774–1779. ISSN: 0022-3697; IF: 1.5	B. K. Singh, N. Sinha, N. Singh, K. Kumar, M. K. Gupta and Binay Kumar
(7) 2010	“Effect of ion irradiation on the m-Nitroaniline single crystals”.	Nucl. Instr. and Meth. in Phys. Res. B 268 (2010) 36–41.	T. Kanagasekaran, P. Mythili, R. Gopala -krishnan and Binay Kumar
(6) 2010	Synthesis and Comparative Study of ZnO Nano rods for Structural, Optical and Dielectric Behaviour.	Integrated Ferroelectrics, 118:61–66, 2010. ISSN: 1058-4587; IF: 0.34	M.K. Gupta, Nidhi Sinha and Binay Kumar
(5) 2010	Organic Ferroelectrics: A Big Surprise.	Nature Asia Materials Research Highlight, doi: 10.1038/asiamat.2010.48, (2010).ISSN (online): 1884-4057; IF: 9.1	Mohd. Shakir, B.K.Singh, G. Bhagavannarayana, and Binay Kumar
(4) 2010	Synthesis and characterization of Sb-doped $\text{Bi}_{0.5}(\text{Na}_{0.5}\text{K}_{0.5})_{0.5}\text{TiO}_3$ ceramic.	Integrated Ferroelectrics, 121:99–105, 2010. ISSN: 1058-4587; IF: 0.34	Krishan Kumar and Binay Kumar
(3) 2010	Growth of 1 0 0 directed ADP crystal with slotted ampoule.	Current Applied Physics 10 (2010) 1221-1226. ISSN: 1567-1739; IF: 1.8	P. Rajesh, P. Ramasamy, G. Bhagavannarayana and Binay Kumar
(2) 2010	Impedance analysis and high temperature conduction mechanism of flux grown $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$ single crystal.	Cryst. Res. Technol. 45, 1003 – 1011 (2010) ISSN: 0232-1300; IF: 1.0	B. K. Singh and Binay Kumar
(1) 2010	Effect of cobalt and DL-malic acid on the growth rate, crystalline perfection, optical, ... ADP single crystals.	Physica B 405 (2010) 2401-06. ISSN: 0921-4526; IF: 1.3	P. Rajesh, P. Ramasamy, G. Bhagavannarayana and Binay Kumar

#### Review Article:

“Growth and Characterization of  $\text{Bi}_2\text{Sr}_2\text{CaCuO}_{8+\delta}$  High Tc Superconducting Single Crystals”

Co authors: P. Kumar, I.K. Bdikin and G.C. Triguñay. In: Superconductivity Research Horizons, Ed: E.H. Peterson, Nova Science Publisher, Inc, USA, p. 71-110 (2007).

**Reviewed** more than 25 submitted papers in Journals like Nano Scale, ACS Appl. Mater. Interfaces, J of Crystal Growth, Materials Letters, Crystal Growth and Design, RSC advances, Materials Research Bulletin, Science of Advanced Materials, Ceramic International, Materials Science and Engineering, etc.

**Examined** more than twenty five Ph.D. thesis and conducted Ph.D. viva voce of over fifteen Ph.D. students of other Universities.

### Projects (Major Grants) during Past 5 years

Sr.No.	Title	Cost (in rupees)	Duration	Agency
5	Flux growth of $Pb(Mg_{1/3}Nb_{2/3})O_3$ - $PbTiO_3$ (PMNT) single crystals for piezoelectric and pyroelectric applications	86 Lac	June 2015- June 2018	ARMREB, DRDO
4	Growth and characterization of n- and p-type ZnO nanostructure for optoelectronic applications	7 Lac	July2012- July2015	UGC
3	Growth of Device Level Lead free Alkali-Based Piezoelectric Single Crystals	25 Lac	Oct-2011- April 2015	DST
2	Growth of Device Level Non Linear Optical Organic/Semi- Organic Single Crystals By Various Methods	35 Lac	Nov 2009- Sept 2013	DU DST PURSE GRANT
1	Synthesis of High Performance Piezoelectric Ceramic & Crystals for Device Fabrication	46 Lac	Sept 2007- March 2011	DST

**Ph.D. Supervision:** Since 2010, ten students completed Ph.D. Degree; Two Ph.D. theses are under submission. Six are currently registered as Ph.D. student.

Sr. No.	Name of Student	Awarded	Ph.D. Thesis Title
11.	Jyoti	Ph.D. thesis submitted in April, 2016	“Growth of piezoelectric non-linear optical organic/semi organic single crystals and their structural, optical, thermal and dielectric characterizations”
10.	N. Tyagi	Ph.D. thesis submitted in Nov, 2015	“Structural, piezoelectric, ferroelectric, dielectric and mechanical properties in amino acid based single crystals”

9.	S. Bhandari	Dec., 2015	“Processing lead free perovskite ceramics, single crystal growth and characterization of pure and Mn-doped $\text{Bi}_{0.5}(\text{Na}_{1-y}\text{K}_y)_{0.5}\text{TiO}_3$ relaxor-like ferroelectrics”
8.	S. Godara	Dec., 2015	“Ferroelectric, ferromagnetic, dielectric and structural characterization of pure and substituted Multiferroic Bismuth ferrite ( $\text{BiFeO}_3$ ) nanoparticles synthesized by auto-combustion route”
7.	G. Ray	April, 2015	“Ceramic synthesis, crystal growth and characterization of pure and Sb-modified lead free ferroelectric ternary perovskite sodium potassium lithium niobate”
6.	N. Goel	Oct, 2012	“Structural, thermal, optical & dielectric characterization of solution grown pure and doped semi organic sodium phthalate single crystals”
5.	S. K. Khushwaha	May, 2012	“Growth and investigation for crystalline perfection <i>vis-à-vis</i> physical properties of pure and doped $\text{LiNbO}_3$ , Benzophenone and ZTS NLO single crystals”
4.	M. K. Gupta	June, 2011	“Growth of Doped and Undoped ZnO Nanostructure & their Morphological, Structural, Optical, Dielectric and Piezoelectric Characterization”
3.	N. Singh	June, 2011	“Structural, Optical And Dielectric Characterization of Solution grown Organic/Semi Organic Single Crystals”
2.	K. Kumar	Oct, 2010	“Synthesis and Characterization of Pure and (Sb,Nb,Ta)-doped Lead Free Piezoelectric $[\text{Bi}_{0.5}(\text{Na}_{1-x}\text{K}_x)_{0.5}]\text{TiO}_3$ Ceramics”
1.	B. K. Singh	March, 2010	“Structural, Piezoelectric, Dielectric, Optical and Electrical Characterization of Flux Grown $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}\text{O}_3$ Single Crystal”

### Teaching Experience ( Subjects/Courses Taught)

Atomic & Molecular Physics, Electronics (Core papers, M.Sc. (F) and (P))

Advanced Solid State Physics Lab, Nanomaterials lab (M.Sc. Final)

Solid State Physics Lab, Waves & Optics Lab (M.Sc. Previous)

## Invited Talk and other presentations in International/ National Conferences

- [1] **Talk in the 25th AACGE Western Section Conference on Crystal Growth & Epitaxy, June 12-15, 2016, in California, USA.** "Flux grown alkali based perovskite crystals for piezoelectric applications"
- [2] **Talk** on "High performance piezoelectric crystals" in the Department of Chemistry (Prof. Cava Group), **Princeton University, USA**, 17 June 2016.
- [3] **Invited Talk** in Twenty Sixth National Seminar On Crystal Growth and Epitaxy (XXVI-NSCGE) during March 14-15, 2016., Crystal Growth Center, Anna University, **Advisory Committee member and Chairing a Technical Session**
- [4] **Invited Talk** in 20th National Seminar on Crystal Growth and Applications (NSCGA), January 19 - 21, 2016, BARC, Mumbai, **Advisory Committee member and Chairing a Technical Session**
- [5] **Invited Talk** in National Seminar on X-Ray Crystallography (NSXC-2014), Madurai Kamraj University, Tamilnadu, 29-Sept-1 Oct 2014, **Chairing a Technical Session**
- [6] **Invited talk** in 43 A National Seminar on Crystallography, IISER Mohali, Chandigarh March 2014; **Advisory Committee member and Chairing a Technical Session**
- [7] **Invited talk** in National Seminar on Crystal Growth, SSN college of Engineering Feb 2014; **Advisory Committee member and Chairing a Technical Session**
- [8] **Invited talk** in VIT March 2014, **International Advisory Committee member**
- [9] **Invited talk** in 42 National Seminar on Crystallography, at JNU Nov 2013; **Advisory Committee member and Chairing a Technical Session**
- [10] **Invited talk** in International Workshop and Seminar on Crystal Growth, Crystal Growth Center, Anna University, Dec 2012
- [11] **Invited talk** in the 3<sup>rd</sup> Collaborative Conference on Crystal Growth (3CG) Orlando, Florida **USA** during 11-15 Dec 2012 on "Optoelectronic and nano generator applications of ZnO nanocrystals" **International Advisory Committee member and Chairing a Technical Session on Nano-Energy.**
- [12] **Invited talk** on in the International Workshop on Crystal Growth and Characterization of Advanced Materials and Devices' and 'XXIV National Seminar on Crystal Growth' 16-22 December 2012, in crystal Growth Center, Anna University, Chennai; **Chairing a Technical Session.**
- [13] **Invited Talk** in International Conference and Workshop on Nano-Structured ceramics and other Nanomaterials (ICWNCN)" March 13<sup>th</sup> – 16<sup>th</sup>, 2012 at University of Delhi, New Delhi. **Core Organizing Group member and Chairing a Technical Session.**
- [14] **Invited Talk** on "Energy harvesting through Piezoelectric ZnO nanorods" 3<sup>rd</sup> International Conference on Current Development in Atomic, Molecular, Optical and Nano Physics" Dec 14-16, 2011, University of Delhi; **Core organizing group member.**
- [15] **Invited Talk** on "ZnO Nanorods: Optical and Nanogenerator Applications" in the "International Conference on Nanomaterials & Nanotechnology (ICNANO) 18-21 December, 2011 University of Delhi, Delhi" **Core organizing group member.**
- [16] **Invited Talk** on "Study of crystal growth and defect features by optical, scanning and tunneling microscope" in the XV National Seminar on Crystal Growth from 23-25, February 2011. Tirunelveli – Tamil Nadu
- [17] **Invited Talk** on "Growth and characterization of technologically important crystals" in UGC Sponsored Conference on

“Recent Trends in Materials Research” during 29th - 30th January, 2011, Kalyan, Mumbai.

- [18] **Invited Talk** “Quality control of technologically important crystals for various applications” in National Symposium “Synthesis, Characterization and Applications of Technologically Important Material” 5-6 Jan. 2010, BHU, Varanasi.
- [19] **Key Note address** “Need of Technologically Important Crystals” at UGC sponsored “National Conference on Recent Trends in Material Synthesis and Characterization”, at Nagpur, 4<sup>th</sup> - 5<sup>th</sup> December 2009.
- [20] **Five papers** are presented in “The 17th American Conference on Crystal Growth and Epitaxy (9-14 August, 2009) at Lake Geneva, **Wisconsin, USA**”.
- [21] **Invited Talk** “Pb-based and Pb-free piezoelectric systems for high performance applications” in International Conference on Electroceramics, Delhi 13-17 Dec. 2009.
- [22] **Invited Talk** “Development of high performance piezoelectric single crystals for applications” at Variable Energy Cyclon Center, Kolkata, 18<sup>th</sup> June 09.
- [23] **Invited Talk** “High performance piezoelectric crystals: Growth, Characterization and Applications” in National Conference on Advanced Materials – Processing, Characterization and Applications. Tirunelveli, Tamilnadu, Aug. 09.
- [24] **Five Invited (Popular) Talks** at Crystal Growth Center, Anna University as **Senior Associate in UGC:CGC-AU Facility, March, 09**. (a) Enhancement of crystalline and material properties of superconducting Bi-2212 and piezoelectric LiNbO<sub>3</sub> single crystals through post growth treatments (b) Piezoelectric, dielectric and structural characterization of flux grown PZNT single crystals (c) Morphology and growth features on variously grown crystals (d) Quality control of semiorganic NLO single crystals through optimization of pH-value (e) Need of Pb-free high performance piezoelectric system.
- [25] **Invited Talk** “Growth and characterization of Pb-based and Pb-free Piezoelectric crystals” In: 13<sup>th</sup> National Seminar on Crystal Growth 27-29 Jan 2009 SSN College of Engineering, Tamil Nadu. Collected Abstract Page I-11.
- [26] **Invited Talk** “Crystals: Through the eyes of microscope” by Binay Kumar. In: National Conference on Microscopy and Allied Fields 17-20 Jan 2009, Jhansi, Collected Abstract p.37-38.
- [27] **Invited Talk** “High performance piezoelectric crystals: Growth, Characterization and Applications” in National Conference on Advanced Materials – Processing, Characterization and Applications. Tirunelveli, Tamilnadu, Aug. 09.
- [28] **Invited Talk** and Four contributory Papers in “The 13<sup>th</sup> National Seminar on Crystal Growth (27-29 January, 2009) SSN College, SSN Nagar, Chennai, Tamilnadu”.
- [29] **Four contributory papers** in “The 38<sup>th</sup> National Seminar on Crystallography, University of Mysore, 11-13 February 2009.

Total Publication Profile **optional**

## DETAILS OF RESEARCH WORK

**Lead-free alkali based piezoelectric (pure and doped BNKT, NKLN, etc) systems** have been synthesized after optimizing composition and sintering temperature. Single crystals of BNKT and NKLN were grown by flux method. Enhanced dielectric, piezoelectric and ferroelectric properties with improved depolarization and transition temperature were achieved for high temperature applications for repeated cycles.

**Project:** One DST Project “Growth of Device Level Lead free Alkali-Based Piezoelectric Single Crystals” from DST is completed in April 2015 (Rs. 25 Lac).

**Manpower Trained:** Three students have completed Ph.D. work as

- (i) “Synthesis and Characterization of Pure and (Sb,Nb,Ta)-doped Lead Free Piezoelectric [Bi<sub>0.5</sub>(Na<sub>1-x</sub>K<sub>x</sub>)<sub>0.5</sub>]TiO<sub>3</sub>

Ceramics” (2010)

- (ii) “Ceramic synthesis, crystal growth and characterization of pure and Sb-modified lead free ferroelectric ternary perovskite sodium potassium lithium niobate” (2015)
- (iii) “Processing lead free perovskite ceramics, single crystal growth and characterization of pure and Mn-doped  $\text{Bi}_{0.5}(\text{Na}_{1-y}\text{K}_y)_{0.5}\text{TiO}_3$  relaxor-like ferroelectrics” (2015)

### **Publications:**

1. “Flexible High Performance Lead-Free  $\text{Na}_{0.47}\text{K}_{0.47}\text{Li}_{0.06}\text{NbO}_3$  Microcubes- Structures Based Piezoelectric Energy Harvester”, MK Gupta, Sang-Woo Kim, and Binay Kumar, ACS Appl. Mater. Interfaces, 8 (3), pp 1766-1773 (2016).
2. Enhanced microstructure and electrical properties of Mn-modified  $\text{Bi}_{0.5}(\text{Na}_{0.65}\text{K}_{0.35})_{0.5}\text{TiO}_3$  ferroelectric ceramics, Ceramics International DOI:10.1016/j.ceramint.2015.11.104, Sonia Bhandari, Nidhi Sinha, and Binay Kumar
3. Enhanced dielectric and electric properties of Ta-doped ferroelectric  $0.50(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3 - 0.50(\text{K}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$  lead-free ceramics Ceramics International 41 (2015) 10237-10242, Krishan Kumar,
4. “Achieving high piezoelectricity and fatigue free hysteresis in lead free relaxor ferroelectric ceramic  $0.94[\text{Na}_{0.5}\text{K}_{0.5}\text{NbO}_3]-0.06\text{LiSbO}_3$ ”, Geeta Ray, Nidhi Sinha, Sonia Bhandari and Binay Kumar, Materials Chemistry and Physics 159, 107-113 (2015).
5. “Lead Free Relaxor Ferroelectric  $\text{Na}_{0.47}\text{K}_{0.47}\text{Li}_{0.06}\text{Nb}_{0.94}\text{Sb}_{0.06}\text{O}_3$  Crystals for Opto-Electronic Applications”, Geeta Ray, Nidhi Sinha, Budhendra Singh, Igor Bdikin, and Binay Kumar, Crystal Growth and Design 15, 1852-1860 (2015).
6. “Enhanced dielectric and electric properties of Ta-doped ferroelectric  $0.50(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3 - 0.50(\text{K}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$  lead-free ceramics” Krishan Kumar, Nidhi Sinha, Sonia Bhandari and Binay Kumar Ceramics International DOI: 10.1016/j.ceramint.2015.04.134
7. “Effect of structural modification by  $\text{MnO}_2$  addition on the electrical properties of lead free flux grown  $(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3-(\text{K}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$  single crystals” Sonia Bhandari and Binay Kumar, Crystal Growth and Design 15, 867–874, (2015).
8. “Observation of non linear optical and photoluminescence properties in ferroelectric  $0.94[\text{Na}_{0.5}\text{K}_{0.5}\text{NbO}_3]-0.06\text{LiNbO}_3$  single crystals” Geeta Ray and Binay Kumar, Materials Letters 143, 105–107, (2015).
9. “Excellent piezo-/pyro-/ferroelectric performance of  $\text{Na}_{0.47}\text{K}_{0.47}\text{Li}_{0.06}\text{NbO}_3$  lead free ceramic near polymorphic phase transition” Geeta Ray, Nidhi Sinha, Sonia Bhandari and Binay Kumar, Scripta Materialia 99, 77–80, (2015).
10. “Flux growth of  $0.94[\text{Na}_{0.5}\text{K}_{0.5}\text{NbO}_3]-0.06\text{LiNbO}_3$  piezo-/ferroelectric crystals for long duration and high temperature applications” Geeta Ray, Nidhi Sinha, Sonia Bhandari, Budhendra Singh, Igor Bdikin and Binay Kumar CrystEngComm, 16, 7004– 7012 (2014).
11. “Processing and properties of ferroelectric  $\text{Bi}_{0.5}(\text{Na}_{0.65}\text{K}_{0.35})_{0.5}\text{TiO}_3$  ceramics under the effect of different sintering temperature”, Sonia Bhandari, Nidhi Sinha, Geeta Ray and Binay Kumar Scripta Materialia 89, 61-64 (2014).



12. "Flux growth of lead free  $(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3 - (\text{K}_{0.5}\text{Bi}_{0.5})\text{TiO}_3$  ferroelectric single crystals and its characterization", Sonia Bhandari, Nidhi Sinah, , Geeta Ray and Binay Kumar CrystEngComm 16, 4459 (2014).
13. "Environment friendly novel piezoelectric  $0.94 [\text{Na}_{0.8}\text{K}_{0.2}\text{NbO}_3]_{0.06} \text{LiNbO}_3$  ternary ceramic for high temperature dielectric and ferroelectric applications", Materials Chemistry and Physics 142 619-625 (2013).
14. "Synthesis, dielectric and relaxation behavior of lead free NBT–BT ceramics" S. Shanmuga Sundari, Binay Kumar, R. Dhanasekarana, Ceramics International (2012) doi.org/10.1016/j.ceramint.2012.06.063.
15. "Effect of SHI Irradiation on NBT-BT Ceramics: Transformation of Relaxor Ferroelectric to Ferroelectric Nature" S. Shanmuga Sundari, Binay Kumar, K. Asokan, R. Dhanasekaran, Applied Surface Science (2012) doi.org/10.1016/j.apsusc.2012.10.199.
16. "Effect of Nb-doping on dielectric, ferroelectric and conduction behavior of lead free  $\text{Bi}_{0.5}(\text{Na}_{0.5}\text{K}_{0.5})_{0.5}\text{TiO}_3$  ceramic", Krishan Kumar and Binay Kumar, Ceramics International 38 1157–1165 (2012).
17. "Enhancement in dielectric and ferroelectric properties of lead free  $\text{Bi}_{0.5}(\text{Na}_{0.5}\text{K}_{0.5})_{0.5}\text{TiO}_3$  ceramics by Sb-doping" Krishan Kumar, B. K. Singh, M. K. Gupta, N. Sinha and Binay Kumar, Ceramic International 37, 2997-3004 (2011).
18. "Synthesis and characterization of Sb-doped  $\text{Bi}_{0.5}(\text{Na}_{0.5}\text{K}_{0.5})_{0.5}\text{TiO}_3$  ceramic" Krishan Kumar and Binay Kumar Integrated Ferroelectrics, 121:99–105 (2010).

**ZnO/BFO nano-particles** have been synthesized by low cost chemical route and piezoelectric, dielectric aspects have been studied. Oriented ZnO nanorods of diameter 20-30 nm and length 80-250 nm have been grown. Effect of doping (K-, Li-, V-, Cr-, etc) on dielectric, ferroelectric, optical, etc properties of ZnO has been studied. Main achievements on these studies are (a) growth of p-type ZnO nanorods (b) enhancement of ferroelectric and dielectric properties (c) band gap tuning, etc. It has been demonstrated that these nanorods can be used for LED, Sensor and Nanogenerator applications. BFO nanoparticles were synthesized by chemical auto combustion method and characterized for ferroelectric, ferromagnetic, dielectric, etc behavior. Effect of co-doping of Ba, Nb, Cr, Ce etc were studied.

**Project:** One UGC project "Growth and characterization of n- and p-type ZnO nanostructure for optoelectronic applications" is recently completed in July 2015 (7.5 Lac).

**Manpower Trained:** Two students have completed their Ph.D. work on

- (i) "Growth of Doped and Undoped ZnO Nanostructure and Their Morphological Structural, Optical, Dielectric & Piezoelectric Characterization" (2012).
- (ii) "Ferroelectric, ferromagnetic, dielectric and structural characterization of pure and substituted Multiferroic Bismuth ferrite ( $\text{BiFeO}_3$ ) nanoparticles synthesized by auto-combustion route" (2015)

**Publications:**

1. "Effect of Ba–Nb co-doping on the structural, dielectric, magnetic and ferroelectric properties of  $\text{BiFeO}_3$

nanoparticles” Sajay Godara and Binay Kumar, Ceramic International (2015) DOI: 10.1016/j.ceramint.2015.01.145

2. “Enhanced electric and magnetic properties in Ce-Cr co-doped Bismuth ferrite nanostructure” Sanjay Godara, Nidhi Sinha and Binay Kumar, Materials Letters 136, 441–444 (2014)
3. “Combined structural, electrical, magnetic and optical characterization of bismuth ferrite nanoparticles synthesized by auto-combustion route” Sanjay Godara, Nidhi Sinha Geeta Ray and Binay Kumar, J Asian Ceramic Society, 2, (2014) 416-421
4. “Enhanced piezoelectric output voltage and Ohmic behavior in Cr-doped ZnO nanorods” Nidhi Sinha, Geeta Ray, Sanjay Godara, Manoj K. Gupta and Binay Kumar, Materials Research Bulletin 54 (2014)267-271
5. “Synthesis and enhanced properties of Cerium doped ZnO nanorods” N. Sinha, G. Ray, S. Bhandari, S. Godara and Binay Kumar, Ceramic International 40 12337–12342 (2014).
6. “Dielectric studies and band gap tuning of ferroelectric Cr-doped ZnO Nanorods” Manoj K. Gupta, Nidhi Sinha and Binay Kumar, Journal of Applied Physics 112, 014303 (2012).
7. “High Tc ferroelectricity in V-doped ZnO nanorods” Manoj Kumar Gupta and Binay Kumar, Journal of Materials Chemistry, , 21, 14559-14562 (2011).
8. “p- type K -doped ZnO Nanorods for opto-electronic applications” Manoj K. Gupta, Nidhi Sinha and Binay Kumar, Journal of Applied Physics 109, 083532 (2011).
9. “Enhanced ferroelectric, dielectric and optical behaviour in Li-doped ZnO nanorods” Manoj K. Gupta and Binay Kumar, Journal of Alloys and Compound 509 (2011) L208–L212.
10. “Synthesis of K-doped p-type ZnO nanorods along (100) for ferroelectric and dielectric applications” Manoj K Gupta, Nidhi Sinha, BK Singh and Binay Kumar, Materials Letters, 64 1825-28 (2010).
11. “Synthesis and Comparative Study of ZnO Nanorods for Structural, Optical and Dielectric Behaviour” M.K. Gupta, Nidhi Sinha and Binay Kumar Integrated Ferroelectrics, 118:61–66 (2010).
12. “Piezoelectric, dielectric, optical and electrical characterization of solution grown ZnO nano crystals” M.K. Gupta, N. Sinha, BK Singh, N. Singh, K. Kumar and Binay Kumar. Material Letters 63 1910-1913 (2009).

**Lead Based Piezoelectric (i)  $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$  (PZN-PT) and (ii)  $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - $\text{PbTiO}_3$  (PMN-PT) single crystals:** PZN-PT single crystals have been grown by flux method of sizes upto 8-9 mm across. The main achievements are increased perovskite phase, higher  $d_{33}$  values (~2400 pC/N compare 20 pC/N for  $\text{LiNbO}_3$  and 450 pC/N for PZT) and better dielectric and mechanical properties. Work on the quality improvement has been undertaken and their suitability for device fabrication has been established.

Work on the synthesis and crystal growth of PMN-PT system has been started recently.

**Project:**

(i) DST project “Synthesis of High Performance Piezoelectric Ceramic & Crystals for Device Fabrication” Sept.

2007-March 2011 (Rs. 46 Lac) has been completed.

(ii) DRDO ARMREB project “Flux growth of  $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3\text{-PbTiO}_3$  (PMNT) single crystals for piezoelectric and pyroelectric applications” (Sanction No ARMREB/MAA/2015/163; 85 lac) has been recently sanctioned.

**Manpower Trained:** One student received his Ph.D. degree in 2010 on “Structural, Piezoelectric, Dielectric, Optical and Electrical Characterization of Flux Grown  $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$  Single Crystal”.

#### **Publications:**

1. “Synthesis of  $0.64\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3\text{-}0.36\text{PbTiO}_3$  ceramic near Morphotropic Phase Boundary for high performance piezoelectric, ferroelectric and pyroelectric applications” Abid Hussain, Nidhi Sinha, Sonia Bhandari, Harsh Yadav, Abhilash Joseph and Binay Kumar, Journal of Asian Ceramic Societies DOI: 10.1016/j.jascer.2016.06.004.
2. “Flux growth and effect of cobalt doping on dielectric, conductivity and relaxation behaviour of  $0.91\text{Pb}[\text{Zn}_{1/3}\text{Nb}_{2/3}]\text{O}_3\text{-}0.09\text{PbTiO}_3$  crystals” B.K. Singh, Igor Bdikin, Ajay Kaushal and Binay Kumar, CrystEngComm 16, 1935-42 (2014)
3. “Investigation of glassy behaviour of flux grown  $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$  crystal” B.K. Singh and Binay Kumar Physica B406 941–945 (2011).
4. “Effect of electric field on dielectric, ac conduction and ferroelectric behavior of flux-grown  $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$  single crystals,” B. K. Singh, K. Kumar, M. K. Gupta and Binay Kumar, Status Solidi A, 1–7 (2010) / DOI 10.1002/pssa. 200925643.doc.
5. “Impedance analysis and high temperature conduction mechanism of flux grown  $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$  single crystal” B. K. Singh and Binay Kumar Cryst. Res. Technol. 45, 1003 – 1011 (2010).
6. “Flux growth and low temperature dielectric relaxation in piezoelectric  $\text{Pb}[(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}]\text{O}_3$  single crystals” B.K. Singh, K. Kumar, Nidhi Sinha and Binay Kumar. Cryst. Res. Technol 44 No.9 915-924 (2009).
7. “Evidence of additional phase transitions at lower temperatures in the flux grown  $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})_{0.91}\text{Ti}_{0.09}\text{O}_3$  single crystal” B.K. Singh and Binay Kumar. Materials Letters 63, p.625–628 (2009).

**Organic and Semiorganic (Anthracene, Benzil, TGS, Glycene, LHFB, Phthalate, Benzophenon, etc) single crystals** are grown by various techniques like slow evaporation, temperature lowering method, CZ method, seed rotation method, SR method, etc. Large variety of crystals for semiconducting, ferroelectric, Non Linear Optial, etc applications have been grown of sizes from few mm to several cm. They were characterized for structural, dielectric, ferroelectric, optical, etc behavior. These crystals were used for the fabrication of patch antenna for communication applications

**Project:** DST-DU PURSE project “Growth of Device level NLO Organic/Semi- Organic single crystals by various

methods” is currently under progress Nov 2009- March 2013; (Rs 35 Lac) has been completed.

**Manpower Trained:** Three Ph.D. student has have completed Ph.D. work

- (i) “Growth of piezoelectric non-linear optical organic/semi organic single crystals and their structural, optical, thermal and dielectric characterizations” Submitted in April 2016.
- (ii) “Structural, piezoelectric, ferroelectric, dielectric and mechanical properties in amino acid based single crystals” submitted in Nov 2015
- (iii) “Structural, thermal, optical & dielectric characterization of solution grown pure and doped semi organic sodium phthalate single crystals” in 2012.
- (iv) “Structural, optical and dielectric characterization of solution grown organic/semi-rganic Single Crystals” in 2011.

**Publications:**

1. New geometrical modeling to study the crystal morphology” Crystal Growth and Design 2016 In Press, Harsh Yadav, Nidhi Sinha, and Binay Kumar
2. “Modified low temperature Czochralski growth of xylenol orange doped benzopheone single crystal for fabricating dual band patch antenna” Journal of Crystal Growth 450 (2016) 74–80.
3. “Growth, morphology, structure and characterization of L-histidinium dihydrogen arsenate orthoarsenic acid (LHAS) single crystal”, Acta Crystallographica Section B. article GW5042, Nidhi Tyagi, Nidhi Sinha, Harsh Yadav and Binay Kumar.
4. “Effect of crystal violet dye on the structural, optical, mechanical and piezoelectric properties of ADP single crystal”, Materials Research Bulletin MRB-15-2299R110.1016/j.materresbull.2016.05.023, Sahil Goel, Nidhi Sinha, Harsh Yadav and Binay Kumar.
5. “Growth, structural, dielectric, ferroelectric and mechanical properties of L-prolinium tartrate single crystal”, Journal of Materials Science, 51, 7614-7623, (2016), Sonu Kumar , Nidhi Sinha, Harsh Yadav and Binay Kumar.
6. “Growth, crystal structure, Hirshfeld surface, dielectric and mechanical properties of a new organic single crystal: ‘Bis glycine’ squarate”, RSC Adv., 6, 24565, (2016), Nidhi Tyagi, Nidhi Sinha, Harsh Yadav and Binay Kumar.
7. “Remarkable Enhancement in dielectric, piezoelectric, ferroelectric and SHG Properties by iron doping in sodium para-nitrophenolate dihydrate single crystals”, Materials Letters (2015), Jyoti Dalal and Binay Kumar.
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**High temperature superconducting  $\text{Bi}_2\text{Sr}_2\text{CaCuO}_{8+\delta}$  (Bi-2212) single crystals and Y-123 ceramic** are grown by self flux method and characterized by various techniques. The main achievement was to control/enhance the transition temperature and other crystal qualities by post growth annealing treatment under varying conditions.

**Project:** Completed UGC project (2001-2004) on "High Tc Superconducting Crystals" (17 Lac).

**Manpower Trained:** One student got his Ph. D. degree titled "Study of as grown and annealed  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$  high Tc superconducting single crystals grown by self flux technique".

**Publications:**

1. "Structural changes in ab plane of Zn-doped Bi-2212 HTSC single crystals". Lovleena, I.K. Bidikin, A.L. Kholkin and Binay Kumar Physica C, 451, p.44-48 (2007).
2. "IR-studies on  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\square}$  single crystals with different oxygen stoichiometry". P. Kumar, G.C. Trigunayat and Binay Kumar. In: Advances in Technologically Important Crystals, Ed: Binay Kumar & R.P. Tandon, Macmillan p.87-92 (2007).
3. "X-ray and AFM studies of  $\text{Bi}_2\text{Sr}_2\text{CaCuO}_{8+\square}$  single crystals grown by different methods". I.K. Bdikin, A.N. Maljuk, A.B. Kulakov, C.T. Lin, P. Kumar, Binay Kumar, G.C. Trigunayat, G.A.Emel'chenko, A.L. Kholkin. J Crystal Growth 275, No.1-2, p. e1799-1805 (2005).
4. "Comparative characterization of undoped and Zn-doped  $\text{Bi}_2\text{Sr}_2\text{CaCuO}_{8+\square}$  single crystals grown by self flux technique". Binay Kumar, P. Kumar, Lovleena, I.K. Bidikin and G.K. Chadha. Ind. J. of Cryogenics, 30, p.175-178 (2005).
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**Review Article:** "Growth and Characterization of  $\text{Bi}_2\text{Sr}_2\text{CaCuO}_{8+\square}$  High Tc Superconducting Single Crystals" P. Kumar, Binay Kumar, I.K. Bdikin and G.C. Trigunayat. In: "Superconductivity Research Horizons"; Ed: Eugene H. Peterson ; Chapter 3 pp.71-110 (2007) Nova Science Publisher, Inc, USA, (ISBN: 1-60021-510-6).

**Piezoelectric LiNbO<sub>3</sub> single crystals** are grown by Cz method (at NPL). The highlight of the works on undoped and Fe-doped LN crystals was to achieve highest values of piezoelectric charge coefficient ( $d_{33}$  pC/N) and removal of small angle grain boundaries (lowest ever reported values of half widths of the rocking curve in the HRXRD) by a combination of annealing and poling processes.

**Manpower Trained:** Two students got their Ph.D. degree

- (i) “Growth, Characterization and Improvement of Undoped and Fe- doped high  $T_c$  LiNbO<sub>3</sub> single crystals” in 2006
- (ii) “Growth and investigation for crystalline perfection *vis-à-vis* physical properties of pure and doped LiNbO<sub>3</sub>, Benzophenone and ZTS NLO single crystals” in 2012

### **Publications**

1. “Crystalline perfection, Raman, UV-VIS-NIR and prism coupler investigations on Cz-grown pure and Zn-doped LiNbO<sub>3</sub> single crystals” S. K. Kushwaha, K. K. Maurya, N. Vijayan, Rajeev Bhatt, S. Ganesamoorthy and G. Bhagavannarayana. and Binay Kumar, *CrystEngComm*, 2012, 14, 3297
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**As a Ph.D. Student in Delhi University during 1988-91, Binay Kumar** worked on the Growth of dendritic single crystals of pure and doped CdI<sub>2</sub> by vapour method and their characterization with respect to structural changes due to doping. Single crystals of various systems were also grown by solution methods and horizontal and vertical moving zone systems. Zone refining systems were designed and fabricated for the purification of metal halides to spectroscopic level.

The Ph.D. title was “Polytypism of vapour grown dendritic single crystals of both undoped and doped cadmium iodide”

1. “Polytypism in PbI<sub>2</sub>-doped dendritic single crystals of cadmium iodide”. Binay Kumar and G. C. Trigunayat. *Acta Cryst.* A47, p.263-267 (1991).

2. "Vapour growth and characterization of cadmium iodide dendritic single crystals". Binay Kumar and G. C. Trigunayat. Proc. Ind. Nat. Sc. Acad. A57, No.2, p.231-239 (1991).
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4. "Growth and characterization of KDP-doped dendritic single crystals of cadmium iodide". Binay Kumar and G.C. Trigunayat. Phase Transition, 43, p.145-152 (1993).
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#### Membership of Professional Societies

1. Indian Crystallographic Association, (Member, National Executive committee)
2. Semiconductor Society of India
3. Indian association of Physics Teachers
4. Electron Microscopic Society of India

**Research Interests / Specialization: Crystal Growth, Nanoparticles, Piezo-/Ferroelectricity, Characterization, Devices**

**Ph.D. Supervised: 12 (+1 under submission)**

**Ph.D. under progress: 6**

**Papers in Referred International Journals: ~110**

**Major Projects: 6 (DST, DRDO, UGC)**

**Talk in National/International conferences: ~ 40**

(Signature of Faculty Member)

(Signature & Stamp of

Head of the Department)