BIODATA

Name:	Dr. T. K. Nath
Nationality:	Indian
Date of Birth:	29th December, 1965
Present Post:	Professor
Father's Name:	Hemanta Kumar Nath
Place of Birth:	Siliguri, Darjeeling, W.B., India
Institution with address:	Department of Physics Indian Institute of Technology, Kharagpur 721 302 IIT Kharagpur Telephone No. : +91-3222-283862, 283863 Mobile phone: +91-9932952097 Email: tnath@phy.iitkgp.ernet.in, tapnath@gmail.com

Qualifications (Academic & Professional Career):

1987 - 89	M.Sc: Indian Institute of Technology, Kharagpur Subject: Solid State Physics Class: First
1989 - 96	Ph. D: Indian Institute of Technology, Kanpur Subject/Field:Low Temperature Condensed Matter Physics. Title: Transport and magnetic studies in γ-$Fe_{80-x}Ni_xCr_{20}$ ($14 \leq x \leq 30$) stainless steel alloys and Cu/Ni-Zr-Al metallic glasses.

Experience:

2015 (February) – till date	Professor, Department of Physics, Indian Institute of Technology, Kharagpur. INDIA.
2010 (July) – 2015 (January)	Associate Professor, Department of Physics, Indian Institute of Technology, Kharagpur. INDIA.
2001 (August) – 2010 (June)	Assistant Professor, Department of Physics, Indian Institute of Technology, Kharagpur. INDIA.
2000 (July)-2001(Aug.)	Research Associate (Post Doctoral-II), North Carolina State University, NSF Center, Dept. of Material Sciences & Engineering, U.S.A. Project work: Advanced epitaxial thin film processing using pulsed laser MBE and characterization through

electrical, magnetic, X-ray, TEM, optical technique on magnetic nano particles, magnetic semiconductors, high-k dielectric gate oxides for C-MOS device applications.

1998 (Feb.)—2000 (Jun.) Research Associate (Post Doctoral-I), Duke University, Department of Mechanical Engineering & Material Sciences, U.S.A.
Project work: Nanoscale controlled growth, characterization and measurements of epitaxial magnetic thin films and multilayers of CMR magnetic oxides for spin valve and spin tunneling device applications (with IBM group); magnetotransport, magnetic domain structure and associated magnetic anisotropy studies in compressively and tensile strained colossal magnetoresistive oxide epitaxial films down to liquid helium temperature (4.2 K).

1997 (June) –1998 (Feb) Visiting Scientist, Tata Institute of Fundamental Research, (TIFR), Mumbai, INDIA.
Project work:, Electrical transport, magneto-transport, high field magnetization study in colossal magnetoresistive oxides (bulk and thin films), C-14 laves phase compounds etc. down to liquid helium temperature (4.2 K) with magnetic field up to 5 Tesla.

1989 - 1996 Ph.D. Scholar, Indian Institute of Technology, Kanpur, INDIA.
Thesis Title: Transport and magnetic studies in γ-$Fe_{80-x}Ni_xCr_{20}$ ($14 \leq x \leq 30$) stainless steel alloys and Cu/Ni-Zr-Al metallic glasses.

Education and Experience:

(a) Degrees Conferred

Degree	University	Field(s)	Year
B.Sc.	Calcutta University	Physics (Hons.) Mathematics, Chemistry, English	1987
M.Sc.	Indian Institute of Technology, Kharagpur	Solid State Physics	1989
Ph.D.	Indian Institute of Technology, Kanpur	Low Temperature Physics Exptl. (Magnetism, Electrical-, Magneto-transport, Hall effect and Thermoelectric properties)	1996

(b) Research Experience:

Institution	Topic of work done	Period
IIT Kharagpur Dept. of Physics and Meteorology	Synthesis, Electrical-, Magneto-transport (spin-polarized tunneling), Magnetism in nanocrystalline CMR, charge and orbital ordered strongly correlated systems (LCMO,LSMO, SCMO, SSMO, NSMO, PSMO) manganites (8-20 nm), Nanocrystalline and epitaxial thin films, Diluted Magnetic Semiconducting **Spintronic materials** (ZnO:Fe/Co/Mn/Ni/), Giant Magneto-Impedance studies at high frequency (1kHz-20MHz) in soft ferromagnetic amorphous and embedded nanocrystalline (~8 nm) metallic glass ribbons, Extra-ordianry Hall effect (EHE) in (i) highly textured Ni nanoparticles embedded in epitaxial TiN matrix grown on Si substrate, (ii) Strained epitaxial 1000 Å LCMO/STO CMR thin films, *Ferromagnetic-ferroelectric multiferroics, Nanostructured* PSMO, NSMO, Ni,Co,Mn-Zn *Ferrites, Magnetic heterojunctions on LSMO/SiO_2/Si, LSMO/STO/Ni-Zn* ferrites etc. using PLD techniques, ***Nano Ferrites*** for applications, Ferrites/MgO/n-Si for Spintronics	2001 (September) - Present
North Carolina State University (NCSU), Raleigh, USA as a Post Doctoral fellow	Advanced epitaxial thin film processing of magnetic (Fe, Ni, LCMO) nanoparticles embedded either in insulating Al_2O_3 or metallic TiN matrix, dilute magnetic semiconductor thin films using KrF-pulsed-excimer-laser deposition in UHV chamber and characterization through electrical, magnetic, XRD, HRTEM, XPS, etc.	2000 (June) – 2001(August)
Duke University, Durham, North Carolina, USA as a Post Doctoral Fellow	Nanoscale controlled growth, characterization (using 4-circle HRXRD, TEM, EDX) and measurements (using electrical-, magneto-transport, magnetic measurements employing Superconducting Magnet and SQUID magnetometer down to 4.2 K and upto a field of 9 Tesla) of Rf-Magnetron sputtered tensile and compressively strained epitaxial thin films and multilayers of CMR manganites (LCMO/STO, LCMO/LAO and LSMO/STO, LSMO/LAO, LSMO/NGO, LSMO/LSAT, all epitaxial	1998 (Jan) – 2000(June)

	LSMO/STO(50 Å, 40 Å, 30 Å)/LSMO trilayers epitaxially grown on NGO, LSAT, LAO and STO for spin polarized tunneling MR device applications; Studies on epitaxial film thickness dependent variation of magnetic domain structure, crystallographic domains and magnetic anisotropy in LSMO and LCMO epitaxial manganites thin films grown on LAO, STO, NGO, STO and BTO single crystal substrates	
T I F R . Mumbai in Low Temperature Physics Division as a Visiting Scientist	Synthesis and Electrical transport, magneto-transport, High field magnetization studies in Lathanides (Ho, Dy, Gd etc.) doped Colossal Magnetoresistive Manganites CMR (bulk and thin film) and C-14 Laves phase compounds down to 4.2 K using Superconducting magnet and SQUID magnetometer	1997-1998
IIT Kanpur in Low Temperature Magnetism group as Ph.D. Scholar	Transport and magnetic studies in γ-$Fe_{80-x}Ni_xCr_{20}$ ($14 \leq x \leq 30$) stainless steel alloys and Cu/Ni-Zr-Al metallic glasses	1989-1996

***List of Research Publications in Refereed International Journals*:**

1. Magnetization study of γ-$Fe_{80-x}Ni_xCr_{20}$ ($14 \leq x \leq 30$) alloys to 20 Tesla, **T. K. Nath**, N. Sudhakar, E. J. McNiff and A. K. Majumdar, *Physical Review B*, **55**, 12389 (1997). (*** Well cited)

2. Magnetoresistance and its correlation with magnetization in γ-$Fe_{80-x}Ni_xCr_{20}$ ($14 \leq x \leq 30$) alloys near the multicritical point, **T. K. Nath** and A. K. Majumdar, *Physical Review B*, **57**, 10655 (1998).

3. Effect of 3-dimensional strain states on magnetic anisotropy in $La_{0.8}Ca_{0.2}MnO_3$ epitaxial thin films, **T. K. Nath**, R.A. Rao, D. Lavric, C.B. Eom, L. Wu and F. Tsui, *Applied Physics Letters*, **74**, 1615 (1999). (*** Well cited)

4. 3-dimensional strain states and crystallographic domain structures of epitaxial colossal magnetoresistive $La_{0.8}Ca_{0.2}MnO_3$ thin films, R.A. Rao, D. Lavric, **T. K. Nath**, C.B. Eom, L. Wu and F. Tsui , *Applied Physics Letters* **73**, 3294 (1998). (*** Well cited)

5. The effect of Holmium doping on the Magnetic and Transport Properties of $La_{1-x}Ho_xSr_{0.3}MnO_3$ ($0 \leq x \leq 0.4$), P. Roychaudhuri, **T. K. Nath**, P. Sinha, C. Mitra, A.K. Nigam, S.K. Dhar and R. Pinto, *Journal of Physics : Condensed Matter,* **9**, 10919 (1997).

6. A phenomenological model for magnetoresistance in granular polycrystalline CMR materials : the role of spin polarised tunnelling at the grain boundaries, P. Roychaudhuri, **T. K. Nath**, A.K. Nigam and R. Pinto, *Journal of Applied Physics*, **84**, 2048 (1998). (*** Well cited)

7. Magnetic Domain structure and domain wall scattering in compressively stressed CMR thin films, Yan Wu, Y. Suzuki, U. Ruediger, Jun Yu, A.D. Kent, **T. K. Nath** and C.B. Eom, *Applied Physics Letters*, **75**, 2295 (1999). (*** Well cited)

8. Temperature dependence of magnetic anisotropy of $La_{0.8}Ca_{0.2}MnO_3$ epitaxial thin films, M.C. Smoak, P.A. Ryan, F. Tsui**, T. K. Nath**, R.A. Rao, D. Lavric and C.B. Eom , *Journal of Applied Physics*, **87**, 6764 (2000).

9. Strain-dependent magnetic phase diagram of epitaxial $La_{0.67}Sr_{0.33}MnO_3$ thin films, F. Tsui, M.C. Smoak, **T. K. Nath**, and C.B. Eom, *Applied Physics Letters*, **76**, 2421 (2000). (*** Well cited)

10. Domain structure and magnetotransport in colossal magnetoresistance thin films, Y. Suzuki, Yan Wu, J. Yu, U. Ruediger, A.D. Kent, **T. K. Nath** and C.B. Eom, *Journal of Applied Physics*, **87**, 6746 (2000). (*** Well cited)

11. Magnetic properties of self-assembled nanoscale $La_{0.7}Ca_{0.3}MnO_3$ particles in alumina matrix, P. Katiyar, D. Kumar, **T. K. Nath**, Alex V. Kvit, J. Narayan, S. Chattopadhay, W. Gilmore, S. Coleman, C. B. Lee, J. Sankar and R. K. Singh, *Applied Physics Letters*, **79**, 1327 (2001).

12. Tunable magnetic properties of metal ceramic composite thin films, D. Kumar, J. Narayan, **T. K. Nath**, A. K. Sharma, A. Kvit and C. Jin, *Solid State Communication*, **119**, 63 (2001).

13. Magnetic properties of self-assembled nanoscale $La_{0.7}Ca_{0.3}MnO_3$ particles in alumina matrix, P. Katiyar, D. Kumar, **T. K. Nath**, Alex V. Kvit, J. Narayan, S. Chattopadhay, W. Gilmore, S. Coleman, C. B. Lee, J. Sankar and R. K. Singh, *J. Nanoscale Science and Technology*, vol.**4**, issue 10, 21 (Sep. 3, 2001).

14. Magnetic properties of epitaxial and polycrystalline nickel particles of nanometer dimension, D. Kumar, H. Zhou, **T. K. Nath**, Alex V. Kvit and J. Narayan, *Applied Physics Letters*, **79**, 2817 (2001). (*** Well cited)

15. Magnetization and Magnetoresistance study on γ-FeNiCr alloys, **T. K. Nath**, N. Sudhakar, A. K. Majumdar and J. McNiff, *Annual Report of Francis Bitter National Magnet Laboratory*, M.I.T. USA, page 77 (1991-1992).

16. Resistivity saturation in substitutionally disordered of γ-$Fe_{80-x}Ni_xCr_{20}$ ($14 \leq x \leq 30$) alloys, **T. K. Nath** and A. K. Majumdar, *Physical Review B*, **53**, 12148 (1996).

17. Quantum interference effects in $(Ni_{0.5}Zr_{0.5})_{1-x}Al_x$ metallic glasses, **T. K. Nath** and A. K. Majumdar, *Physical Review B*, **55**, 5554 (1997).

18. Quantum corrections to Boltzmann conductivity in (Cu,Ni)-Zr-Al amorphous alloys, **T. K. Nath** and A. K. Majumdar, *International Journal of Modern Physics* B, **12**, 125 (1998).

19. Effects of film thickness and lattice mismatch on strain states and magnetic properties of $La_{0.8}Ca_{0.2}MnO_3$ thin films, R.A. Rao, D. Lavric, **T. K. Nath**, C.B. Eom, L. Wu and F. Tsui, *Journal of Applied Physics*, **85**, 4794 (1999).
Same paper has been presented in the *43rd Annual Conference on Magnetism and Magnetic Materials*, Miami, Florida, USA, November 9 - 12, 1998.

20. Metal-insulator transition in $NdNi_{1-x}Fe_xO_{3-\delta}$, A. Tiwari, K.P. Rajeev, **T. K. Nath** and A.K. Nigam, *Solid State Communications*, **110,** 109 (1999).

21. Strain modification of epitaxial perovskite oxide thin films using structural transitions of ferroelectric $BaTiO_3$ substrate, M.K. Lee**,** **T. K. Nath**, C.B.Eom, M.Smoak, and F. Tsui, *Applied Physics Letter,* **77**, 3547 (2000). (*** Well cited).

22. Magnetotransport in Manganite Trilayer Junctions Fabricated from 90^0 Off-axis Sputtered Manganite Films, Jin-Seo Noh, **T. K. Nath,** J.Z. Sun, and C.B. Eom, *Applied Physics Letters*, 79, 233 (2001). (*** Well cited)

23. Improved magnetic properties of self-assembled epitaxial nickel nanocrystallites in thin-film ceramic matrix, D. Kumar, H. Zhou, **T. K. Nath**, Alex V. Kvit, J. Narayan, V. Craciun and Rajiv K. Singh, *Journal of Material Research* (USA), **17**, 738-742 (2002).

24. Magnetoresistance in γ-$Fe_{80-x}Ni_xCr_{20}$ ($21 \leq x \leq 30$) alloys, **T. K. Nath** and A. K. Majumdar, *Journal of Applied Physics*, **70**, 5828 (1991).
Same paper has been presented at *5th joint Magnetism and Magnetic Materials – intermag Conference*, 18 - 21 June, 1991 held at Pittsburgh, Pennsylvania, USA.

25. Superconducting fluctuation study of the 110 K phase in polycrystalline $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$ high Tc superconductor, S. V. Sharma, G. Sinha, **T. K. Nath**, S. Chakraborty and A. K.Majumdar, *Physica C,* **242**, 351 (1995).

26. Micro-wave absorption and para coherence excess conductivity in high Tc superconductors, S. V. Sharma, **T. K. Nath** and A. K. Majumdar, *Physica C,* **290**, 229 (1997).
27. Effect of Er-Substitution on Superconducting and Metal-Insulator Transitions in 2212 Bismuth Cuprate, A. Sattar, J. P. Srivastava, S. V. Sharma and **T. K. Nath**, *Physica C* **266**, 335 (1996).

28. Synthesis, magnetic and structural studies of the 110 K phase of $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_3O_y$ high Tc superconductors, S. V. Sharma, G. Sinha, **T. K. Nath**, S. Chakraborty and A. K. Majumdar, *Physica C*, **235-240**, 489 (1994).

29. Effect of Er doping on resistivity of $Bi_2Sr_2Ca_{1-x}Er_xCu_2O_{8+\delta}$ ($0 \leq x \leq 1$) high Tc Superconductor, S. V. Sharma, **T. K. Nath**, A. K. Majumdar, A. Sattar and J. P. Srivastava, *Indian Journal of Cryogenics*, (1997) Volume Date 1995, 20(4), 11-15.

30. Strain modification of $La_{0.67}Sr_{0.33}MnO_3$ CMR thin films using structural transitions of ferroelectric (001) $BaTiO_3$ substrate, P. Dey and **T. K. Nath**, *Indian Journal of Physics*, **78**, 833-836 (2004).

31. Effect of nanosize modulation of granular $La_{0.67}Sr_{0.33}MnO_3$ manganites on temperature dependent low field spin polarized tunneling magnetoresistance" by P. Dey, **T. K. Nath**, Uday Kumar and P. K. Mukhopadhyay, *Journal of Applied Physics,* **98**, 014306 (2005).

32. Enhanced grain surface effect on the temperature dependent behaviour of spin polarized tunneling magnetoresistance of nanometric manganites by P. Dey and **T. K. Nath** , *Appl. Phys. Letters*, **87**, 162501 (2005).

33. Extraordinary Hall effect in self assembled epitaxial Ni-nanocrystallites embedded in TiN matrix by P. Khatua, **T. K. Nath** and A. K. Majumdar, *Physical Review B*, **73**, 064408 (2006).

34. Microsructural, Magnetic and Optical Properties of ZnO:Mn ($0.01 \leq x \leq 0.25$) Epitaxial Diluted Magnetic Semiconducting Films, S. K. Mandal and **T. K. Nath**, *Thin Solid Films*, **515**, 104315 (2006).

35. Extraordinary Hall effect in self assembled epitaxial Ni-nanocrystallites embedded in TiN matrix by P. Khatua, **T. K. Nath** and A. K. Majumdar, *J. Nanoscale Science and Technology*, vol.**13**, issue 7, 121 (Feb. 20, 2006).

36. Effect of grain size modulation on the magneto- and electronic-transport properties of $La_{0.7}Ca_{0.3}MnO_3$ nanoparticles: The role of spin-polarized tunneling at the enhanced grain surface by P. Dey and **T. K. Nath**, *Physical Review B*, **73**, 214425 (2006). (*** Well cited)

37. Temperature dependence of solubility limits of transition metals (Co, Mn, Fe and Ni) in ZnO nanoparticles by S. K. Mandal, A. K. Das, **T. K. Nath** and Debjani Karmakar, *Appl. Phys. Letters*, **89**, 144105 (2006). (*** Well cited)

38. Tunable room temperature low-field spin polarized tunneling magneto-resistance of $La_{0.7}Sr_{0.3}MnO_3$ nanoparticles by P. Dey and **T. K. Nath,** *Applied Physics Letters*, **89**, 163102 (2006). **(*** Well cited)**

39. Magnetic Cluster Glass phase in $Zn_{0.85}Fe_{0.15}O$ Diluted Magnetic Semiconducting Nanoparticles by S. K. Mandal, **T. K. Nath,** A. Das and R. K. Kramer, *Applied Physics Letters*, **89**, 162502 (2006).

40. Microstructural, Magnetic and Optical properties of $Zn_{1-x}TM_xO$ (TM = Co, Mn) diluted magnetic semiconducting nanoparticles by S. K. Mandal, **T. K. Nath,** Debjani Karmakar et al., *Journal of Applied Physics*, **100**, 104315 (2006).

41. Microstructural, magnetic and optical properties of $Zn_{1-x}(Mn_{x/2}Co_{x/2})O$ (x = 0.1 and 0.2) semiconducting nanoparticles, S. K. Mandal, **T. K. Nath**, Debjani Karmakar et al., *Journal of Applied Physics*, **101**, 063913 (2007).

42. Ferromagnetism in Fe-doped ZnO Nanocrystals: Experiment and Theorety Debjani Karmakar, S. K. Mandal, **T. K. Nath**, G. P. Das et al. *Physical Review B*, **75**, 144404 (2007). (*** Well cited)

43. Room Temperature Ferroelectric and Ferromagnetic properties of multiferroic $xLa_{0.7}Sr_{0.3}MnO_3 - (1-x)ErMnO_3$ (weight percent x = 0.1, 0.2) composites, P. Dey, **T. K. Nath**, T. K. Kundu and M. L. NandaGoswami, *Applied Physics Letters,* **90**, 162510 (2007).

44. Reduction of magnetization in $Zn_{0.9}Fe_{0.1}O$ diluted magnetic semiconducting nanoparticles by doping of Co or Mn ions, S. K. Mandal, **T. K. Nath** and A. Das *Journal of Applied Physics*, **101**, 123920 (2007).

45. Effect of substrate-induced strain on transport and magnetic properties of epitaxial $La_{0.66}Sr_{0.33}MnO_3$ thin films, P. Dey, **T. K. Nath** and A. Taraphder, *Applied Physics Letters,* **91**, 012511 (2007). **(*** Well cited)**

46. Enhanced grain surface effect on magnetic properties of $La_{0.5}Gd_{0.2}Sr_{0.3}MnO_3$ nanoparticles : A comparison with bulk counterpart, P. Dey, **T. K. Nath** and A. Banerjee, *Applied Physics Letters*, **91**, 012504 (2007**).**

47. Effect of disorder on magnetic ordering of $La_{0.5}Gd_{0.2}Sr_{0.3}MnO_3$ manganite, P. Dey, **T. K. Nath** and A. Banerjee*, Journal of Physics: Condensed Matter*, **19**, 376204 (2007).

48. Effect of nanometric grain size on room temperature magneto-impedance, magneto-resistance and magnetic properties of $La_{0.7}Sr_{0.3}MnO_3$ nanoparticles, P. Dutta, P. Dey and **T. K. Nath**, *Journal of Applied Physics*, **102**, 073906 (2007).

49. Magnetic and optical properties of Zn_{1-x} Fe_xO ($0.05 \leq x \leq 0.15$) diluted magnetic semiconducting nanoparticles, S. K. Mandal, **T. K. Nath** and D. Karmakar *Philosophical Magazine*, **88**, 265 (2008).

50. Magnetoimpedance, magnetoresistance, and magnetic properties of nanometric CMR manganites, **T. K. Nath**, P. Dutta, and P. Dey, *Journal of Applied Physics*, **103**, 07F725/1 – 07F725/3 (2008).

51. Quantum interference effects and magnetic scattering in the electrical resistivity of Ni nanocrystallites in TiN matrix, P. Khatua, **T. K. Nath,** Mitali Banerjee, and A. K. Majumdar, *Applied Physics Letters*, **92**, 193106 (2008).

52. Effect of nanometric grain size on electrical-transport, magneto-transport and magnetic properties of $La_{0.7}Ba_{0.3}MnO_3$ nanoparticles by S. K. Mandal, **T. K. Nath** and V. V. Rao, *Journal of Physics: Condensed Matter*, **20**, 385203 (2008).

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54. Enhanced grain surface effect on magnetic properties of nanometric $La_{0.7}Ca_{0.3}MnO_3$ manganite : Evidence of surface spin freezing of manganite nanoparticles by P. Dey, **T. K. Nath,** P. K. Manna and S. M. Yusuf, *Journal of Applied Physics*, 104, 103907/1-103907/12 (2008), (***American Institute of Physics Publishing).*** **(*** Well cited)**

55. Magnetic Circular Dichroism spectroscopy in epitaxial $La_{0.7}Sr_{0.3}MnO_3$ thin films, **T. K. Nath**, J. R. Neal and G. A. Gehring *Journal of Applied Physics*, **105**, 07D709/1-07D709/3 (2009).

56. Electrical properties of Pulsed Laser Deposited ZnO thin films, S. Chattopadhyay and **T. K. Nath**, *Advanced Material Research*, **67**, 121 (2009).

57. Microstructural, magnetic, magneto-transport and complex impedance spectroscopy of x $La_{0.7}Sr_{0.3}MnO_3$ – (1-x) $ErMnO_3$ multiferroic ($0 < x < 1$) composites, P. Dey, **T. K. Nath**, S. K. Mandal and A. Das, *International Journal of Modern Physics* B, **23**, 4889 (2009).

58. Nano dimensional effect on magnetic and electrical properties of $Pr_{0.8}Sr_{0.2}MnO_3$ ferromagnetic insulating manganite, S. Mondal, A. Taraphder and **T. K. Nath,** *Advanced Materials Research* (2009).

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61. X-ray Magnetic Circular Dichroism Investigations of The Origin of Room Temperature Ferromagnetism in Fe-Doped ZnO Nanoparticles *By* Takashi Kataoka, Masaki Kobayashiy, Gyong Sok Song, Yuta Sakamoto, Atsushi Fujimori, Fan-Hsiu Chang, Hong-Ji Lin, Di Jing Huang, Chien Te Chen, Sanjay Kumar Mandal, **Tapan Kumar Nath**, Debjani Karmakar, and Indra Dasgupta *Japanese Journal of Applied Physics* **, 48**, 04C200 1-3 (2009.).

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72. Enhancement of room temperature ferromagnetism of Fe-doped ZnO epitaxial thin films with Al co-doping, S. Chattopadhyay, **T. K. Nath,** A. J. Behan, J. R. Neal, D. Score, Q. Feng, A. M. Fox and G. A. Gehring, *Journal of Magnetism and Magnetic Materials,* **323**, 1033 (2011).

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110. Investigation of Magnetic and Electrical properties of multiferroic CZFO-PZT nanocomposites, P. R. Mandal and **T. K. Nath**, Proceedings of National Conference on Magnetic Materials and Applications, (MAGMA-2011) page 123 (2011).
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124. Investigation of magnetic and electrical properties of multiferroic $Ni_{0.35}Co_{0.30}Zn_{0.35}Fe_2O_4$ – $PbZr_{0.52}Ti_{0.48}O_3$ Nanocomposites, P. R. Mandal and **T. K. Nath,** Proceedings of XVII NFSD-2012, page 129 (2012), held on 17-19 December, (2012) ITER, Bhubaneswar.
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142. Magnetodielectric effect in double perovskite LaSrCoMnO6, P. R. Mandal, R. Sahoo and **T. K. Nath**, International Conference on Magnetic Materials and

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151. Temperature dependent current – voltage characteristics of $Co_{0.65}Zn_{0.35}Fe_2O_4$/n-Si magnetic diode like structure, A. Santosh kumar, J Panda and **T. K. Nath**, Proceedings and Abstract book on National Seminar on Recent Trend in Condensed Matter Physics, Institute of Technical Education & Research, Siksha o Anusandhan University, Bhubaneswar, 8 – 9 February, 2014, page 18 (2014).
152. Large Magneticaloric effect in SmCaMnO compound, invited talk in ICFM 2014, February 5 -7, 2014, Mat. Sc., IIT Kharagpur.
153. Enhanced magnetocaloric effect in Sm-based Phase separated Manganites, invited talk in ICMAGMA-2014, September 15-17, 2014, page-28 (2014).
154. Exchange Bias Effect in $Sm_{1-x}Ca_xMnO_3$ (x = 0.4, 0.5, 0.6) Phase separated Manganite Nanoparticles, S. K. Giri, S. K. Hazra, R. C. Sahoo and T. K. Nath, in ICMAGMA-2014, September 15-17, 2014, page-66 (2014).
155. Magneto-Dielectric Behaviour of Sm_2CoMnO_6, P.R. Mandal, R. Sahoo and T. K. Nath, ICMAGMA-2014, September 15-17, 2014, page-114 (2014).

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159. Fabrication of low cost and high precision Thermoelectric Power setup in the temperature range of 77 – 300 K, S. K. Hazra, S. K. Giri, T. K. Nath, DAE Solid State Physics Symposium, December 16-20, 2014 (VIT), page 154 (2014).
160. Magnetic, Dielectric , Magnetoelectric properties and impedance spectroscopy of multiferroic Bi1-xndxFe1-yCoyO3 (x=0,0.1, 0.15, 0.2, y= 0, 0.10) nanoceramics, K.P. Bera, P.R.Mandal and T. K. Nath, DAE Solid State Physics Symposium, December 16-20, 2014 (VIT), page 280 (2014).
161. Sr doping effect on microstructural, transport and magnetic properties in Pr1-xSrxMnO3 ($0.2 \leq x \leq 0.4$) nanomanganite, P. T. Das, S. K. Giri, A. Taraphder and T. K. Nath, DAE Solid State Physics Symposium, December 16-20, 2014 (VIT), page 292 (2014).
162. Size-induced exchange bias effect and griffiths phase in electron doped Sm0.09Ca0.91MnO3 manganites, S. K. Giri and T. K. Nath, IOP Conference Series: Materials Science and Engineering, **73**, 012148 (2015).
163. Electronic and magneto transport property of Pr0.7Sr0.3MnO3 system in nanometric gran size modulation, P. T. Das, J. Panda, A. Taraphder and T. K. Nath, IOP Conference Series: Materials Science and Engineering, **73**, 012142 (2015).
164. Electrical and magneto-electronic properties of p-La0.7Ca0.3MnO3/SrTiO3/n-Si heterostructure for spintronics application, J. Panda, S. K. Giri and T. K. Nath, IOP Conference Series: Materials Science and Engineering, **73**, 012134 (2015).
165. Structural and magnetization behavior of highly spin polarized Co2CrAl full Heusler alloy, S. N. Saha, J. Panda and T. K. Nath, AIP Conf. Proc., **1591**, 1395 (2014).

Awards/Fellowship:

1. **Royal Society Grant Award** for short term research visit in Univ. of Sheffield, Dept. of Physics, Sheffield, U.K.for 3.0 months (2008).

2. **MRSI MEDAL-2012**, Material Research Society of India (Recipient of MRSI MEDAL 2012), Bangalore.

3. **Editorial Board member** of Spintronics and Magnetic Nanoparticles, American Scientific Publisher (USA).

4. **Editorial Board member** of Dataset papers in Nanotechnology, Hindwai Publishers (USA).

5. Member American Nano Society, Material Research Society of India, Magnetic Research Society of india.

6. Postdoctoral Research Fellowship in Duke University, North Carolina, USA for 2 and ½ years (1998-2000)

7. Postdoctoral Research Fellowship in North Carolina State University (NCSU), North Carolina, USA for 1 and ½ years (2000 – 2001).

8. Postdoctoral Visiting Research Fellowship in Tata Institute of Fundamental Research (TIFR), Mumbai, INDIA for about 1 year (1997-1998).

9. Ph.D. Fellowship (IIT Kanpur, Dept. of Physics)

10. UGC-CSIR (NET) in INDIA fellowship (National Level fellowship) for Ph.D. Research Fellowship

11. GATE (Graduate Aptitude Test Examination, IIT) in INDIA for Ph.D. Research fellowship.

Teaching experiences:

Courses taught in the Dept. of Physics & Meteorology, IIT Kharagpur (2001 – 2014)

(1) Condensed Matter Physics-I (2) Magnetic and Superconducting Properties of Solids (3) Semiconductor Physics (4) Undergraduate Physics-1 lab course (5) Analog and digital electronics laboratory course (6) M.Tech. Solid State Technology (7) Condensed Matter-II Laboratory Course (8) Electrodynamics Laboratory Course (8) B.Tech. 1st year Physics, (9) Magnetism & Superconductivity (Theory Course for M.Sc 5th (Final) Yr. students). (10) Physics of semiconductor devices (11) Analytical techniques (12) Experimental Methods (13) Thermodynamics and General Properties of Matter laboratory course (14) Electromagnetism and Optics Lab.(15) Condensed Matter Physics – I laboratory course.

Courses taught in the Dept. of Physics, IIT Kanpur (1989-1996)

(1) M.Sc. Physics (4th and 5th yr.) Laboratory course at IIT Kanpur for 3 years

(2) B.Tech. Laboratory course at IIT Kanpur for 4 years.

Courses taught in the Duke University, USA (1998-2000)

(1) Tutor for X-ray diffraction in thin films and multilayers and (2) Magnetic Materials and magnetic measurement techniques at Duke University, North Carolina, USA for 2 and ½ years.

Courses taught in North Carolina State University, USA (2000 - 2001):

(1) Tutor for Physics of Materials and x-ray crystallography course

Research Guidance:

M.Sc. Project Thesis Guide: (M.Sc. students):	26 students completed and 02 in progress.
M.Tech Project Thesis Guide: (M.Tech. Students)	14 students completed and 02 in progress.
Ph.D. Thesis supervisor (Ph.D. Scholars):	9 Ph.D. research scholars completed, and degree awarded, at present 5+2* Ph.D. scholars in progress (* jointly).

Ph.D. Thesis Guidance:

(1) Dr. Sanjay Kumar Mandal : *Microstructural, Magnetic, Optical and Transport Studies of Nanostructured Diluted Magnetic Semiconducting $Zn_{1-x}TM_xO$ (TM=Co, Mn, Fe, Ni) and Manganite $La_{0.7}Ba_{0.3}MnO_3$ Spintronic Oxides* (2007).

(2) Dr. Puja Dey : *Investigation of Microstructural, Electronic- Transport, Magneto-Transport and Magnetic Properties of Nanostructured Spintronic Colossal Magnetoresistive Manganites* (2008).

(3) Dr. Sourav Chattopadhyay : *Thin Film Oxides and Heterostructures for Spintronics* (2011).

(4) Dr. Sourav Kundu: *Effect of Grain size on Magnetic, Electronic- and Magneto-Transport Properties of Nd-based Nanostructured manganites and Cobaltites* (2012).

(5) Dr. Trilochan Sahoo: *Microstructure Controlled Magnetoimpedance behavior of rapidly Solidified Fe- and Co-based Metallic Glass Ribbons* (2013).

(6) Mr. Samir Kumar Giri : *On the Magnetic and Electronic-Transport Properties of Sm and La based Perovskite Manganites: Fundamental Investigation and Possible Applications* (2014).

(7) Ms. Pampa Rani Mandal: Establishing Correlation in Structural, Magnetic and Magnetodielectric Properties of Doped Multiferroic Transition Metal Oxide (2015)

(8) Mr. Praloy Taran Das: Cooperative Phenomena and Nanosize Effects in Doped Manganites (2016)

(9) Mr. Jaganandha Panda: Electrical Spin Injection into Si From Magnetic Metals and Metal Oxides using SiO_2 and MgO Tunnel Barrier for Spintronics (2016)

On Going/Completed Sponsored Projects:

Dept. of Science and Technology (DST): Investigation of electrical transport, Magnetotransport, Hall effect, specific heat and magnetic studies in nanostructured CMR Manganites. (**PI)** **Amount**: 128 lakhs (2008 – 2012)

DRDO: Development of artificially structured nanomagnetic materials for high frequency sensor applications**.** **(Co-PI**) **Amount** : 35 lakhs (2005-2009**)**

BRNS (DAE/BRNS): Cooperative phenomena and nanosize effect in some strongly correlated systems. **(Co-PI)** **Amount:** 18 lakhs (2007 – 2011)

DST/FIST: Augmentation of the experimental infrastructure in condensed matter physics (**Co-PI**) **Amount**: 65 lakhs (2003-2008)

ISIRD: Fabrication of cost-effective AC-magnetic susceptibility set up for use with a liquid N_2 cryostat assembly down to 70 K. (PI) **Amount**: 3 lakhs (2003-2007)

SGIRG, IIT Kharagpur：Upgradation of Basic Low Temperature and High Magnetic Field Facility for Spin-Electronics Research, **(PI)** **Amount:** 25 lakhs (2014-2017)

SGIGC, IIT Kharagpur : Studies on Ultrafast Processes for Electronic, Spintronic, Magnonics and Photonics, **(Co-PI)** **Amount:** 250 lakhs (2014-2017)

International Research Collaborations:

- **University of Sheffield, U.K**. : Investigation on Optical and Magnetic properties of PLD grown epitaxial ZnFeO Thin films, Dilute Magnetic Semiconducting ZnO thin films for Spintronics, Characterization using MCD, Spectroscopy, SQUID facility
- **University of Tokyo, Japan**: Investigation of electronic and magnetic structure, valence states, surface and bulk magnetism etc. of 3d-transition metal doped ZnO dilute magnetic semiconductor nanoparticles through XMCD, XAS
- **Japan, Photon Factory, Japan**: Magnetism in 3d-transition metal doped ZnO dilute magnetic semiconductor nanoparticles using XMCD technique
- **National Synchrotron Radiation Research Center, Taiwan**: Using Synchroton radiation source in National Synchrotron Radiation source facility of the Research Center,Hsinchu 30076, Taiwan, probing the magnetic structure in 3d transition metal doped ZnO epitaxial thin films.
- **Rice University**, Physics and Astronomy Department, 6100 Main St, MS-61, Houston, TX, 77005, USA *(For High Tc SUPERCONDUCTIVITY)*
- **Wuhan National High Magnetic Field Center,** School of Physics, Huazhong

University of Science and Technology, Wuhan, 430074, China *(High Tc SUPERCONDUCTIVITY)*
- **Beijing Normal University, Beijing, 100875, China** *(For High Tc SUPER CONDUCTIVITY)*

National Research collaboration:

-**Bhabha Atomic Research Centre, Mumbai**: Neutron diffraction studies on charge ordered, antiferromagnetic and ferromagnetic manganite nanoparticles and bulk.
-**Tata Institute of Fundamental Research, Mumbai**: Magnetization relaxation behavior, specific heat studies of phase separated manganites, Magnetocaloric materials etc.
-**Saha Institute of Nuclear Physics, Kolkata**: Exchange bias studies on charge ordered phase separated manganites nanoparticles, magnetocaloric studies, Kinetic arrest behavior.
-**UGC-DAE research consortium, Indore**: High field magnetization behavior of perovskite manganites, phase separated manganites etc.
-**IACS, Kolkata:** Dilute magnetic semiconductor theoretical simulation work
-**IIT Roorkee**: Simulation work using VASP package to calculate the reconstruction of surface state, DOS etc. of nanostructured charge ordered manganites.

Participation in Departmental, Institute and Students' activities :

Asst. Warden (Maintenance & Mess) **Nehru Hall & MMM Hall**	**2003-2006, 2007-2010**
Warden of **Homi Jahangir Bhabha (HJB) Hall**	**2013-2015**
Prof.-in-Charge of Hall effect Lab.- CRF center, IIT KGP	**2005-till date**
M.Sc. 4th year undergraduate Laboratory-in-Charge, Dept. of Physics	**2002-2008**
M.Sc. 2nd year undergraduate Laboratory-in-Charge, Dept. of Physics	**2011-till date**
Preparotory laboratory Professor-in-Charge, Dept. of Physics	**2014-till date**
Departmental TIME TABLE IN-CHARGE	**(2008 - 2011)**
Departmental Administrative Committee (DAC) member	(**2008- 2017)**
Faculty Advisor, M.Sc. physics integrated students	(1 June, 2011 – 30 June, 2016)
Faculty Advisor, M.Sc. 2 year physics students (lateral)	(1 June, 2014 – 30 June, 2016)
Convener of Departmental Experimental facility committee	(2014-2017)
Member, Departmental purchase Committee	**(2011-2017)**
Departmental UGPEC Member,	**(2011-2013)**
DST-FIST laboratory-co-in-Charge (involved through out for lab. development)	(**2003-2008)**
Committee member to frame new UG M.Sc. Physics Curriculum in Dept. of Physics	**(2006 – 2007)**
Prof.-in-Charge, Magnetism and Magnetic Materials Laboratory in Dept. of Physics	**(2001-present)**
(DST sponsored Low temperature and high magnetic field facility developed as a PI of the project)	
Technology Film Society, IIT KGP (Treasurer, Prof.-in-Charge)	**2002-2005**
P.G. (Research Scholar) Coordinator	**2014 (Jan – Feb)**
Participated in IIT JEE, GATE and JAM examinations to conduct and for Evaluations (Evaluation of answer scripts, Conduct exams. in various centers)	**2002-2016**
External Practical Examiner : Vidyasagar University, M.Sc. Physics Part-**I**	**2002, 2003, 2004, 2005, 2011 – 2014 (Solid State Physics, advance paper)**
External Practical Examiner : Vidyasagar University, M.Sc. Physics Part-II	**2002 - 2007 2011-2014 (Solid State Physics, special paper)**
Delivered Some Guest Lecturers in Vidyasagar University M.Sc. Part-I & II	

Seminar/Conference organized: International Conference on Advanced Materials and Modelling-2005 (Programme Coordinator and local organizer), ICTAP- 2011, ISJPS – 2013, PLD-2013

Presented Paper (Oral presentation) in 7th international Conference on Nanostructured Materials, Wiesbaden, Germany (June 20-24, 2004), 52nd MMM Conference in Tampa, Florida, USA 2007, ICMAT- 2011 Singapore, IUMRS-ICA 2012, Busan, South Korea

Short term course: Nanoscience and Nanotechnology (guest lecturer at Dept. of Physics, IIT Kharagpur)

Presented paper/invited talks in different National and International conferences (Germany, Nano-2004, ICRTNT-2006, ISAMAP-2004, Nanoscience and Technology, MNTA-2009, MMM 2007 (USA), PLD-2009 (IIT Chennai), DAE-SSPS 2003, 2006, 2007 , 2012), PLD-2011 (IISC Bangalore),ICMAT-2011 (NUS Singapore), PLD-2013 (IIT KGP), IUMRS-2012 (South Korea), ICANN- 2011, ICN- 2012, Nagpur University, NIT Hamirpur, V.U. etc.

Active team member in the Nano-initiative programme in IIT KGP funded by DST.

CRF purchase committee member (FIB, FESEM, e-beam lithography, AFM, SQUID, PLD etc.).

Faculty member associated with School of Nanoscince and Nanotechnology (New School proposed)

(Developed an elective course for Nanoscience & Technology "Magnetic & Electrical Properties of Nanostructured materials")

Life Time member of (1) Magnetic Society of India (2) Material Research Society of India, (3) American Nano Society

Refereeing in international/national Journals: Scientific Reports (Nature Publishing group, U.K.), Journal of Applied Physics (American Institute of Physics publication, USA), Solid State Communications (Elsevier publishing, Netherland), Journal of Alloys and Compounds (Elsevier, Netherlands), J. Magnetism and Magnetic materials, Advances in Condensed matter Physics, Nanoscience and Nanotechnology Letters, Applied Nanoscience, Material Science and Engineering B (Elsevier, Netherlands), Applied Physics Letters, Physical Review B, Applied Surface Science (Elsevier, Netherlands), New journal of Physics, IEEE Transaction on Magnetics (USA), Advances in Applied Research, International journal of Nanoscience, Indian Journal of Physics, Journal of Physics D: Applied Physics (Institute of Physics (IOP), U.K.), Scripta Materiala, Advance material Research, Journal of Physics: Condensed Matter (IOP, U.K.), DAE Solid State Physics Symposium Proceedings, BARC-DAE, India; Regular Reviewer /Referee for DST (SERC) Project Proposals, DST, India, ISIRD project reviewer,

Ph.D. Thesis Examiner:

1. Ph.D. Thesis Examiner, Jadavpur University (2011)
2. Ph.D. Thesis Examiner, Jadavpur University (2012)
3. Ph.D. Thesis Examiner, NIT Durgapur (2012)
4. Ph.D. Thesis Examiner, IIT Guwahati (2012)
5. Ph.D. Thesis Examiner, IIT Guwahati (2013)
6. Ph.D. Thesis Examiner, NIT Hamirpur (2013)
7. Ph.D. Thesis Examiner, Nagpur University (2012)
8. Ph.D. Thesis Examiner, Goa University (2013)
9. Ph.D. Thesis Examiner, IIT Kanpur (2014)
10. Ph.D. Thesis Examiner, IIT Kanpur (2015)

11. Ph.D. Thesis Examiner, NIT Raipur (2016)
12. Ph.D. Thesis Examiner, Devi Ahalya University, Indore (2016)
13. Ph.D. Thesis Examiner, Calcutta University (2016)
14. Ph.D. Thesis Examiner, Jadavpur University (2016)
15. Ph.D. Thesis Examiner, Goa University (2016)

Major Achievements in Research (2002-2013):

Experimental facility developed from the DST sponsored Project (PI)

- To measure Electronic-transport, Magneto-transport, Hall Voltage, I-V, C-V etc. in the temperature range of 1.6 – 300 K in absence or presence of magnetic field in the range of 0 - ± 8 T using the 8T CFM VTI cryostat using superconducting magnet system (Established high magnetic field low temperature measurement facility)
- To measure Linear and Non-linear complex Ac magnetic susceptibility ($\chi = \chi' + i\chi''$) down to 1.6 K in presence or absence of dc-field superimposition in the frequency range of 2 Hz to 10 kHz using the 8T CFM VTI cryostat.
- To measure I-V, C-V, magneto-impedance, magneto-capacitance etc. measurements down to 1.6 K up to 5 MHz frequency in presence of magnetic field in the range of 0 - ± 8 T using the 8T CFM VTI cryostat in superconducting magnet system.
- To measure Thermoelectric power in the temperature range of 5 – 300 K in presence of magnetic field in the range of 0 - ± 8 T using the 8T CFM VTI cryostat in superconducting magnet system.
- Measurement of all chemically synthesized nanosized magnetic oxides, spintronic oxides, epitaxial magnetic films and multilayers using the newly installed 8 T CFMVTI superconducting magnet system interfaced with GPIB-USB PC (automation) with all measuring equipments using LABVIEW (version 8.5) software.

Brief Outline of Research Contribution

We have been carrying out research work mainly in the area of strongly correlated systems, epitaxial magnetic thin films and multilayers for spintronics applications, nanostructured magnetic oxides (manganites, ferrites, cobaltites etc.) for fundamental study (transport, magnetism, Hall effect, Thermoelectric power etc.) and various applications, Dilute magnetic semiconductors for spintronics, Soft Ferromagnetic Metallic Glasses for GMI sensor applications, Magnetic Huesler alloys (highly spin polarized), Ferromagnet/semiconductor heterojunction for efficient spin injection, detection etc. for magneto-electronics, Magnetocaloric effect, Exchange-bias effect, Griffiths Phase singularity, Spin glasses for memory and aging effect, Magnetization relaxation dynamics, Pnictide and high Tc Superconductivity, Multiferroics etc. The major research contributions are the following:

Magnetic Thin Film & Multilayers:

1. Enhanced effect of substrate induced lattice strain (substrate engineering) in epitaxial manganites films and multilayers on magnetic domain structure, magnetic anisotropy,

magnetic transition (T_c), metal-insulator transition (T_p), surface morphology, charge and orbital ordering, magnetic and electronic transport properties etc.

2. Tunnel assisted Frenkel-Poole emission and spin injection properties in p - $La_{0.7}Ca_{0.3}MnO_3/SiO_2/n$ - Si MOS, $La_{0.7}Sr_{0.3}MnO_3/SiO_2/n$ - Si MOS, $TiN(Ni)/SiO_2/p$-Si MIS like heterostructure.
3. Enhancement of room temperature carrier induced ferromagnetism of Fe-doped ZnO epitaxial thin films with Al co-doping.
4. Quantum interference effects and magnetic scattering in the electrical resistivity of Ni nanocrystallites in TiN matrix/n-Si structure film.
5. Enhanced Spin polarized Magnetotransport in Manganite Trilayer Junctions Fabricated from 90^0 Off-axis Sputtered Manganite Films.

Nanostructured Mangnetic oxides:

1. Observation of Exchange Bias effect and surface spin glass ordering in ~17 nm sized antiferromagnetic $Sm_{0.5}Ca_{0.5}MnO_3$, $Sm_{0.09}Ca_{0.91}MnO_3$, $Sm_{0.35}Pr_{0.15}Sr_{0.5}MnO_3$ manganites nanoparticles.
2. Observation of Grifiths phase singularity in $Nd_{0.8}Sr_{0.2}MnO_3$, $Sm_{0.09}Ca_{0.91}MnO_3$, $Sm_{0.5}Ca_{0.5}MnO_3$, $La_{0.32}Eu_{0.68}MnO_3$, $R_{0.5}Eu_{0.5}MnO_3$ (R = Pr, Nd, Sm) manganites nanoparticles.
3. Large magnetocaloric effect observed in $Sm_{0.55}Sr_{0.45}MnO_3$ $Sm_{0.09}Ca_{0.91}MnO_3$, $Sm_{0.35}Pr_{0.15}Sr_{0.5}MnO_3$ phase separated manganite nanoparticles (1^{st} order trans.).
4. Observation of suppression of charge and antiferromagnetic ordering and appearance of ferromagnetism in 17 nm $La_{0.5}Ca_{0.5}MnO_3$, $Nd_{0.5}Sr_{0.5}MnO_3$, $Sm_{0.5}Ca_{0.5}MnO_3$, $Nd_{0.4}Sr_{0.6}MnO_3$ nanoparticles.
5. Evidence of electronic phase arrest (kinetic arrest) and glassy ferromagnetic behavior in $(Nd_{0.4}Gd_{0.3})Sr_{0.3}MnO_3$, $Sm_{0.35}Pr_{0.15}Sr_{0.5}MnO_3$ etc. manganite nanoparticles
6. Size-induced ferromagnetism, critical behavior, magnetic relaxation dynamics, aging, memory effect and enhanced magnetoresistance in naoparticles of antiferromagnetic $Nd_{0.4}Sr_{0.6}MnO_3$.
7. Enhanced grain surface effect on magnetic, electronic transport, spin polarized tunneling magnetoresistance properties of nanometric $La_{0.7}Ca_{0.3}MnO_3$, $La_{0.5}Gd_{0.2}Sr_{0.3}MnO_3$, $La_{0.67}Sr_{0.33}MnO_3$ etc. manganite nanoparticles of 14 nm diameter.
8. Multiferroic behaviour observed in $BiFeO_3$ Nanoparticles of 35 nm diameter.

Experimental work:

A: Research on *Magnetic Nanoparticles* of CMR manganites (10-22 nm)

- **Synthesis of nanostructured magnetic fine particles (10-22 nm) using novel "Chemical Pyrophoric Reaction process".**
- **Characterization through XRD, SEM, EDAX, HRTEM etc.**
- **Electrical transport [ρ(T)],** Spin-polarized tunneling Magneto-resistance **[Δρ/ρ(H,T)], Magneto-Impedance [ΔZ/Z (ω,H), Z = Z'+iZ"] studies on CMR manganite nanoparticles.**
- Complex linear and Non-linear Ac-susceptibility **[χ(ω,T,h) = χ' +iχ"] down to 77 K, DC magnetization M(T,H), ZFC & FC down to 77 K.**

B. Research on ***dilute magnetic semiconducting*** epitaxial thin films & nanoparticles (7-20 nm) for ***SPINTRONICS*** applications.

- **Synthesis of** dilute magnetic semiconducting (DMS) nanoparticles (10-22 nm) **using novel** "chemical pyrophoric reaction process" and epitaxial thin films through PLD technique.
- **Characterization through XRD, SEM, EDAX, HRTEM, XPS, UV-Visible optical spectroscopy for** semiconducting band gap (E_g) determination, etc.
- **Electrical transport**, Complex Impedance [$Z(\omega) = Z'+iZ''$] spectroscopy, EPR studies.
- **Magnetization M(H,T), ZFC & FC, Magnetic hysteresis** down to 4.2 K (ground state).

C. Research on epitaxial ***Magnetic thin films and multilayers:***

- **Chararacterization of** epitaxial magnetic thin films **through HRXRD, HRTEM (cross-sectional, bright field and dark field imaging), STEM-Z imaging, AFM, STM etc.**
- **Electrical –transport [ρ(T)], Magneto-transport [Δρ/ρ(H,T)],** *Magnetic anisotropy*, Magnetization [M(H,T)] FC & ZFC, Magnetic Hysteresis loops (T) **studies in epitaxial magnetic thin films.**
- Tunneling magnetoresistance (TMR) studies on epitaxial thin films *Trilayer magnetic tunnel junctions of* ***LSMO/STO/LSMO*** **grown on LSAT, NGO, LAO and STO single crystalline substrates.**
- Extra-ordinary Hall resistivity (EHE**) in epitaxial Ni nano dots embedded in epitaxial TiN matrix grown on single crystalline Si substrate using** Pulsed Laser Deposition technique.
- EHE studies in RF-Magnetron sputtered epitaxial CMR manganite films **down to 4.2 K and magnetic field up to 7 Tesla.**

D. Research on ***Soft Ferromagnetic Metallic Glasses for GMI sensor applications:***

- Characterization through XRD, DTA, DSC, SEM, EDAX etc.
- **Giant Magneto-Impedance** (GMI) [$\Delta Z/Z\ (\omega,H)$, $Z = Z'+iZ''$] studies on as-quenched and nanocrystalline **FINEMET, HITPERM, and NANOPERM metallic glasses** in low magnetic field regime. ***98% GMI was obtained in FINEMAT at only a magnetic field of 50 Oe at a excitation frequency of 1 MHz .***
- Electrical transport [ρ(T)], Magnetotransport studies on FM metallic glasses (**Weak-localization and Quantum interference effect** observed in these strongly disordered metallic glasses) in the low temperatures regime down to 4.2 K.

Fabrication/Development of experimental setup in the Dept. of Physics & Meteorology, IIT Kharagpur

A. Research Laboratory:

- Setting up a new **Magnetism and Magnetic Materials Laboratory**, Dept. of. Physics, IIT Kharagpur.
- Electrical transport **ρ(T) measurement set up** down to 77 K (liquid Nitrogen).
- **Ac-Susceptibility ($\chi=\chi'+i\chi'$, both linear and non-linear)** measurement set up down to 77 K, **automated using LAB-VIEW software with PC**.
- Magnetic permeability measurement set up in the temperature range 77 – 400 K.
- **Home made Vibrating Sample Magnetometer** (**VSM**) assembled with local vibrating assembly, home made pick up coils, electromagnet (1 Tesla), Lock-in-amplifier (Signal Recovery), Power amplifier (Sonodyne), Temperature controller (Lakeshore) etc. (DST/FIST

funded (2003-2008)); Home made Variable temperature **VSM dc-magnetic measurement** set up down to 77 K **automated using LAB-VIEW software with PC.**

- **Magneto-impedance set up** in the low field (up to 1500 Oe) regime in the frequency range (40 Hz – 15 MHz).
- **Magneto-transport and Hall measurement** facilities down to 77 K (liquid Nitrogen temperature) **automated using LAB-VIEW software with PC.**
- **Establishment of high field (8 Tesla Magnetic Field with** Cryogen Free **Superconducting Magnet)** and low temperature **(down to 1.2 K,** with Closed cycle **Helium closed cycle refrigerator/compressor**) facility in Magnetism & Magnetic materials Laboratory, Dept. of Physics, IIT Kharagpur, DST funded **(PI, Rs. 128 lakhs)** to measure Electronic-transport, Magneto-transport, Hall Voltage, thermoelectric-power, I-V, C-V magneto-impedance, magneto-capacitance etc. in the temperature range of 1.6 - 300 K in absence or presence of magnetic field in the range of 0 - ± 8 T using the 8TCFMVTI cryostat using superconducting magnet system (Developed high magnetic field low temperature measurement facility), to measure **Linear and Non-linear complex Ac magnetic susceptibility ($\chi = \chi' + i\chi''$)** down to 1.6 K in presence or absence of dc-field superimposition in the frequency range of 2 Hz to 10 kHz using the 8T CFM VTI cryostat. Measurement of all nanostructured magnetic oxides, spintronic materials, epitaxial magnetic films and multilayers using the newly installed 8TCFMVTI superconducting magnet system interfaced with GPIB-USB PC-automation with all measuring equipments using LABVIEW (version-8.5) software.
  (PI of DST sponsored project, Amount Rs.: 128 lakhs (2008-2011)).
- **Fabrication of Multi-target RF/DC sputtering** unit assembled with DC and RF sputtering source, sputter guns, **turbo molecular and rotary vane pumps,** digital gauges and read outs, with controlled argon gas flow to grow ***in-situ metallic magnetic thin films and multilayers,*** metallization **on epitaxial dilute magnetic semiconducting thin films for SPINTRONICS applications.**
- **Fabrication of Pulsed Laser Thin film Deposition facility using Femto-second Laser Pulse in the department (ongoing, 2014)**

B. M.Sc. 4th year and 2nd year Undergraduate Teaching Laboratory:

- Experimental set up for determination of Magnetostriction coefficient ($\lambda = \Delta l/l$) of iron (Fe) rod using Michelson interferometer technique employing monochromatic Laser [He-Ne (628 nm)] source and a digital counter.
- Magnetic Hysteresis loop tracing (B-H loop) set up for various ferromagnetic materials, viz., hard steel, commercial Ni, Fe-Ni alloy etc.
- A set up to study plane-polarized, elliptically polarized and circularly polarized light using a He-Ne laser (628 nm unpolarized), polariser, analyzer, quarter wave plate and optical bench.
- Experimental set up to study Hall effect in p and n type semiconductors (Germanium crystal) with PC interfacing.
- Experimental set up to study Dielectric Constant, Ferroelectric Phase transition (Curie) temperature (Tc), Dielectric Loss (tan δ), Complex Impedance spectroscopy studies [$Z(\omega, T) = Z'(\omega,T) + i\, Z''(\omega,T)$], etc.
- Experimental set up to study Photoconductivity (σ_{ph}) in semiconducting films.
- Experimental set up to study Solar Cell (Photo-Voltaic effect) characteristics (efficiency).
- Experimental set up for Michelson interferometer with laser light.
- Experimental set up for Fabry-Perot interferometer with laser light.
- Write up of new laboratory experiments manuals, organize, edit etc. all the old write ups to give a proper shape for complete laboratory experiments manuals.
- Systematize stock entry, maintenance, new purchase etc. for the 4th year undergraduate laboratory.
- Verification of Maxwell's law in electrodynamics (magnetic flux in a AC-coil circuit)
- Semiconductor Thermoelectric power set up

- Experiments on Magnetic induction and magnetic flux
- Experiments on Luminosity
- Experiments on coulomb potential and Coulomb field
- Experiments on magnetic field outside a conductor