Summary Report

About Department/Center/School: The Department had its inception in 1956. Over the years, the Department has developed excellent expertise in the areas of Extractive and Physical Metallurgy, Manufacturing Processes, Mechanical Behaviour of Materials, Nano-Science and Technology, Modelling and Simulation, Surface Engineering, Powder Metallurgy and Environmental Degradation of Materials. The Department takes pride for its wide spectrum of state of the art laboratories both for teaching and research purposes. Keeping its tradition for producing world class metallurgists, the Department has actively diversified to advanced materials for addressing today's technological challenges in renewable energy and healthcare. The Department has provided the required manpower for sustainable growth in India's backbone of steel industry and continues to do so even today with the establishment of "Steel Technology Center" at IIT Kharagpur.

1. Academic Programs (Range of Degrees and Disciplines):

i) ***B.Tech*** *– 4 years' duration*
ii) ***Dual Degree*** *(B.Tech +M.Tech) – 5 years' duration*
iii) ***M.Tech -*** *2 years' duration*
iv) ***Ph.D***

2. Major 4-5 Thrust Areas of Research: *i) Classical Metallurgy & Materials Science; ii) Advanced Materials; iii) Computational Materials Science; iv) Corrosion and Surface Engineering, and v) Iron and Steel Technology.*

3. Curriculum and Courses & Teaching Environment

Items	**Ratio/ Number**	**Items**	**Number/%**
Teacher-student Ratio	**1:11.2**	Average No. of students motivated (%) to opt of careers Eng/ Tech. Sectors UG/PG/PhD	**60/55/40**
No. of Faculty members as on today	**26**	Average No. of students motivated (%) to opt of careers in Science sectors UG/PG/PhD	**10/40/60**
Average No. of Tutorial Assistants	**58**	No. of teaching labs	**10**
No. of UG/DD students	**128/80**	Average No. of students per experiments in core courses	**4-6**
No. of PG students/PhD students	**68/65**	No. of Students' workshops/``Tinkering'' Labs	**0**
Average no. of tutors with more than 100 students	**01**	No. of new courses introduced	**UG: 19 PG/PhD: 12**
Average Students placements (%) (UG/DD/PG)	**88/94/55**	No. of New program introduced	**01**
No of major curriculum review in both UG & PG level	**01**	Undergraduate Vs PhD strength expressed as Percentage	**31**

No of UG lab (teaching labs) developed/set-ups	**01**	No of PG/research labs developed/new set up	**11**
No of E class rooms	**07**	No. of lab classes per week	**12**
Average No. of Course done per student for B. Tech/DD/M. Tech/Ph.D	**51/57/14/4**	No. of core/elective/seminar/ projects subjects taken for B. Tech, DD, and M. Tech respectively	**29/14/01/02 30/18/01/04 05/12/02/02**

4. Research and Development & its Environment

Items	**Number**	**Items**	**Number**	**Items**	**No.**
Total No. of Publications in Journals (2008-13)	**525**	Average no. of citation per paper	**6.62**	No of large interdisciplinary research projects	**20**
Total No. of Publications in Conference & Symposium	**47**	Average Journal publication per year	**87.5**	Number of Int. conf./workshops attended by students	**32**
Total No of Books & e-books published	**03**	h-Index of the department since 2008/overall h-index in Scopus	**24**	No. of PDF hired in the Institute	**0**
Total No of Edited Conference Proceedings/book chapters	**01**	Number of papers with citation more that the average no. of citation of the Journals	**---**	No. of international Students as PhDs/PDFs	**0**
Total No. of Technology Developed/transferred	**01**	No. of recognitions & Awards, fellows etc to faculty/students (provide break up if necessary)	**36**	No. of International visiting researchers/adjunct faculty stayed here for at least a week	**02**
Total No. of Patents Filed/Obtained	**06/01**	Average Retention(%) of Young faculty for at least 10 years	**91%**	No. of short courses/workshops /conf. organized with international participations	**01**
Total No. of Copyright Filed/Obtained	**01**	No. of Sponsored research Project /fund(lakh) generated from non-internal source	**78/5940**	Average No. of PhD granted per year	**8.6**
No. of Publications per Faculty/Masters/PhD students	**20.1/ 3.01/7.27**	No. of Consultancy /fund (lakh) generated from non-internal source	**43/290**	Average No. of PhD Granted per year per faculty	**0.33**
No. of Publications per Faculty/Masters/PhD students in Top Ten Journals as Identified by the department	**18/2/6**	No of Internal and external Collaborations research papers/research projects/PhD	**136/41/34**	Patent granted per faculty	**0.04**

		students			
Average No. of Citation per faculty per year	**28.8**	No of M. Tech students motivated into pursuing PhD/PhD graduates motivated to pursue career in Academics(abroad or IIT etc)	**30/60 (%)**	Number of articles in collaborations with Ten countries*	**31**
Ranking of the department in terms of average citations per paper within the Institute	**05**	Ranking of the department in terms of total number of Journal publications within the Institute/ publications per faculty	**03**	No of articles of the dept. contributing towards h-index of the Institute since 2008	**04**

5.External Stakeholder Engagement and others

Items	**Number**	**Amount Lakh**
No. of PhD/Master students' thesis funded by Industries	**25**	
Total number of Industry sponsored projects and its income (Lakh)	**30**	**204**
No. of Curriculum Development Initiative for Industries	**02**	
No of Technology transfer/adopted by Industry/Labs	**01**	
No. of Nationally relevant research projects	**135**	
No of Policy inputs/consultancies provided	**43**	
No. of Research grant and seed money from internal savings of the Institute per young faculty of the department and its total fund	**1**	**4.5,** **32**
No. of Community Relevant projects	**0**	

6. Vision for the Future (in brief):

(a) Departments/centers/schools should spell out its Mission and Vision Statements, (b) Plans for future to achieve the projected goals and (c) measures adopted towards above.

Consistent with the Mission and Vision of the Institute, the Department aims to establish itself as a global leader in frontier areas of Metallurgical & Materials research and education so that it can effectively cater to the growing needs of industry, academia and research institutions of India. Excellence in teaching and research is the key element of this vision and the Department has set clear-cut objectives and strategies to realize this vision.

A thorough road-map has been chartered to achieve the goals and effective ways to monitor the progress and suggest course-correction have been devised.

7. External peer review of the Dept./centre/schools (in brief): (a) Date: February 2013

(a) Name of the Experts involved and their affiliations in short:

Professor H.S Ray, Ex. Director IMMT, Emeritus Scientist, CGCRI, Kolkata
Professor R.K Ray, Ex. Professor IITK, Advisor Tata Steel.

(b) Overall recommendations of the peer review committee: Strengths, weaknesses, suggestions and comments

i) Experts feel to lay emphasis and encourage teachers for their efforts in teaching. They also felt that excellence in teaching should be given due credit through awards and putting teaching as one of the criteria in faculty selection procedure.

ii) Department should hire at least 10 permanent qualified technicians for training of PG students for use and maintenance of the various research instruments. This exercise should be carried out under the supervision of faculty members. Experts justified their suggestion based on the large amount of fund the department attracts from sponsored research programs, many of which require instrumental supports.

iii) Department should consider for introduction of a course on "Experimental Techniques" to be supported by laboratory experiments, some of which may come from the existing laboratory curricula.

(c) Measures adopted/action taken at the department level to address the recommendations of the peer review report:

i) According to the reviewer's suggestion, the request for acknowledging teachers has been forwarded to the institute and the institute is taking the necessary actions.

ii) As par the suggestion, the department has requested for 26 staff members for various laboratories.

iii) We thank the reviewers for their suggestion regarding introducing new course on "Experimental Techniques". However, introducing a single course on "experimental techniques" will undermine the vast experimental techniques used in research purposes. Therefore, the existing curriculum was designed to cover almost all of the experimental techniques through multiple courses.

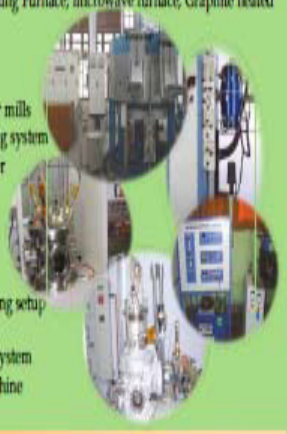
Important Highlights

RESEARCH FACILITIES

The Department of Metallurgical and Materials Engineering has augmented state-of-the-art laboratory facilities over the years. The Central Research Facility of the Institute also acquired world class research infrastructure of the Department.

PROCESSING: SYNTHESIS and FABRICATION

1. Different furnaces like High frequency vacuum induction melting furnace, High Temperature Muffle and tube Furnaces, Fluidized Bed Furnace and Tungsten Inert Gas Arc Melting Furnace, microwave furnace, Graphite heated (~ 2200°C) furnaces.
2. Hot and cold rolling mill
3. Hydraulic hot forging press
4. High energy ball and attritor mills
5. RF/DC magnetron sputtering system
6. High temperature viscometer
7. Hot press
8. Pulsed laser deposition
9. Rheometer
10. Ultrasound Casting setup
11. Rapid solidification processing setup
12. Spin coater
13. Electron beam evaporation system
14. Electron beam Welding Machine



MECHANICAL and FUNCTIONAL PROPERTIES ASSESSMENT

1. Universal testing machine
2. Creep testing machine
3. Macro/micro/nano hardness tester
4. Rotating bending fatigue testing machine
5. Impact testing machine
6. Ball/pin on disk and Fretting Wear testing machine
7. Young's modulus determination (natural and ultrasonic frequency)
8. Thermal conductivity: Solid and liquid
9. DTA/TMA analyzers
10. Dilatometer
11. LCR meter
12. Potentiostat/galvanostat
13. Source meter and resistivity measurement facility
14. P-E, P-T Loop tracer

PHASE, COMPOSITIONAL and MICROSTRUCTURAL ANALYSIS

1. X-ray diffractometer
2. High Resolution X-Ray Diffractometer with hot stage,
3. residual stress and Texture goniometer attachments
4. Glancing Angle X-ray Diffractometer
5. Differential Thermal Analyzer
6. Differential Scanning Calorimeter
7. Transmission Electron Microscope
8. High Resolution Transmission Electron Microscope
9. with EDS and Liquid Nitrogen Cooled Stage
10. Scanning Electron Microscope with EDS, WDS and EBSD
11. Field emission scanning electron microscope with EDS and EBSD
12. Optical microscope with hot stage attachment and Image Analysis
13. Atomic Force Microscope
14. Atomic Absorption Spectrometer
15. Surface Stylus Profilometer
16. BET Surface Area Measurement
17. He-pycnometry
18. Raman Spectrometer
19. Wavelength Dispersive X-ray Fluorescence

THRUST AREAS

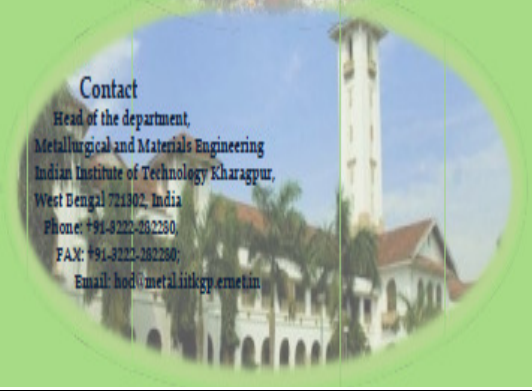
CLASSICAL METALLURGY AND MATERIALS SCIENCE	COMPUTATIONAL MATERIAL SCIENCE
Extractive Metallurgy Solidification and non-equilibrium processing Metastable alloys and Phase transformation Deformation and fracture behaviour Joining of metals Corrosion behaviour and high temperature oxidation Powder Metallurgy	Modeling and simulation in ferrous and non-ferrous metallurgy, phase transformation and Solidification Molecular dynamics Design and scale-up of metallurgical processes Genetic algorithms in materials design and processing First principle based modelling of various systems
IRON AND STEEL	**ADVANCED MATERIALS**
Raw material processing and mineral beneficiation Alternative routes of iron making Advanced auto-grade steel Improvement in mechanical properties like creep, fatigue, fracture and non-destructive testing Blast furnace modeling using thermodynamic and data-driven strategies	Composites & functionally graded materials Nanomaterials and nanocomposites Surface engineering & Interfacial phenomena Thin film & coatings Biomaterials Energy materials: Lithium ion battery, Solid oxide fuel cells (SOFCs), Hydrogen storage

FACULTY

- Acharya Narendra Nath, Associate Prof., Research Area: Particulate Tech. (metals, non-metals), Modeling (Artificial Neural Network & Genetic Algorithm), Multimedia
- Alok Sharma, Associate. Prof., Research Area: Rapid Solidification, Magnetic Materials, Bio Materials, Surface Modifications, Shape Memory Alloy, Core-Shell Nanostructures
- Bandyopadhyay Tapas Kumar, Asst. Prof., Research Area: Metal Matrix Composite, Material Processing, Intellectual Property-Transaction, Policy
- Bhaduri Amit, Asst. Prof. Research Area: Mechanical Properties and Working of Metals & Alloys, Heat Treatment of Steel.
- Biswas Koushik, Associate. Prof., Research Area: Bio-, Structural-, Electro-ceramics, Energy Materials (SOFC, LIB, H2-storage), Tribology, Composites, Modeling
- Chakrabarti Debalay, Associate. Prof., Research Area: Microstructure Property Correlation, Thermo-Mechanical Processing, Fracture Behaviour
- Chakraborti Nirupam, Prof., Research Area: Computational Materials Science, Genetic Algorithms, Process Metallurgy
- Chakraborty Madhusudan, Prof., Research Area: Solidification Processing, Scanning Electron Microscopy, Metal Matrix Composites, Ti-based Alloys
- Das Jayanta, Asst. Prof., Research Area: Metastable Alloys, Solidification, Phase Transformation, Fracture
- Das Karabi, Prof., Research Area: Metal Matrix Composites, Nanocomposites, Physical Metallurgy, Powder Metallurgy, Wear of Materials
- Das Siddhartha, Prof., Research Area: Physical Metallurgy, Nanomaterials & Nanocomposites, Surface Engineering, Electron Microscopy, Tribology, Failure Analysis
- Dutta Majumdar Jyotsna, Prof., Research Area: Surface Engineering, Laser Materials Processing, Electron Beam Assisted Materials Processing, Biomaterials, Corrosion
- Manna Indrani, Prof., Research Area: Nanocrystalline Materials, Surface Engineering, Mathematical Modeling, Material Development
- Ghosh Sudipto, Associate Prof., Research Area: Process Modeling, Solidification Processing, Deformation Behavior, Lithium Ion Batteries
- Ghosh Rabindra Nath, Chair Professor, Research Area: Physical & Mechanical Metallurgy, High Temperature Materials: Steel & Superalloys, Modeling, Simulation & Failure Analysis
- Kar Sujoy, Asst. Prof., Research Area: Materials Modeling, Alloy Design, Micro-mechanistic Study of Deformation, Microstructure & Microtexture Evolution
- Kundu Tarun Kumar, Asst. Prof., Research Area: Extractive Metallurgy, Mineral Processing, Atomistic Simulation, Synthesis of Nanomaterials by Wet Chemical Route
- Laha Tapas, Asst. Prof., Research Area: Nanomaterials and Nanocomposites, Interfacial Phenomena, Surface Engineering and Coating, Nanotribology
- Manna Indrani, Prof., Research Area: Nanocrystalline Materials, Surface Engineering, Mathematical Modeling, Material Development
- Mitra Rahul, Prof., Research Area: Materials for High Temperature Applications, Composite Materials, Nanocrystalline Materials
- Pabi Shyamal Kumar, Prof., Research Area: Nano structured Materials, Phase Transformation in Materials, Refractory Alloys, Mathematical Modeling
- Ray Kalyan Kumar, Prof., Research Area: Mechanical Metallurgy, Fracture Mechanics, Nondestructive Evaluation, Structural Integrity, Failure Analysis
- Roy Gour Gopal, Prof., Research Area: Modeling and Simulations in Process Metallurgy, Alternative Routes of Iron making, Secondary Steelmaking
- Roy Mangal, Asst. Prof., Research Area: Biomaterials, Ceramics, surface modification
- Roy Sarat Kumar, Prof., Research Area: Mineral Processing, Extractive Metallurgy, Environmental Degradation of Materials, Nano-ceramics, Laser Materials Processing
- Sarit Sudhindra B, Associate Prof., Research Area: Semiconductor Thin Films, Spintronics, Photovoltaics, Piezoelectric Thin Films and Creation of MEMS Devices
- Sen Indrani, Asst. Prof., Research Area: Ceramics
- Sen Prodip Kumar, Chair Professor, Research Area: Design & Scale-up of Metallurgical Processes, Modeling and Simulation of Iron Making Processes, Process Metallurgy
- Singh Shiv Brat, Prof., Research Area: Physical Metallurgy of Steel

Department of Metallurgical and Materials Engineering
Indian Institute of Technology Kharagpur

Practice of knowledge in "metals and materials" has remained the primary foundation behind the technical and economic progress of our Nation and for more than five decades now, the Department of Metallurgical and Materials Engineering at IIT Kharagpur has been making enormous contributions towards this progress. The department had its inception in 1956 and over the years, it has developed into one of the best places for academics and research oriented studies in metals and materials, be it in extractive or physical metallurgy, surface engineering, corrosion engineering, modeling and simulation, mechanical properties of materials, powder metallurgy or recent advancements in the field of advanced materials like nanomaterials and nanocomposites, biomaterials, ultra-high temperature ceramics, solid oxide fuel cells or lithium-ion batteries to name a few. Needless to say, the department has excellent laboratory facilities with sophisticated instruments, backed by highly qualified staff to help the students and scholars in carrying out their academic and research activities successfully.



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