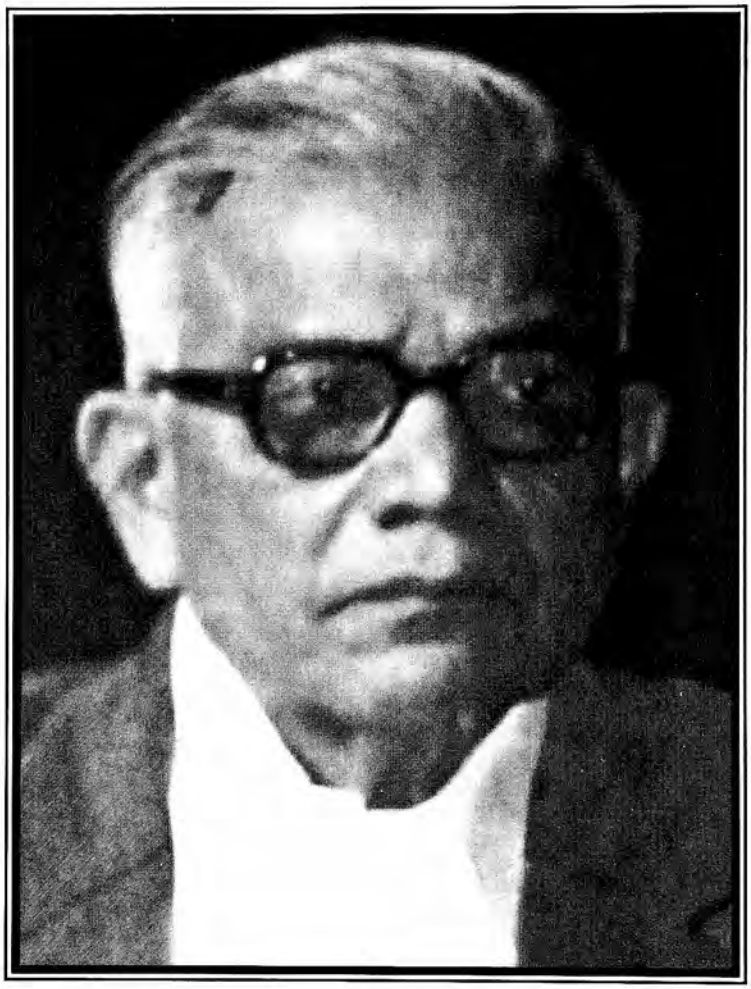
AMARNATH MAITRA

(9 February 1943 - 14 April 2012)

Biog. Mem. Fell. INSA, New Delhi **40** (2013) 137-149



AMARNATH MAITRA

(1943-2012)

Elected Fellow 2000

EARLY LIFE

AMARNATH MAITRA rose to highest scientific acclaim from a very humble beginning. He was born on February 9, 1943, in a small village named Amrah, located on the banks of the Mayuraakshi river in the Birbhum District of West Bengal. His father, Late Purna Chandra Maitra, was a conductor for Calcutta (Kolkata) Tram Corporation, and his mother, Late (Smt.) Santimoyee Maitra was a housewife. Professor Maitra was the eldest of six siblings, and throughout his adult life, he dutifully fulfilled the obligations of his parents and siblings being the family's eldest son. During his childhood, Amrah was still a village that lacked electricity and running water, and Professor Maitra grew up as a true "child of nature". He attended elementary and middle school in Amrah itself, in a one room mud building with a thatched roof, studying late into the night under the light of hurricane lamps. After completing elementary schooling in his native village, and high school in nearby Hetampur, he went to Kolkata for further studies. He obtained B.Sc. (Honours) in Chemistry from Ashutosh College, Kolkata University in 1962, and M.Sc. in Chemistry, with specialization in Inorganic Chemistry, from Kolkata University in 1964. Following that, he obtained a Ph.D. degree from Jadavpur University, Kolkata, in 1971, under the Supervision of Professor Debabrata Sen, in the subject area of boron and silicon heterocyclic chemistry.

TEACHER, RESEARCHER AND INVENTOR

After obtaining his Ph.D., Professor Maitra joined Ashutosh College, Kolkata, as a lecturer. However, his penchant for research soon brought him to the Department of Chemistry at the University of Delhi, where he joined as a lecturer in 1972, and this was his "home" where he spent the rest of his remarkable academic and scientific career. He devoted the initial years of his research endeavours at Delhi University in the area of corrosion chemistry. Later, he went to Europe for post-doctoral research fellowships, first in the laboratory of Prof. G Hertz at the University of Karlsruhe, Germany (1978-80) for conducting research in the area of nuclear magnetic resonance (NMR) relaxation spectroscopy, followed by a stint at the University of Basel, Switzerland (1980-82), in the laboratory of Prof. HF Eicke. While at Basel, Professor Maitra explored the structure and kinetics of microemulsions, an area of research which would play a critical role in shaping his future work and rise to

scientific acclaim. Later in his career he was also invited to several academic institutions in Europe and USA as a Visiting Professor, including Lund University, Sweden (1987); University of Florida at Gainesville, USA (1989); and School of Pharmacy, University of London (2004); to name a few.

Beginning in the early 1980's, Professor Maitra started research on the various aspects of microemulsions, which included basic phase-diagram studies, exploring the biological activities of enzymes and other proteins immobilized in microemulsions, and the synthesis and characterization of various inorganic nanoparticles in microemulsion media. He synthesized a number of such nanoparticles, particularly gamma ferric oxides, barium ferrite nanocrystals, and silver halides. From the early 1990's, he took a keen interest in nanoparticle-mediated drug and gene delivery for the treatment of various diseases, including infections and cancer, and thereafter, solely focussed his research in this area. Today, nanotechnology and nanobiomedicine are probably two of the most popular research areas in India and the world; however, twenty years ago these were newly emerging disciplines which many researchers were unwilling to embrace. Owing to his early recognition of the immense potential of nanotechnology and nanobiomedicine in the healthcare industry, Professor Maitra is widely regarded as one of the pioneers of these research areas in India.

In a short span of less than 20 years of research in nanotechnology and nanobiomedicine, Professor Maitra made prolific and significant contributions. He passionately worked at the interface of science and technology, as a result of which his work has been critically acclaimed by academia and industry alike. He developed and patented a number of drug-doped nanoformulations, most of which were licensed to pharmaceutical companies around the world. Professor Maitra has been granted five US patents, one EU patent and 11 Indian patents on targeted drug and gene delivery. Some of these are listed below:

Process for the preparation of highly monodispersed polymeric hydrophilic nanoparticles (United States Patent 5,874,111, year 1999) was licensed to Dabur India Ltd, New Delhi, India.

Formulations of paclitaxel, its derivatives or its analogs entrapped into nanoparticles of polymeric micelles, process for preparing same and the use thereof (United States Patent 6,322,817, year 2001) was also licensed to Dabur India Ltd, New Delhi, India.

Sustained release and long residing ophthalmic formulation and the process of preparing the same (United States Patent 6,579,519, year 2003) was licensed to Panacea Biotech, New Delhi, India.

Process of entrapping genetic materials in ultra-low size nanoparticles of inorganic compounds to form non-viral carriers (United States Patent 6,555,376, year 2003) licensed to Abraxis Biosciences (now Celgene Corporation), San Diego, USA.

Professor Maitra has supervised the graduate (Ph.D.) thesis work of close to 40 students, and published about 120 peer-reviewed articles in international journals of repute. The extraordinary standards of his research can be gauged by the number of citations received for some of his early seminal papers on microemulsions, including a 1995 publication in Advances in Colloid and Interface Science (cited 350 times), a 1989 publication in The Journal of Physical Chemistry (cited ~320 times), and a 1984 single-author publication in The Journal of Physical Chemistry (cited 293 times). Several of his more recent papers on nanotechnology and nanoparticle-mediated delivery platforms have been cited between 100-200 times in literature per Google Scholar, again underscoring the broadly felt impact of his research. In one of his most fruitful collaborations, Professor Maitra spent about one year (during 2006 and 2007) as a Visiting Professor in the laboratory of his son, Professor Anirban Maitra, at the Sol Goldman Pancreatic Cancer Research Centre at Johns Hopkins University School of Medicine in Baltimore, USA. This research collaboration resulted in the generation of one of the first ever formulations of the anticancer and anti-inflammatory agent, curcumin, encapsulated within polymer nanoparticles ("nanocurcumin"), and resulted in seven peer-reviewed publications in various international journals over five years, the last one as recently as 2012. In fact, the article describing the synthesis and characterization of nanocurcumin, published in the Journal of Nanobiotechnology in 2007, remains one of the highest ever downloaded publications for this journal, and has been cited over 260 times in literature.

In addition to being a prolific researcher, Professor Maitra was an extraordinary mentor, and many of his former students currently hold high ranking positions in academia or industry, including Professor or Director level positions. His counsel and expertise was actively sought by a number of pharmaceutical companies, as well as multiple academic institutions that have opened centres of nanotechnology research and education in the last few years. He was also associated with the Indian Nanoscience and Technology Initiative, and other nanotechnology-based endeavours in this country. Professor Maitra had an enduring passion for training India's next generation of scientists in nanotechnology research and enterprise. To this effect, he initiated and established a Masters level (M.Tech.) course in Nanoscience and Nanotechnology at the University of Delhi.

Professor Maitra received numerous awards and recognitions for his scientific achievements, but none for which he felt more privileged than being named as a Fellow of the Indian National Science Academy (FNA) in 2000. He was also a recipient of the prestigious International Einstein Award for Scientific Achievement in the field of Nanotechnology and Nanomedicine from the International

Biographical Centre, Cambridge, United Kingdom in 2010, and the Materials Research Society of India (MRSI) medal in 2004. Professor Maitra was the Editor of the *Journal of Surface Science and Technology*, and a member of the International Advisory Board of the *Journal of Colloid and Interface Science*. He was also a council member of the International Association for Colloid and Interface Science and a member of The Controlled Release Society, USA. The former President of India, Dr APJ Abdul Kalam, himself a distinguished scientist, mentioned the laudable contributions of Professor Maitra to the fields of nanotechnology and nanobiomedicine research in several of his talks. Even following his retirement from Delhi University in 2007, he remained active in laboratory research in the capacity of INSA senior scientist, first at the Indian Association for the Cultivation of Sciences (Kolkata), and subsequently at the University of Delhi.

THE HUMAN BEING

Despite having achieved exemplary scientific recognition, Professor Maitra remained deeply rooted to his humble upbringings, and always came across as a simple man with simple needs. His simplicity was often reflected in his approach towards research, where he would seek the most elementary of tools to tackle the most complex of problems. He was always on the lookout for new and exciting areas of research, whose lessons could rapidly be translated for societal benefits. In fact, Professor Maitra insisted that nanotechnology research in this country have a strong translational bent, such that taxpayer-funded research would eventually benefit the common man.

Apart from his scientific achievements, Professor Maitra was also known for his humane and charitable side, which he confided only in those who were close to him. He donated all the money that he earned through his various patents and royalties to fund the construction of a science building and scholarships for women students in a higher secondary school near his birthplace in West Bengal. To his students and protégés, in whom he had inculcated his philosophy towards research and life, he was much more than just a research guide.

Sadly, Professor Maitra passed away on 14th April, 2012 in New Delhi, after a brief illness. Till the end, he was actively involved in research at Delhi University. Professor Maitra was an extraordinary mentor, whose fatherly presence, childlike enthusiasm, and undying optimism will be sorely missed.

I am indebted to Professor Maitra's wife, Professor (Mrs.) Krishna Maitra and his son, Professor Anirban Maitra, for providing valuable inputs in this memoir.

Dr. INDRAJIT ROY
Department of Chemistry
University of Delhi, Delhi-110007, India
Mobile: 9560721851
E-mail: indrajitroy11@gmail.com

BIBLIOGRAPHY

1972 (With SEN D) Solvolytic Studies of Biguanides and related compounds in presence of Boron Trifluoride as Catalyst. *J Indian Chem Soc.* **49:** 153.

– (With SEN D) Synthesis of Boron Heterocycles from Guanylthiourea and related compounds. *J. Inorg Nucl Chem.* **16:** 2643.

– (Boron Analogue of Uracil. *Indian J. Chem.* **16B:** 793.

– (With SEN D) Cationic Silicon-Silicon(IV)Biguanides. *Inorg Nucl Chem Letts.* **8:** 793.

1973 (With CHAKRABORTY A) Guanylthiourea: an inhibitor for acid corrosion of iron. *Corrosion Science* **13:(9):** 689-690.

– (With CHAKRABORTY A) Guanylthiourea: an inhibitor for acid corrosion of iron. *Corrosion Science* **13:** 587.

– Boron Chelates of Salicylhyroxamic Acid. *J. Indian Chem Soc.* **50:** 361.

– 12-Molybdophosphates of biguanides and related compounds. *J Indian Chem Soc.* **50:** 157.

1974 (With SEN D) Cationic Boron-Boron(III)Biguanides by Transammination Reaction. *Indian J. Chem* **18:** 183.

– (With BARUA S) Dicyandiamide—an inhibitor for acid corrosion of pure aluminium *Corrosion Science* 14, Issue 10, 587–590.

– Uranyl 12-Molybdophosphates. *J. Indian Chem Soc.* **51:** 370.

– (With CHAKRABORTY A) Dicyandiamide—an inhibitor for acid corrosion of pure aluminium. *Corrosion Science* **14:** 511.

– Studies on the corrosion inhibition characteristics of Some Furan Derivatives from their quantum chemiscal parameters. *Indian J. Chem.* **15:** 451.

1979 (With BHATTACHARYYA K) Galvanostatic studies of the corrosion of Nickel in Sulfuric acid in presence of organic inhibitors. *Trans SAEST* **14:** 1979, 221.

– (With BHATTACHARYYA K) Effect of Dicyandiamide on the acid corrosion of aluminium alloys. *J Indian Chem. Soc.* **56:** 850.

– (With HECHT A, DROSTE B and FELLER HG) Das Anodische Verhalten von Nickel bi Zusatz von Thioharnstoffen und Dicyanamide. *Metalloberflache* **112:** 2345.

1980 (With SINGH G) Galvanostatic and temperature kinetic studies of acid corrosion of low carbon steel in presence of dicyanamide. *Indian J. Chem.* **19A:** 953.

– (With SINGH G) Galvanostatic and temperature kinetic studies of acid corrosion of low carbon steel in presence of biguanide. *Indian J. Chem.* **20A:** 338.

– (With SINGH G) Dicyandiamide-An inhibitor for acid corrosion of low carbon steel. *Trans SAEST (India)* **16:** 61.

– (With BHATTACHARYYA K) Effect of halide ions on cathodic polarisation of Nickel in presence of Dicyandiamide and related compounds in sulphuric acid. *J. Indian Chem. Soc.* **57:** 854.

– (With SINGH G) Galvanostatic and temperature kinetic studies of acid corrosion of low carbon steel in presence of Guanylurea. *Indian J. Chem.* **19A:** 11.

1981 (With BHATTACHARYYA K) Effect of Dicyandiamide and related inhibitors during anodic dissolution of Nickel in sulphuric acid. *Indian J. Chem.* **20A:** 1209.

– (With HERTZ HG, MILLS R and WEINGARTNER H) The interpretation of excess conductivity of HCl in water in terms of velocity correlation defects. *J. Chim. Physique (Paris)* **78:** 69.

1981 (With EICKE HF) The effect of rotational isomerism on water solubilising properties of Aerosol OT in Reverse Micelles. *J. Phys. Chem.* **85:** 2687.

1982 (With BHATTACHARYYA K) Effect of Organic Inhibitors on the Anodic Dissolution of Nickel. *Corrosion and its Control, SAEST, India* 378.

– (With SINGH G and CHAKRAVORTY BB) Adsorption kinetics and inhibition by some Guanidine derivatives during corrosion of pure iron in neutral aqueous solution. *Advances on Corrosion Control, SAEST, India* **3:** 1.

1983 (With SINGH G and BHATTACHARYYA K) Inhibition of corrosion of Nickel in different acids in presence of organic inhibitors. *Proc Natl Acad Sci (India)* **49A:** 143.

– (With SINGH G and BHATTACHARYYA K) Biguanide-A potential inhibitor for corrosion of pure iron in neutral aqueous solutions. *Trans SAEST(India)* **18:** 335.

– (With VASTA G and EICKE HF) Revisiting the effects of nonamphiphilic organic additives on the water solubilizing properties of aerosol ot within the L2 phase. *Journal of Colloid and Interface Science,* **93** Issue **2:** 383-391.

– (With SINGH G and CHAKRABORTY BB) Study of Corrosion Inhibitor/Stimulator Characteristics of Guanidine Derivatives. *British Corrosion Journal* **18(3):** 152-155(4).

1984 Determination of size parameters of water-Aerosol OT-oil reverse micelles from their nuclear magnetic resonance data. *The Journal of Physical Chemistry* **88(21):** 5122-5125.

1985 (With SINGH G, KAUSHIK RK and BHATTACHARYYA K) Inhibition characteristics of some organic heterocycles during acid corrosion of nickel as studied in the light of their structural parameters and interfacial reactions. *Proc Natl Acad Sci (India)* **51A:** 441.

1986 (With SARANGI A) Solubilization and interaction of α-tocopherol in water-aerosol OT-isooctane systems. *Journal of Biosciences* **10, 3:** 403-412.

– (With PATANJALI PK and VARSHNEY M) Head group interaction in membrane - cholesterol association: Studies in Aerosol OT model membrane system by 13C chemical shifts, relaxation and nuclear Overhauser enhancement effects. *Colloids and surfaces* **20, 3:** 211-219.

1987 (With MATHEW C) Studies on the clustering behaviour of water-Aerosol OT-Isooctane Microemulsions from their low frequency permittivity data. *J. Surf. Sci. Technol* **3:** 99.

1987 (With JAIN TK) Study of the vibrational characteristics of aerosol OT by laser raman spectroscopy. *Colloids and Surfaces,* **28:** 19–27.

– (With VARSHNEY D and VARSHNEY M) Revisiting the rotational isomerism of aerosol OT from the selective heteronuclear nuclear overhauser effect. *Colloids and surfaces* **24: 2-3:** 119-126.

– (With PATANJALI PK) Effect of cholesterol solubilised in membranes on the interfacial water structure — a study by water proton NMR relaxation in reverse micelles. *Colloids and Surfaces,* **27** Issue **4:** 271–276.

1988 (With C MATHEW, PK PATANJALI and A NABI) On the concept of percolative conduction in water-in-oil microemulsions. *Colloids and Surfaces* **30** Issue 3-4, 1988, 253-263.

1988 Microdynamical behaviour of benzene solubilized in reverse micelles. A study of deuterium NMR relaxation. *Colloids and surfaces* **32:** 149-157.

1989 (With JAIN TK) Chain conformation of aerosol OT in water-in-oil microemulsions as studied by laser Raman spectroscopy. *Colloids and Surfaces* **36(1):** 87–95.

– (With JAIN TK and VARSHNEY M) Structural studies of Aerosol OT reverse micellar aggregates by FTIR spectroscopy. *The Journal of Physical Chemistry* **93(21):** 7409-7416.

– (With DAS S) Temperature dependent Catalytic Behavior of Peroxidase Entrapped in Reverse Micelles. *Colloids Surfaces* **35:** 101.

1990 (With MATHEW C and VARSHNEY M) Closed and open structure aggregates in microemulsions and mechanism of percolative conduction. *Journal of Physical Chemistry* **94(13):** 5290-5292.

– (With JAIN TK and SHERVANI Z) Interfacial water structure in lecithin–oil–water reverse micelles. *Colloids and Surfaces,* **47** Issue **1,** 255-267.

– (With AYYUB P and SHAH DO) Formation of Theoretical Density Microhomogeneous Yba2Cu3O7-x using Microemulsion mediated process. *Physica C.* **168:** 571.

1991 (With SHERVANI Z, JAIN TK and DINESH) Water solubilization investigations of phosphatidylcholine reverse micelles. *Colloids and surfaces* **60:** 161-173.

– (With SHERVANI Z) Non-conventional Lecithin Gels in Hydrocarbon Oils. *Colloid Polymer Sci.* **269:** 720.

– (With PARIDA S and PARIDA GR) Studies on the catalytic activity of horseradish peroxidase hosted in Aerosol OT reverse micelles containing cholesterol. *Colloids and surfaces* **55:** 223-229.

1992 (With ROYCHOUDHARY S, YADAV R and JAIN PC) A New Lamellar Phase in CTAB/Water/Hexanol Reverse Micelles. *Material Sci. Forum.* **105:** 1517.

– (With SARCAR S and JAIN TK) Activity and Stability of Yeast Alcohol Dehydrogenase (YADH) Entrapped in Aerosol OT Reverse Micelles. *Biotechnology and Bioengineering* **39:** 474-478.

– (With ROYCHOUDHARY S, YADAV R and JAIN PC) On the existence of bicontinuous phase in CTAB/Water/Hexanol Reverse Micelles. *Material Sci. Forum.* **105:** 1521.

1993 (With HOUSSEIN P and JAIN PC) Phase Transformation Studies in TTAB/Pentanol/Water/n-Octane System. *J. de Physique (Paris)* **IV 3:** 321.

– (With AYYUB P and SHAH D) Microstructure of the CTAB-Butanol Octanewater Microemulsion System : Effect of Dissolved Salts *J. Chem Soc Faraday Trans.* **89, 19:** 3585-3589.

1994 (With ROYCHOUDHARY S, YADAV R and JAIN PC) Structural Transformation in CTAB Aggregated system investigated by Positron Life Time Spectroscopy. *Colloid Surfaces* **A82:** 49.

– (With SARCAR S, MUNSHI N and JAIN TK) The effect of droplet dynamics on the enzyme kinetic reactions by yeast alcohol dehydrogenase in reverse micelles. *Colloids and Surfaces A: Physicochemical and Engineering Aspects,* 88, Issues 2–3, 169–180.

– (With MUNSHI N and SARCAR S) The effect of droplet dynamics on the kinetics of the horseradish peroxidase catalysed reaction in reverse micelles. *Colloids and Surfaces A: Physicochemical and Engineering aspect* **88**: 2-3, 181-189.

1995 (With VARSHNEY M) Conformational Studies of Aerosol OT Reverse Micelles using Phase Sensitive Double Quantum COSY NMR Spectroscopy. *Colloid Surfaces* **A96:** 165.

– (With MUNSHI N, CHAKRAVARTY K and DE TK) Activity and stability Studies of Ultrafine Nanoencapsulated Catalase and Penicillinase. *Collid Polymer Sci* **273:** 464.

– (With CHHABRA V, LAL M and AYYUB P) Preparation of ultrafine high density gamma ferric oxides using Aerosol OT Microemulsion and their characterisation. *Colloid Polymer Sci.* **273:** 939.

– (With CHHABRA V, LAL M and AYYUB P) Nanophase Barium Ferrite BaFe12O19 synthesized from non-aqueous microemulsion with Ba- and Fe- containing surfactants. *J. Material Res.* **10:** 2689.

– (With CHAKRAVORTY K and VARSHNEY M) Activity and stability of alpha Penicillinase entrapped in Reverse Micelles.

– (With DE TK) Solution behaviour of Aerosol OT in non polar solvents. *Advances in colloid and interface science* **59:** 95-193.

1996 (With SHARMA D, CHELVI TP, KAUR J, CHAKRAVORTY K, DE TK and RAHLAN R) Novel Taxol formulation: polyvinylpyrrolidone nanoparticle-encapsulated Taxol for drug delivery in cancer therapy. *Oncology Research* 8, 7/8, 281-286.

– (With KUMAR A) Supression of residual hydrophobicity of some amphilic amino acids by forming association complexes with beta cyclodextrin. *J. Indian Chem. Soc.* **73:** 516.

– (With CHABBRA V, AYYUB P and CHATTOPADHAYAY S) Preparation Accicular Gamma Ferric Oxides particles from Microemulsion mediated Reactions. *Material Research* **26:** 21-26.

– (With DE TK) Particle Engineering of Drug Loaded nanoparticles and their potential Drug Targeting Applications. *CRC Hand Book of Surface and Colloid Chemistry, (1998). Ed. KS Birdi,* CRC Press, Boca Raton, Florida, pp603, 1996.

– (With SHARMA RK and JAIN V) Cellular MR Spectroscopy: A Useful tool in Developing New Strategies for Tumor Radiotherapy. *Mediquest (Ranbaxy Medical Information Series),* **14(3):** 4.

1997 (With THAKUR LK and DE TK) Role of Interfacial Rigidity on Electrical Conductivity and Electrolyte exchange in the infinite droplet clusters of oil continuous microemulsion. *J. Surf Sci. Technol* **13:** 35-43.

– (With MUNSHI N and DE TK) Size Modulation of Polymeric Nanoparticles under Controlled Dynamics of Microemulsion Droplets. *Journal of Colloid and Interface Science,* **190, Issue 2,** 387-391.

– (With MADAN T, MUNSHI N, DE TK, SARMA PU and AGGARWAL SS) Biodegradable nanoparticles as a sustained release system for the antigens/allergens of Aspergillus fumigatus: preparation and characterisation. *International Journal of Pharmaceutics* 159, 2, 135–147.

– (With LAL M, CHHABRA V and AYYUB P) Preparation and characterization of Ultrafine TiO2 particles in Reverse micelles by hydrolysis of Titanium Diethylhexyl Sulfosuccinate. *J. Mater Res.* **12:** 345.

– (With LAL M and DE TK) Enzyme hosted Nanometer sized Ceramic Particles: Preparation and Characterization. *J Colloid Inter Sci.*

1998 (With JAIN TK, ROY I and DE TK) Nanometer Silica Particles Encapsulating Active Compounds: A Novel Ceramic Drug Carrier. *Journal of the American Chemical Society* **120(43):** pp 11092–11095

– (With SAHOO SK, DE TK and GHOSH PK) pH- and Thermo-sensitive Hydrogel Nanoparticles. *Journal of Colloid and Interface Science* 206, Issue 2, 361-368.

– (With LAL M, CHHABRA V and AYYUB P) Preparation and characterization of ultrafine TiO~2 particles in reverse micelles by hydrolysis of titanium di-ethylhexyl sulfosuccinate. *Journal of Materials Research –Pittsburgh*, 13, 5, 1998, 1249-1254.

– (With GHOSH PK, DE TK, SAHOO S, GHOSH PC and GAUR U) Long Circulating RES Evading Hydrophilic Nanoparticles Prepared Through Reverse Micelles. *J. Controlled Release.*

2000 (With SHARMA RK, SINGH S, DEGAONKAR M, RAGHUNATHAN P and JAIN V) Optimization of Tumor Radiotherapy Part VI: Modification of Tumor Glucose Metabolism for Increasing the Bioavailability of 2-Deoxy-D-Glucose (2-DG) in a Mutine Tumor Model. *Strahlentherapie und Onkologie*, **176(3):** 135-143.

– (With DAS S and MOZUMDAR S) Activity and Conformation of Yeast Alcohol Dehydrogenase (YADH) Entrapped in Reverse Micelles. *Journal of Colloid and Interface Science* 230, 2, 328–333.

– (With U GAUR, SAHOO SK, DE TK, GHOSH PC and GHOSH PK) Biodistribution of fluoresceinated dextran using novel nanoparticles evading reticuloendothelial system. *International Journal of Pharmaceutics*, **202, Issues 1–2**, 1-10.

– (With GUPTA AK, MADAN S and MAJUMDAR DK) Ketorolac entrapped in polymeric micelles: preparation, characterisation and ocular anti-inflammatory studies. *International Journal of Pharmaceutics*, **209, Issue 1-2**, 1-14.

2002 (With DAS S and JAIN TK) Inorganic–Organic Hybrid Nanoparticles from *n*-Octyl Triethoxy Silane. *Journal of Colloid and Interface Science*, 252, Issue 1, 82-88.

– (With BANERJEE T, MITRA S, SINGH AK and SHARMA RK) Preparation, characterization and biodistribution of ultrafine chitosan nanoparticles. *International Journal of Pharmaceutics*, 243, Issues 1–2, 93–105.

– (With JANA SS, BHARALI DJ, MANI P, GUPTA CM and SARKAR DP) Targeted cytosolic delivery of hydrogel nanoparticles into HepG2 cells through engineered Sendai viral envelopes. *FEBS Letters*. **515(1-2):** 184-188.

2003 (With ROY I, MITRA S and MOZUMDAR S) Calcium phosphate nanoparticles as novel non-viral vectors for targeted gene delivery. *International Journal of Pharmaceutics* 250, Issue 1, 25-33.

2003 (With DAS SK, DAS S and GANGULY BN) Self association of sodium salicylate system. *Chemical physics*, **293(2):** 211-216.

– (With BHARALI DJ, SAHOO SK and MOZUMDAR S) Cross-linked polyvinylpyrrolidone nanoparticles: a potential carrier for hydrophilic drugs. *Journal of Colloid and Interface Science* **258(2):** 415-423.

– (With SHARMA RK and SHARMA P) Size-dependent catalytic behavior of platinum nanoparticles on the hexacyanoferrate (III)/thiosulfate redox reaction. *Journal of Colloid and Interface Science*, **265(1):** 134-140.

– (With NAD S, SHARMA P and ROY I) Anamalous nanostructured titanium dioxide. *Journal of Colloid and Interface Science.* **264(1):** 89–94

2004 (With SHARMA RK and DAS S) Surface modified ormosil nanoparticles. *Journal of Colloid and Interface Science*, **277(2):** 342–346.

2005 (With BISHT S, BHAKTA G and MITRA S) pDNA loaded calcium phosphate nanoparticles: highly efficient non-viral vector for gene delivery. *International Journal of Pharmaceutics*, **288(1):** 157-168.

– *Expert Review of Molecular Diagnostics*, **5(6):** 893-905

– (With BHAKTA G and MITRA S) DNA encapsulated magnesium and manganous phosphate nanoparticles: potential non-viral vectors for gene delivery. *Biomaterials*, **26(14):** 2157–2163.

– (With TYAGI R, LALA S, VERMA AK, NANDI AK, MAHATO SB and BASU MK) Targeted delivery of arjunglucoside I using surface hydrophilic and hydrophobic nanocarriers to combat experimental leishmaniasis. *Journal of Drug targeting*, **13(3):** 161-171.

– (With SHARMA RK and DAS S) Enzymes in the cavity of hollow silica nanoparticles. *Journal of Colloid and Interface Science*, **284(1):** 358-361.

– (With SONI S, BABBAR AK, SHARMA RK and BANERJEE T) Pharmacoscintigraphic Evaluation of Polysorbate80-Coated Chitosan Nanoparticles for Brain Targeting. *American Journal of Drug Delivery*, **3(3):** 205-212.

2006 (With BISHT S and CHATTOPADHYAY D) Intraperitoneal Administration of Calcium Phosphate Nanoparticles Encapsulating pSVβgal Elicits Immune Response to Encoded Protein. *Journal of Biomedical Nanotechnology*, 2, 3-4, 229-238(10).

– (With BISHT S and CHATTOPADHYAY D) Intraperitoneal Administration of Calcium Phosphate Nanoparticles Encapsulating pSVssgal Elicits Immune Response to Encoded Protein. *Journal of Biomedical Nanotechnology*. **2(¾):** 229-238.

– (With SONI S, BABBAR AK and SHARMA RK) Delivery of hydrophobised 5-fluorouracil derivative to brain tissue through intravenous route using surface modified nanogels. *Journal of Drug Targeting*, 14**(2):** 87-95.

2007 (With BISHT S, FELDMANN G, SONI S, RAVI R and KARIKAR C) Polymeric nanoparticle-encapsulated curcumin ("nanocurcumin"): a novel strategy for human cancer therapy. *Journal of Nanobiotechnology* **5:** 3.

– (With SAMIM M and KAUSHIK NK) Effect of size of copper nanoparticles on its catalytic behaviour in Ullman reaction. *Bulletein of Material Science* **30(5):** 535–540.

2008 (With BISHT S, FELDMANN G, KOORSTRA JM, MULLENDORE M, ALVAREZ H, KARIKARI C, RUDEK MA and LEE CK) *In vivo* characterization of a polymeric nanoparticle platform with potential oral drug delivery capabilities. *Mol Cancer Ther* **7(12):** 3878–88.

2009 (With BISHT S) Dextran-doxorubicin/chitosan nanoparticles for solid tumor therapy. *Nanomedicine and Nanobiotechnology* **1(4):** 415–425.

– (With BHAKTA G and SHRIVASTAVA A) Magnesium Phosphate Nanoparticles can be Efficiently Used In Vitro and In Vivo as Non-Viral Vectors for Targeted Gene Delivery. *Journal of Biomedical Nanotechnology* **5(1):** 106-114(9).

– (With SHARMA RK and ROY I) Glucose Oxidase Doped Silica Nanoparticles Show Significant Enzymatic Activity. *Journal of Scientific Conference Proceedings*, **1:** 48-53(6).

2010 (With BISHT S, MIZUMA M, FELDMANN G, OTTENHOF NIKI A, HONG SEUNG-MO, PRAMANIK D, CHENNA V, KARIKARI C, SHARMA R, GOGGINS MICHAEL G, RUDEK

MICHELLE A and RAVI R) Systemic Administration of Polymeric Nanoparticle- Encapsulated Curcumin (NanoCurc) Blocks Tumor Growth and Metastases in Preclinical Models of Pancreatic Cancer. *Molecular Cancer Therapeutics* **9(8):** 2255-2264.

2011 (With RAY B, BISHT S and LAHIRI DK) Neuroprotective and Neurorescue Effects of a Novel Polymeric Nanoparticle Formulation of Curcumin (NanoCurc™) in the Neuronal Cell Culture and Animal Model: Implications for Alzheimer's disease. *Journal of Alzheimer's Disease* **23(1):** 61-77.

– (With BISHT S , KHAN MA , BEKHIT M , BAI H , CORNISH T , MIZUMA M , RUDEK MA, ZHAO M , RAY B , LAHIRI D and ANDERS RA) A polymeric nanoparticle formulation of curcumin (NanoCurc™) ameliorates CCl4-induced hepatic injury and fibrosis through reduction of pro-inflammatory cytokines and stellate cell activation. *Laboratory Investigation* **91:** 1383–1395.

– (With BHAKTA G, SHARMA RK, GUPTA N, COOL S and NURCOMBE V) Basic science Multifunctional silica nanoparticles with potentials of imaging and gene delivery. *Nanomedicine: Nanotechnology, Biology and Medicine*, **7(4):** August 2011, Pages 472–479.

– (With SAMIM M , NAQVI S , ARORA I and AHMAD FJ) Antileishmanial activity of nanocurcumin. *Therapeutic Delivery* **2(2):** 223-230.

2012 (With D PRAMANIK, CAMPBELL NR, DAS S, GUPTA S, CHENNA V, BISHT S, SYSA-SHAH P, BEDJA D, KARIKARI C, STEENBERGEN C and GABRIELSON KL) A composite polymer nanoparticle overcomes multidrug resistance and ameliorates doxorubicin-associated cardiomyopathy. *Oncotarget*. **3(6):** 640–650.

– (With DINDA AK, PRASHANT CK, NAQVI S, UNNITHAN J and SHAMIM M) Curcumin loaded organically modified silica (ORMOSIL) nanoparticle; a novel agent for cancer therapy. *International Journal of Nanotechnology* **9:** 10-12, 862-871.