KUMKUM BANERJEE

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RESEARCH INTERESTS

Thermo mechanical Processing of Steels, Microstructural Characterization of Metallic Alloys, Physical Metallurgy of Welding of Steels and Aerospace Alloys, Corrosion and Hydrogen Embrittlement of Metals, Texture in Metals,Recrystallization and Precipitation Kinetics, Product Development in Steel

SKILLS

- Hands on experience in using EG&G PARC & PS6 potentiostats
  (*for corrosion rate measurement*)
- Hands on experience in handling Instron tensile testing equipments
  (*for tensile properties of materials*)
- Hands on experience in using CORTEST slow strain rate testing machine
  (*for hydrogen embrittlement studies*)
- Hands on experience in using X-ray goniometer (*for textural studies*)
- Hands on experience in using optical microscope, SEM including FEG-SEM-EBSD and TEM
  (*for materials characterization*)
- Hands on experience in handling Gleeble 3500 thermomechanical simulator.
  (*for thermomechanical simulation studies*)

Computer

- Experience with Windows operating system, such as, Windows 95/98/NT/XP and Microsoft office, such as Word/Excel/PowerPoint and ability to handle different softwares.
- Experience in specialized softwares such as those applicable for EG & G and PS6 systems for corrosion studies, texture goniometry, XRD, image analysis, SEM-EDS, EBSD, TEM-EDS, Gleeble 3500, Thermo-Calc, etc.

EDUCATION

1999 Ph.D. - Metallurgical Engineering from Indian Institute of Technology (IIT), Kharagpur, India
Title of Thesis: Hydrogen Embrittlement of HSLA-80 and HSLA-100 Steels in Seawater under Cathodic Charging Conditions

1994 B.Sc. Engineering (Metallurgical) from Birsa Institute of Technology (BIT), Sindri, Dhanbad, Vinoba Bhave University, Hazaribagh, India
Title of Thesis: A Review on Composite Materials

1988 B.Sc (Physics-Chemistry-Maths) from Sri Sri Laxmi Narayan Trust (SSLNT) Women's College, Dhanbad, Ranchi University, Ranchi, India

Linguistic Abilities: English, Hindi and Bengali

WORK EXPERIENCE

• Aug 2010-Till date	Dept. of Metallurgical & Materials Eng. **National Institute of Technology Karnataka** **Surathkal, India**	**Associate Professor**
▪ Aug 2004- Aug 2015	Research and Development Division **Tata Steel Limited** **Jamshedpur, India**	**Principal Researcher**
• April 2008-Feb 2009 (*On study leave from Tata Steel Limited Jamshedpur*)	Dept. of Materials Eng. **The University of British Columbia** **Vancouver, BC, Canada**	**Research Associate** (In a sponsored project—Development of HAZ microstructure models of high strength line pipe steels)
▪ May 2002-March 2004	Dept. of Mechanical & Industrial Eng. **University of Manitoba, Winnipeg** **Manitoba, Canada**	**Post-Doctoral Fellow** (In a sponsored project: Weldability studies of nickel based superalloys)
▪ Jan 2002-April 2002	Dept. of Metallurgical & Materials Eng. **Indian Institute of Technology** **Kharagpur, India**	**Project Consultant** (In a BRNS sponsored project: Stress Corrosion Cracking of Hastelloy 'C' in fluoride environment)
▪ Jan 2001-Jan 2002	**National Metallurgical Laboratory**, **Jamshedpur, India**	**Scientist**
▪ Aug 2000-Jan 2001	Dept. of Materials Science & Eng. **Carnegie Mellon University** **Pittsburgh, Pennsylvania, USA**	**Research Associate** (In a sponsored project- "Microstructure, mechanical properties & texture of strip cast low C steel sheets")
▪ Feb 2000-July 2000	Dept. of Construction, Materials Eng. and Industrial Design **Western Michigan University** **Kalamazoo, Michigan, USA**	**Assistant Professor**
▪ Dec 1999-Jan 2000	Dept. of Metallurgical & Materials Eng. **Indian Institute of Technology** **Kharagpur, India**	**Research Associate** (In an Indo-US project- "Corrosion characteristics of advanced ferrous alloys" in collaboration with Naval Research Laboratory (NRL), Washington, DC, USA)
▪ Nov 1995-Nov 1999	Dept. of Metallurgical & Materials Eng. **Indian Institute of Technology** **Kharagpur, India**	**Research Fellow (Ph.D. Candidate)** (In an Indo-US project--"Corrosion characteristics of advanced ferrous alloys" in collaboration with Naval Research Laboratory (NRL), Washington, DC, USA)
▪ June 1995-Oct 1995	Dept. of Fuel & Mineral Eng. **Indian School of Mines** **Dhanbad, India**	**Research Fellow** (In a sponsored project-"Modelling and scale-up studies of water only cyclone treating coal")

POST-DOCTORAL RESEARCH EXPERIENCE

- Research Associate at the Department of Materials Science and Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA in the year 2000-2001.
- Post-Doctoral Fellow at the Department of Mechanical and Industrial Eng, University of Manitoba, Winnipeg, Manitoba, Canada in the year 2002-2004.
- Research Associate at the Department of Materials Engineering, The University of British Columbia, Vancouver, British Columbia, in the year 2008-2009.

SPONSORED PROJECT

Young Scientist's Project – "Mechanical and Corrosion Characteristics of Al-Ni and Al-Fe-Ce alloys'', while working at NML Jamshedpur in 2002, funded by Department of Science and Technology, Govt. of India.

SUPERVISION/MENTORING & COACHING

- Co-supervised an M. Tech. Thesis – "Ageing and Recrystallization Behaviour of IF-Cu-steel" of IIT Kharagpur, India (awarded in 2006).
- B. Tech and M. Tech students in thesis work during my PhD at IIT Kharagpur (1996-1999).
- Master's students at Western Michigan University, Kalamazoo, USA as Assistant Professor (2000).
- Summer interns, Research Assistants, Research Associates, Project members, Supervisors at Tata Steel, India (2004-2015).
- PhD Thesis Examiner BITS Pilani (awarded in 2013).

ASSOCIATIONS

- Served as Lab In-charge of the Gleeble 1500 thermomechanical simulator in the R & D Dept of Tata Steel, Jamshedpur, India (Sept 2009-Dec 2012).
- Served as member of the Editorial Committee of Tata Steel Ltd., Jamshedpur, India.
- Coordinator and Editor of the first five Quarterly R & D Highlights of Tata Steel, Jamshedpur, India (Jan 2010-Apr. 2011.
- Life Member of the Indian Institute of Metals.
- Corresponding Editor of Metal News, Indian Institute of Metals.
- Reviewing Committee Member of Trans. Indian Institute of Metals.
- Reviewer of Journal of Materials Science.
- Reviewer of Journal of Alloys and Compounds.
- Reviewer of Metallurgical and Materials Transactions A.

RESEARCH PROJECTS HANDLED

University/ Research Lab/ Post-doctoral Projects

- ✓ Modelling and scale up studies of water only cyclone treating coal.

  ---Indian School of Mines, Dhanbad, India

- ✓ Corrosion characteristics of advanced ferrous alloys (Ph.D. work)

  ---Indian Institute of Technology, Kharagpur

- ✓ Microstructure, mechanical properties and texture of strip cast Low C steel sheets (Post Doc)

  —Carnegie Mellon University, Pittsburgh, USA

- The work was supported by the renowned steel industries (AKV, SMS, LTV, Dofasco, US-Steel etc) in North America, and the steel, first of its kind, was supplied by Broken Hill Proprietary (*now BlueScope*), Australia.
- This study helped render knowledge about microstructure, texture and recrystallization kinetics in the steel in various non-conventional novel processing conditions that subsequently helped select suitable operating conditions for obtaining favourable microstructure and texture to generate desired mechanical properties
- The optimized processing parameters were implemented duly.
- The work was published in 'Iron and Steelmaker' in 2003 and was presented in an international conference.

- ✓ Weldability improvement in Ni-Based superalloys (Post Doc)

  ---University of Manitoba, Winnipeg, Canada

- The project was sponsored by NSERC, Canada and was in collaboration with Bristol Aerospace Limited, Canada.
- Weldability of the alloys was improved and the same was subsequently implemented.
- A part of the work was presented at the 15th Canadian Materials Science Conference, Nova Scotia, Canada, held in June 2003 and the full work was published in the 'Metallurgical and Materials Transactions A', 2005.
- A review article on the effect of magnesium on superalloys was published in Materials Sciences and Applications in 2011.

- ✓ Development of HAZ microstructure models of high strength line pipe steels (Post Doc)

  --- University of British Columbia, Canada

- The project had partners from the leading Canadian manufacturer of linepipe, EVRAZ (formerly IPSCO) and the builder and operator of major Canadian pipelines (TransCanada), and the leading supplier of pipeline welding equipment (CRC-Evans).
- The work had been published in the 'Metallurgical & Materials Transactions A', 2010, 'Solid State Phenomena', 2011and 'Materials Science Forum', 2012.
- A patent was filed for a part of the work (Application No. 172/KOL/2010 dated 23 Feb 2010).

  The work was also published in 2-international conference proceedings and presented in 2-international conferences and 1-national conference.

- ✓ Corrosion behaviour of low carbon strip cast steels

  ---National Metallurgical Laboratory, Jamshedpur, India

- ✓ Mechanical and Corrosion Characteristics of Al-Ni and Al-Fe-Ce alloys

  ---Indian Institute of Technology, Kharagpur

Industrial Projects carried out at Tata Steel

- ✓ Texture evaluation of CRCA IF, IF-HS and EDD grade steels.
- ✓ Development of IF steel for critical applications.
- ✓ Improvement of formability in Interstitial Free High Strength (IF-HS) Steel.
- ✓ Reduction in mill load of HSM Stand (1, 2 & 3) for TMBP-2.

- ✓ Development of high carbon graphitic steels with enhanced drawability.
- ✓ Development of advanced high strength steels (AHSS) with superior weldability aiming plug type nugget of diameter $<6\sqrt{t}$
- ✓ Development of X-70 linepipe steel through TSCR for non-sour environment.
- ✓ Optimisation of microstructure of TFF tubes for eliminating the defects during processing.
- ✓ Designing of microstructure in medium/high carbon steels for superior properties using electro pulsing.
- ✓ Improving tensile properties of low-carbon steels by rapid annealing technique.

RECOGNITIONS/AWARDS

Awards/Honors	Awarding Body	Year Received	Description
Apex Aspire Recognitions-2006 Award	**Tata Steel Limited, Jamshedpur**	2007	• For the project: "Development of interstitial free steel (super extra deep drawing quality) for critical applications (autobody)" at the Managing Director level • Implemented in the plant of Tata Steel Limited, Jamshedpur, India and commercialized since year 2007. • The project was successful in improving the drawability of IF-Ti steel from 1.9 to ~2.29 using batch annealing route. • The work was patented: Title--"Development of batch annealed Ti-stabilized IF steel with improved drawability by optimization of processing parameters" (Granted Patent No. 242358 dt 24.8.10, Govt of India). • A part of the work was also published in the 'Metallurgical and Materials Transactions A', 2007. • Besides, the work was presented at the ATM of IIM and at an international conference in the year 2006. • Subsequently, a project titled "Improvement of formability in interstitial free high strength steel (IF-HS-Ti)" had also been implemented in the plant of Tata Steel Limited, Jamshedpur, India

PUBLICATIONS

Publication in Refereed Journals

- ❑ Kumkum Banerjee and U. K. Chatterjee: Hydrogen Embrittlement of A HSLA-100 Steel in Seawater, ISIJ international, Vol. 39, No. 1 (1999), pp. 47-55.
- ❑ K. Banerjee and U. K. Chatterjee: Hydrogen Embrittlement of a HSLA-80 Steel in Seawater under Cathodic Charging Conditions, Mater. Sci. Technol., Vol. 16 (2000), pp. 517-523.
- ❑ K. Banerjee and U. K. Chatterjee: Effect of Applied Potential On Hydrogen Embrittlement of Weld Simulated Hsla-80 Steel in Seawater, British Corrosion Journal, Vol. 35, No. 4 (2000) pp. 273-278.

- Kumkum Banerjee and U. K. Chatterjee: Hydrogen Permeation and Hydrogen Measurement on Cathodic Charging in HSLA 80 and HSLA 100 Steels, Scripta Materialia, Vol. 44, No. 2 (2001) pp. 213-216.
- Kumkum Banerjee and U. K. Chatterjee: Effect of Microstructure on Hydrogen Embrittlement of Weld-Simulated HSLA-80 and HSLA-100 Steels, Metall. & Mater. Trans. A, Vol. 34, 2003, pp. 1297-1309.
- Kumkum Banerjee and A. D. Rollett: Microstructure and Crystallization Texture of a Low Carbon Strip Cast Steel, Iron and Steelmaker, Vol. 30, No. 6, June 2003, pp. 62-68.
- K. Banerjee, N. Roy, R.N. Ghosh and U.K. Chatterjee: Strain Rate Dependence of Plastic Flow Behaviour of HSLA-100 Steel in Seawater During Cathodic Charging of Hydrogen. K. Banerjee, N. Roy, R.N. Ghosh and U.K. Chatterjee, Trans. Indian Inst. Metals, Vol. 57, No. 6, 2004. pp. 611-616.
- K. Banerjee, N. L. Richards and M. C. Chaturvedi : Effect of Filler Alloys on HAZ Cracking in Pre-Weld Heat Treated in 738LC GTA Weld, Metall. & Mater. Trans. A, Vol. 36, No. 7, July 2005, pp. 1881-1890.
- Kumkum Banerjee: Recrystallization texture evaluation in IF and EDD steels, Tata Search, Vol. 2, 2006, pp. 365-375.
- K. Banerjee: Evaluation of Annealing Texture in IF and EDD Steels, Materials and Manufacturing Processes, Vol. 22, 2007, pp. 462-468.
- Kumkum Banerjee: Evolution of Annealing Texture in Ti-Stabilized interstitial Free Steel, Steel Grips, Vol. 6, No. 4, 2008, pp. 278-282.
- K. Banerjee, A. K.Verma and T. Venugopalan: Improvement of Drawability of Titanium-Stabilized interstitial-Free Steel by Optimization of Process Parameters and Texture, Metall. & Mater. Trans. A, Vol. 39, No. 6, 2008, pp.1410-1425.
- K. Banerjee and T. Venugopalan: Development of Hypoeutectoid Graphitic Steel for Wires, Mater. Sci. Technol., Vol. 24, No. 10, 2008, pp.1174-1178.
- Kumkum Banerjee, Matthias Militzer, Michel Perez and Xiang Wang: Non-Isothermal Austenite Grain Growth Kinetics in A Microalloyed X-80 Linepipe Steel, Metall. & Mater. Trans. A, Vol. 41, Dec, 2010, pp.3161-3172.
- Kumkum Banerjee, Michel Perez and Matthias Militzer: Non-Isothermal Austenite Grain Growth Kinetics in The HAZ of A Microalloyed X-80 Linepipe Steel, Solid State Phenomena, Vols. 172-174, 2011, pp 809-814.
- Kumkum Banerjee: The Role of Magnesium in Superalloys—A Review, Materials Sciences and Applications, Vol. 2, No. 9, 2011, pp. 1243-1255.
- Kumkum Banerjee, Michel Perez and Matthias Militzer: Austenite Grain Growth Kinetics During Continuous Heating of A Microalloyed X-80 Linepipe Steel, Materials Science Forum, Vols. 715-716, 2012. pp. 292-296.
- Kumkum Banerjee, Krishnan Balasubramaniam and Issac Anto: Ultrasonic focused C-Scan imaging for the determination of weld quality of resistance spot welded nuggets in advanced high strength steel, J Non-Destructive Testing and Evaluation, Vol. No. 3, Dec 2012, pp. 43-48.
- Kumkum Banerjee: Role of Base Metal Microstructure on Tensile Properties and Weldability of Simulated Continuously Annealed Advanced High Strength Steels, International Journal of Metallurgical Engineering, Vol. 2, No. 1, 2013, pp. 100-110.
- Kumkum Banerjee: Improving Weldability of an Advanced High Strength Steel by Design of Base Metal Microstructure (Accepted and under publication in *Journal of Materials Processing Technology*)
- Kumkum Banerjee: Hydrogen Induced Cold Cracking in High Frequency Induction Welded Steel Tubes (Accepted for publication in *Metallurgical and Materials Transactions A).*

Publication in Conference Proceedings

- Kumkum Banerjee and U. K. Chatterjee (1998): Hydrogen induced cracking of HSLA steels in seawater under potentiostatic conditions. Published in the Proceedings of the Third Pacific Rim International Conference on Advanced Materials and Processing (PRICM 3) (eds. M. A. Imam, R. DeNale, S. Handa, Z. Zhong and D. N. Lee), The Minerals, Metals & Materials Society (TMS), pp. 173-177, at Honolulu, Hawaii, USA, July 12-16, 1998.
- Kumkum Banerjee and U K Chatterjee (2000): Microstructural dependence of hydrogen embrittlement in HSLA 80 and HSLA 100 steels (Invited paper). Published in the Proceedings of the International Conference on Processing and Manufacturing of Advanced Materials (THERMEC 2000) (eds. T. Chandra, K. Higashi, C. Suryanarayana & C. Tome) at Las Vegas, USA, December 2000.
- Kumkum Banerjee and A. D. Rollett (2002): Recrystallization and texture behavior of a low carbon strip cast steel. Published in the Proceedings of the International Conference on Advanced Materials and Materials Processing (ICAMMP-2002) (eds. N. Chakraborty and U. K. Chatterjee), pp. 431-435, Indian Institute of Technology, Kharagpur, India, 1-3 February 2002.
- U. K. Chatterjee, K. Banerjee and A. K. Chakrabarti : An experience in the development of corrosion resistant reinforcement steel. Published in the Proceedings of the International Workshop and Conference on Construction Management and Materials (CONMAT 2003), Indian Institute of Technology, Kharagpur, India, 9-11 January 2003, 511-515.
- K. Banerjee, N. L. Richards and M. C. Chaturvedi: Published in the proceeding of American Welding Society on Recent Advances in Materials Processing Technology (RAMPT), 2005.
- K. Banerjee: Evaluation of annealing texture in IF and EDD steel sheets. Published in the proceedings of International Conference on Advanced Materials and Materials Processing (ICAMMP-2006), Indian Institute of Technology, Kharagpur, India, 3-5 Feb., 2006.
- K. Banerjee, A. K. Verma and T. Venugopalan: Improvement of drawability of Ti-stabilized interstitial free high strength steel. Published in the Proceedings of International Conference “Microalloying 2007”, Bengal Engineering and Science University, Shibpur, Kolkata, India, 9-11 March, 2007.
- K. Banerjee and U. K. Chatterjee: Hydrogen embrittlement of HSLA-80 and HSLA-100 steels (*Invited Paper*). Published in the Proceedings of International Conference “Microalloying 2007”, Bengal Engineering and Science University, Shibpur, Kolkata, India, 9-11 March, 2007.
- Kumkum Banerjee, M. Perez and M. Militzer: Non-Isothermal Austenite Grain Growth Kinetics in the HAZ of a Microalloyed X-80 Linepipe Steel. Published in the Proceedings of International Conference “Solid-Solid Phase Transformations in Inorganic Materials”, PTM 2010, held in Avignon, France, during 6-11 June, 2010.
- Kumkum Banerjee, Michel Perez and Matthias Militzer: Austenite grain growth kinetics during continuous heating of a microalloyed X-80 linepipe steel. Published in the Proceedings of International Conference ReX & GG IV 2010 held in Sheffield, UK during 4-9 July 2010.
- Kumkum Banerjee: Role of base metal microstructure on tensile properties and weldability of simulated continuously annealed advanced high strength steels. Published in the Proceedings of 3rd International Conference “Thermomechanical Simulation and Processing of Steel” (SimPro 2012), held in RDCIS SAIL Ranchi, India during 12-14 Dec, 2012.

Presentation at Conferences and Workshops

- Kumkum Banerjee, B. Sasmal and U.K. Chatterjee: Some studies on hydrogen induced cracking in a HSLA-100 steel by slow strain rate technique. Presented at the 50th Annual Technical Meeting (ATM) of Indian Institute of Metals, New Delhi, held in Nov., 1996.
- Kumkum Banerjee and U. K. Chatterjee: Environmental assisted cracking of HSLA-100 steels in seawater under cathodic protection conditions by slow strain rate technique. Presented at the Indo-US Project Review Meeting, New Delhi, held in March 1997.
- Kumkum Banerjee, B. Sasmal and U. K. Chatterjee: Hydrogen-induced cracking of HSLA-100 steel by slow strain rate technique. Presented at the 51st ATM of Indian Institute of Metals, Jamshedpur, held in Nov., 1997.
- Kumkum Banerjee and U. K. Chatterjee: Hydrogen embrittlement of HSLA-80 steel in weld simulated conditions with different heat inputs. Presented at Annual Technical Meeting of Indian Institute of Metals, Kanpur, held in Nov., 1999.
- Kumkum Banerjee and U. K. Chatterjee: Hydrogen embrittlement of weld simulated HSLA steels. Presented at the Indo-US meeting at Washington DC, USA, held in May 2000.
- K. Banerjee, N. Roy, R. N. Ghosh and U. K. Chatterjee: Mathematical modeling of plastic flow behavior of a cathodically charged HSLA-100 steel in seawater. Presented (poster) at the Annual Technical Meeting of Indian Institute of Metals, Bhubaneshwar, held in Nov., 2001
- O. A. Ojo, K. Banerjee, N. L. Richards and M. C. Chaturvedi: On the liquation cracking of cast Inconel 738LC superalloy. Presented at 15th Canadian Materials Science Conference, Nova Scotia, Canada, held in June 2003.
- K. Banerjee and U. K. Chatterjee: Microstructural variation of HAZ in weld-simulated microalloyed HSLA-80 and HSLA-100 steels. Presented at the workshop on 'Cast and Forged Microalloyed Steels' at Ispat Niketan, Bullygunge Circular Road, Kolkata, held in Dec. 2005.
- K. Banerjee and T. Venugopalan, Improvement of drawability of Ti stabilized interstitial free steel. Presented at the 60th Annual Technical Meeting (ATM) of Indian Institute of Metals, Jamshedpur, held in Nov., 2006.
- K. Banerjee and T. Venugopalan: Study of precipitation behaviour and texture in a Ti-stabilized interstitial free steel. Presented at the 61st ATM of Indian Institute of Metals, Mumbai, held in Nov., 2007.
- K. Banerjee, A. K. Verma and T. Venugopalan: Improvement of drawability of Ti-stabilized interstitial free high strength steel. Presented at the International Conference "Microalloying 2007", Bengal Engineering and Science University, Shibpur, Kolkata, India, 9-11 March, 2007.
- K. Banerjee and U. K. Chatterjee: Hydrogen embrittlement of HSLA-80 and HSLA-100 steels (*Invited Paper*). Presented at the International Conference "Microalloying 2007", Bengal Engineering and Science University, Shibpur, Kolkata, India, 9-11 March, 2007.
- Kumkum Banerjee, Michel Perez and Matthias Militzer: Prediction of austenite grain size in the presence of growing particles in the weld HAZ of a X-80 linepipe steel. Presented at the 63rd ATM of Indian Institute of Metals, Kolkata, held in Nov., 2009.
- Kumkum Banerjee, M. Perez and M. Militzer: Non-isothermal austenite grain growth kinetics in the HAZ of a microalloyed X-80 linepipe steel. Presented at the International Conference on Solid-Solid Phase Transformations in Inorganic Materials, PTM 2010, held in Avignon, France, during 6-11 June, 2010.
- Kumkum Banerjee, Michel Perez and Matthias Militzer: Austenite grain growth kinetics during continuous heating of a microalloyed X-80 linepipe steel. Presented at the ReX & GG IV 2010 International Conference, held in Sheffield, UK during 4-9 July 2010.
- Kumkum Banerjee: Role of base metal microstructure on tensile properties and weldability of simulated continuously annealed advanced high strength steels, Presented at the 3rd International Conference

"Thermomechanical Simulation and Processing of Steel" (SimPro 2012), held in RDCIS SAIL Ranchi, India during 12-14 Dec, 2012.

- Kumkum Banerjee: Presentation of NITK Metallurgical course curriculum at the TEQIP Workshop on the discussion of Metallurgical and Materials Curricula at NITs and IITs at NIT Srinagar during 8-9 Oct, 2015.
- Kumkum Banerjee, Soudip Basu and Ashish Mukherjee: Microstructural Modification in Cold Drawn High Carbon Steel Wires using Electropulsing. To be presented at Annual Technical Meeting of Indian Institute of Metals, to be held in Coimbatore, India during 13-16 Nov., 2015.
- Kumkum Banerjee: *Invited for Keynote* lecture at the International Conference on Thermo-mechanical Simulation and Processing of Steels, SimPro' 16, to be held in RDCIS, SAIL Ranchi, India during 10-12 Feb 2016.

BOOK CHAPTER

Book Chapter Title (*Invited*): "Physical Metallurgy and Drawability of Extra Deep Drawing and Interstitial Free Steels" for the book--"Recrystallization", ISBN 978-953-51-0122-2, Ed. Krzysztof Sztwiertnia, Publisher—InTech, March, 2012.

PATENTS

- Development of Batch Annealed Ti-Stabilized IF Steel with Improved Drawability by Optimization of Processing Parameters (**Granted** --Patent No. 242358 dated 24 Aug. 2010, Govt. of India).
- Development of graphitic steel for wires (**Granted** --Patent No. 266385 dated 8 May 2015, Govt. of India).
- A novel etching technique for the determination of prior austenite grain size in low carbon microalloyed high strength steel (**Published**--Application No. 172/KOL/2010 dated 23 Feb 2010).
- A cooling system for post-heat treatment cooling of cold-worked steel sheets to produce dual phase steels (**Published**--Application No. 367/KOL/2012, 30 March 2012).
- Developing defect free weldable dual phase steels of tensile strength >650 MPa by base metal microstructural engineering (**Filed**--Application No. 956/KOL/2013, 16 Aug 2013).
- A new physical simulation method for making low carbon-microalloyed X-70 linepipe steels through thin slab casting direct rolling route (**Filed**--Application No. 776/KOL/2015, 9 Jul 2015).
- A novel technique for making an 1-kV electropulsing generator for generating favourable microstructure in steel. (*filing under process*)
