Pratip Kumar Mukhopadhyay

Professor
CMPMS
pkm@bose.res.in

Professor Pratip Kumar Mukhopadhyay is an experimental condensed matter physicist who works on magnetic properties of matter in solid and fluid forms. The present focus is on smart materials. These are at the cutting edge of technology. His lab was the first one in Eastern India to start working on FSMA materials and magnetorheological fluids. He is also working a little bit of ferroelectric properties.

Supervision of Research / Students

Ph.D. Students

1. Injamamul Arief – Ph. D. – Completed and defended, January 2017
2. Tanmoy Ghosh – Ph. D. – Completed & Submitted, March 2017
3. Sarowar Hossain – Ph. D. – Ongoing
4. Abhishek Bagchi – Ph. D. – Ongoing
5. Chayan Mitra (External)- Ph. D. – Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Animesh Basak - Extra mural project student - completed
2. Kartik Panda, Ramakrishna Mission Vivekananda University, Belur Math, Howrah - Summer semester
3. Chirantan Deb, Tushar Ajitsaria & Jinesh Surana; VNIT, Nagpur - Fall semester

Post Doctoral Research Scientists

1. Alo Dutta (Young Scientist)
2. T. Paramanik (resigned on 31/12/16)
3. S. Vinoth (Selected in February 2017, joined in April 2017)

Teaching activities at the Centre

1. Fall 2016; Research Methodology; 50; Sanjoy Choudhury

Publications in Journals

1. Tanmoy Ghosh, Takashi Fukuda, Tomoyuki Kakeshita, S. N. Kaul, and **P. K. Mukhopadhyay;** *Concomitant antiferromagnetic transition and disorder-induced weak localization in an interacting electron system;* Phys. Rev. B; 2017; **95;** 140401 (R).
2. Injamamul Arief, **P.K. Mukhopadhyay;** *Yielding behavior and temperature-induced on-field oscillatory rheological studies in a novel MR suspension containing polymer-capped Fe_3Ni alloy microspheres;* J. Magn. Magn. Mater; 2017; **429;** 236.
3. Alo Dutta, Sanjay Mandal, Premlata Kumari, **P. K. Mukhopadhyay,** S. K. Biswas and T. P. Sinha; *Crystal Structure and Dielectric Properties of Microwave Ceramics $CaLa(CaM)O_6$ [M = Nb, Sb];* Journal of Electronic Materials; 2017; **46;** 1889.
4. Injamamul Arief and **P.K. Mukhopadhyay;** *Magnetorheological Payne effect in bidisperse MR fluids containing Fe nanorods and Fe_3O_4 nanospheres: A dynamic rheological study;* J. Alloy. Compd; 2017; **696;** 1053.
5. B. Rajini Kanth, **P.K. Mukhopadhyay;** *Magnetic field and stress Induced strain in CoNiAl Ferromagnetic Shapememory Alloy;* Materials Today: Proceedings; 2016; **3;** 3960.
6. Tanmoy Ghosh, Sandeep Agarwal and **P. K. Mukhopadhyay;** *Structural and magnetic properties of $Mn_{50}Fe_{50-x}Sn_x$ (x=10, 15 and 20) alloys;* J. Magn. Magn. Mater; 2016; **418;** 260.
7. Alo Dutta, **P.K. Mukhopadhyay,** T.P. Sinha, Dipankar Das, Santiranjan Shannigrahi; *Structural and magnetic properties of double perovskite oxide Ba_2CeSbO_6;* Solid State Sciences; 2016; **58;** 64.
8. Alo Dutta, **P.K. Mukhopadhyay,** T.P. Sinha, Santiranjan Shannigrahi, A.K. Himanshu, Pintu Sen and S.K. Bandyopadhyay; *Sr_2SmNbO_6 perovskite: Synthesis, characterization and density functional theory calculations;* Mater. Chem. Phys.; 2016; **179;** 55.

Other Publications

1. A. Bagchi, B. R. Kanth and **P. K. Mukhopadhyay**, Investigations on Photo Induced Microactuation of FSMA, Proceedings of ICFSMA '16, Tohoku University, Japan, 2016

2. S. Hossain, B. R. Kanth and **P. K. Mukhopadhyay**, Effect of Annealing on Elastic Moduli for a FSMA, Proceedings of ICFSMA '16, Tohoku University, Japan, 2016
3. Md Sarowar Hossain, Tanmoy Ghosh, B. Rajini Kanth and **P.K. Mukhopadhyay**, Effect of annealing on the structural transformations and magnetic properties of CoNiAl FSMA, ICMAGMA '17 Proceedings, Hyderabad, 2017
4. Kartik Panda, Md. Sarowar Hossain, and **P. K. Mukhopadhyay**, "Structural anomaly and shape memory effect in a CoNiAl FSMA system due to heat treatment.", ICMAGMA '17 Proceedings, Hyderabad, 2017

Lectures Delivered

1. Effect of Composition on Elastic Moduli for a CoNiAl System - B. R. Kanth, S. Hossain and P. K. Mukhopadhyay, ICFSMA'16, Tohoku University, Japan, September 2016.
2. Magnetic field induced Elastic behaviour of FINEMET Melt spun ribbon – (invited) S. Hossain, A. K. Hakim & P. K. Mukhopadhyay, ICMAGMA 2017, Hyderabad, Feb 1- 3, 2017.

Membership of Committees

External Committee

Member, APS; Life Member, Indian Science Congress; Member of governing body of Magnetic Society of India; International advisory board member of ICFSMA international conference series.

Internal Committee

Convenor, Project and Patent Cell; Convenor, Technical Committee; Chairman, Internal Standing Committee; Ex officio Chairman, Departmental Purchase Committee; member of various thesis committees; Ex officio member, SCRE; Ex officio member, CAC; Ex officio member, AC and BoS for CU-Ph.D. course; Ex officio member, APMP; Convenor and chairman, NPEP/EVLP; Incharge, Mechanical Workshop; Chairman, Liquid Helium Plant Committee; Member, Technical Research Project.

Awards / Recognitions

1. Chairman for a session of FSMA materials, in ICFSMA'16, Tohoku University, Sendai
2. Referee for various international peer reviewed journals

Fellow / Member of Professional Body

1. Member of APS, Indian Science; GB member of Indian Physical Association, Magnetic Society of India.

Sponsored Projects

1. "Feasibility study of development of synthetic body armour based on smart fluids" – DRDO – Concluded on September 2016
2. TRC project – DST – 2016

Conference / Symposia / Workshops / Seminars etc. organized

1. National Symposium on Ultrasonics, NSU-16; 08; 10/11/2016; SNBNCBS; Convener.
2. International Conference on Ferro magnetic Shape Memory Alloys (ICFSMA'16); 05; 09/09/2016; Sendai, Japan; Organizing Committee member.

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. S .N. Kaul (Sl. No. 1)
2. T.P. Sinha (Sl. No. 3, 7, 8)
3. Santiranjan Shannigrahi (Sl. No. 7, 8)
4. A.K. Himanshu, Pintu Sen, S.K. Bandyopadhyay (Sl. No. 8)
5. Dipankar Das (Sl. No. 7)
6. Sanjay Mandal, Premlata Kumari, S. K. Biswas (Sl. No. 3)
7. B. Rajinikanth (Sl. No. 5)
8. I. Arief (Sl. No. 2, 4)

International

1. T. Fukuda, T. Kakeshita (Sl. No. 1)
2. S. Agarwal (Sl. No. 6)

Significant research output / development during last one year

General research areas and problems worked on

1. Magnetic and other properties of metallic alloys –
   a) Functional properties, like magnetocaloric effects, Elastic moduli etc. of FSMA systems
   b) Theory and experiments on various interesting disordered alloys
2. Properties of Magnetic Rheological fluids
3. Development of body armors with smart fluids

Interesting results obtained

While the main interest of the lab is still magnetic properties of materials, we also diversified a bit on ferroelectric and rheological properties. Some of the highlights are as follows –

In case of a simple system like $FeAl_2$, we showed that addition of isoelectronic Ga in the system ($FeAl_{2-x}Ga_x$, $0 \leq x \leq 0.5$), antiferromagnetic transition in these intermetallic

compounds occurred concomitantly with a disorder-induced weak localization of electrons; the temperatures TN and Tm, at which antiferromagnetic transition and the weak localization respectively occurred closely track each other as the Ga concentration was varied. The antiferromagnetic transition was confirmed from the magnetic and specific heat measurements, and the occurrence of weak localization was confirmed from the temperature variation of resistivity and magnetoresistance measurements. With increasing Ga concentration, substitutional disorder in the system increases, and the consequent disorder-enhanced magnetic exchange interaction and disorder-induced fluctuations simultaneously drive antiferromagnetic transition and weak localization, respectively, to higher temperatures. This is the first reported case of such occurrence of simultaneous presence of AFM and disordered induced localization in the same system. We did both the experiments as well as ab initio theoretical calculations to explain the phenomenon. Figure 1 shows the correlations among two different measurements.

Another noteworthy work was on the DRDO sanctioned project on development of smart fluids for body armour. It was planned to have a smart fluid that would be light weight and free flowing like an ordinary liquid in quiescent state. This will be therefore easy to wear and carry, and will offer minimum resistance to maneuverability to the wearer. However, on contact with a fast moving object, like a fired bullet, it will instantly (in µsec) turn into a solid, thereby offering enhanced protection against the projectile. Upon passing of the impacting object, the sold will turn to ordinary liquid once again, in the same time scale.

This was tested in PXE firing grounds in Chandipore. One of the tested liquid was so good that it could damage a bullet fired upon by an INSAS rifle, and deflect it out of its incoming path. However, this is a classified item, so I can not divulge more on this. Only I can inform that the state level peacekeeping force is interested in this material and will be testing soon with their weapons.

We are also working on the photomicroactuation effect. While the basic understanding of the effect is still unknown, we are making a prototype for a microgripper to using this effect. This will be a self-activated and self-propelled system that requires no power source. This will be for the first time in the world.

Proposed research activities for the coming year

As stated in the previous entry, we are vigorously pursuing work on various smart materials. We are trying to develop materials which will be actually useful for everyday use. This will continue, and more and more avenues will be explored.

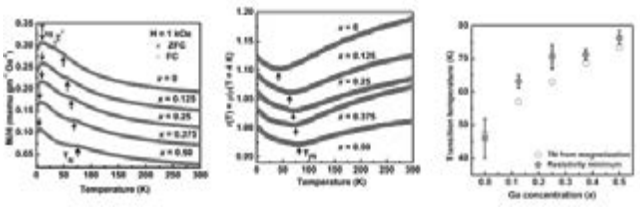

Fig. 1 (a, b, c) Temperature dependence of ZFC and FC magnetizations of $FeAl_{2-x}Ga_x$. Upward (wine) and downward (olive) vertical arrows indicate the antiferromagnetic transition temperature *TN* and spin-glass transition temperature *Tsg* , respectively. Downward gray arrow indicates the second magnetic transition at *T** observed only in the composition x = 0. (b) Temperature dependence of resistivity in FeAl2−xGax. Upward red arrows indicate the position of resistivity minimum. (c) Variation with Ga composition of the antiferromagnetic transition temperature (*TN*) and the temperature at which the resistivity minimum occurs (*Tm*).