

Rahul Bhattacharya
Industriell Produktion
Adresstyp: Besöksadress.
Ole Römers väg 1F
22363
Lund
Sverige
Adresstyp: Postadress.
Box 118
221 00
Lund
Sverige
E-post: rahul.bhattacharya@iprod.lth.se
Mobil: +46769710234



Forskning

Dr. Rahul Bhattacharya

Metallurgical & Materials Engineer | Project Manager | Extractive Metallurgy | Powder Metallurgy | Hard Materials | Steel | High entropy alloys | High-Temperature Materials | Advanced Electron Microscopy | Advanced Materials Characterization Techniques | Furnace operations | Sustainable Metals Innovation

Dr. Rahul Bhattacharya is a **Metallurgical and Materials Engineer** with **12 years** of combined industrial and academic experience driving innovation across ironmaking, steelmaking, powder metallurgy, cemented carbides, hydrogen-based reduction, advanced alloys, and safety-critical furnace operations. His work integrates industrial metallurgy and manufacturing processes with advanced material characterization and microscopy-driven fundamental research, enabling process optimization and sustainability to develop and implement energy-efficient, fossil-free, sustainable and circular metallurgical solutions.

His expertise spans powder metallurgy, cemented carbides, steels, high-entropy alloys, advanced characterization techniques and high-temperature material behavior, with a strong focus on thermodynamics, kinetics, and process-microstructure-property relationships. Rahul specializes in alloy development, process development, process optimization, furnace sintering, FAST sintering and gas handling. His ongoing research emphasizes on in-operando atomic-scale observation of gas-metal interactions using High-Resolution Environmental TEM (ETEM at nCHREM) during in-situ gas experiments at elevated temperatures, providing direct insight into phase transformations, diffusion, wettability, and sintering mechanisms governing material performance and process efficiency.

Academic & Professional Background

Rahul holds a **Ph.D. in Metallurgical and Materials Engineering** through a Joint Cotutelle Doctoral Program, a **Master's degree** specializing in powder metallurgy, sintering, oxidation, material degradation, compositionally complex alloys, and advanced high temperature alloys, and a **Bachelor's degree in Metallurgical Engineering**. His career uniquely combines large-scale industrial operations with advanced academic research, gaining hands-on experience and skillsets acquired over 12 years on:

Advanced characterization techniques: (In-situ studies under gas environments in Environmental-TEM at elevated temperatures, BF/DF imaging, STEM, X-EDS, CVD-TEM, HAADF, ADF, Electron Diffraction, NBD, SAED, NanoMEGAS ASTAR Precession Diffraction, HR-SEM, EDS, EBSD, XRD, DSC/TGA, Glow Discharge OES)

Iron and steelmaking: MIDREX, pelletization, EAF/LF operations, furnace operation and maintenance, H₂ based solid-state reduction)

Furnace operations: (Safety-critical processes like Sintering, Heat treatment, Vacuum, EAF, LF) along with associated gas handling systems and procedures

Manufacturing processes: Brazing, joining, welding, casting, metal working, rolling (HR, CR), and forging

Powder metallurgy: Mechanical alloying, Ball milling, Solid-state and Semisolid-state sintering, FAST/SPS, Furnace sintering, and nanocrystalline alloys

Cemented carbides, other Hard materials and binders (Co-based, Fe/Ni-based, Steel-based, HEA-based)

Alloy design and Microstructural engineering: (Bimodal grain structure, Oxide dispersion strengthening, solid solution strengthening, grain boundary engineering, crystallographic template effect)

Synthesis, advanced characterization, design, and structure-property-performance correlations in cemented carbides, high entropy alloys, steels, and transition metals (Co, Fe, Ni, Cr) based binders

Mechanistic studies: Binder systems, High temperature oxidation and Materials Degradation

Thermodynamic and kinetic studies of high temperature alloys, metallic materials, and nanomaterials

At **ArcelorMittal Nippon Steel India**, Rahul gained first-hand experience in **gas-based iron ore reduction, EAF/LF Operations, process optimization, steelmaking operations, and Technology Development and Coordination** division, developing a strong foundation in large-scale metallurgical manufacturing and a safety first approach.

His research career includes appointments at **IIT Madras (India), Deakin University (Australia), the Austrian Academy of Sciences (Erich Schmid Institute, Leoben), and Lund University (Sweden)**, advancing **microscopy-driven process development, solid-state reduction, powder metallurgy, compositionally complex alloys, and low-temperature sintering strategies for cemented carbides.**

Research Focus

Rahul's current research focuses on **enhancing binder wettability, flowability, and capillary-driven rearrangement in cemented carbides**, enabling **low-temperature densification of WC-Co systems**. By leveraging **in-situ formation of transient phases (TMPs)** that rapidly dephosphorize above 1200 °C, his work demonstrates pathways applicable to **Co-, Fe/Ni-, steel-, and HEA-based binders.**

Using **in-situ Environmental TEM** and **other advanced characterization techniques**, he directly visualizes **gas-solid reactions, diffusion, and phase evolution at atomic resolution**, particularly at **WC/binder interfaces**, linking nanoscale mechanisms to macroscopic sintering and reduction behavior.

Core Research Areas:

Cemented carbides and advanced binder systems

Nanocrystalline materials and grain growth studies

Material evaluation, material testing and product development

Material behaviour at high temperature and pressure

Hydrogen-based solid-state reduction of Fe, Ni, Co, Cu, and Cr oxides

Gas actuated Bonding, Semi-solid and Solid state sintering, Joining, Brazing, Casting, Welding, Forging, and Machining

Powder metallurgy, Furnace sintering, and FAST/SPS

Thermodynamic & kinetic modeling of reduction and oxidation

Microstructure-process-property optimization

Oxidation, degradation, and failure of advanced alloys

Fossil-free solid-state ironmaking routes for metal powder production

Industrial Experience

Deputy Manager – Steelmaking Operations

ArcelorMittal Nippon Steel India (formerly *Essar Steel*), *Surat, India*

June 2010 – December 2013

As part of one of India's most advanced **integrated steel plants utilizing Midrex-based Direct Reduction of Iron (DRI) technology**, I gained extensive industrial experience in **Technology Development and Coordination (TDC) Cell, Electric Arc Furnace (EAF), Ladle Furnace (LF) operations, vacuum degassing (VD/RH), and continuous casting**. My work focused on producing high-quality steels, low carbon grades, **interstitial-free (IF) steels**, and **boiler pressure vessel grades**, ensuring metallurgical consistency and superior mechanical properties.

Key Responsibilities and Achievements:

Process Optimization & Energy Efficiency: Planned and executed **Ladle Furnace (LF) processing, VD/RH treatment, and continuous casting of sequential heats** of critical grades (like IFS01, IFS02, IFH01, HSS, BPV, LNC) reducing caster power consumption, minimizing end cuts, and getting cost saving.

Feed Mix and Yield Improvement: Developed and implemented **new feed mix combinations** based on process requirements of the Steel Melting Plant, including the optimized use of **low-metallic Fe Cold DRI fines**, significantly enhancing EAF yield and energy utilization.

Operational Streamlining: Reduced **heat processing and turnaround time** by optimizing tapping, LF processing, and casting sequences, enhancing energy efficiency, furnace availability, and throughput.

Standard Operating Procedures (SOPs): Designed and implemented **SOPs for EAF operations** using variable feed mixes (hot metal, hot DRI, cold DRI, scrap, DRI fines), ensuring stable melting conditions and reducing process variability.

Ladle Furnace Operations: Served as **Ladle Furnace Operator**, directly contributing to the **development and refinement of transformer-grade high-silicon steels, interstitial-free steels, extra-deep-drawing steels, and high-strength steels.**

Cost & Material Efficiency: Implemented **cost-saving alloying practices** and **optimized secondary refining processes, and balancing material as well as energy efficiency** with product performance

Current Work & Collaborations

Rahul is currently part of the **VINNOVA-funded UGAF Project** and **ERC project**, collaborating with **Seco Tools, Alfa Laval, Linde, and Thermo-Calc**, alongside **A/Prof. Filip Lenrick** and **Dr. Martin Ek** at **Lund University**. His research at the **National Center for High Resolution Electron Microscopy (nCHREM)** focuses on **in-situ gaseous reactions of metals, alloys, oxides, carbides, binders, and hard materials**, supporting **Sweden's vision for fossil-free manufacturing and circular materials innovation.**

Professional Strengths

Integration of **process metallurgy, alloy design, powder processing, manufacturing, and advanced characterization**

Strong skills in **experimental design, thermodynamic modeling, and process simulation**

Proven **project management** in multi-stakeholder industrial-academic collaborations

Experience in **teaching, supervision, patents, technical reports, and peer-reviewed publications**

Fluent in **English**; actively learning **Swedish** (Swedish for University Staff, Lund University and SFI C)

Anställning

Postdoc

Industriell Produktion
Lunds universitet
Lund, Sverige
2024 mars 22 → present

Research Scientist

Erich Schmid Institute of Materials Science
Leoben, Österrike
2023 feb. 1 → 2024 apr. 1

Master Thesis Exchange Student

Deakin University
Warrnambool, Australien
2015 jan. 1 → 2015 juni 1

Deputy Manager (Operations of Steel Melting Shop)

ArcelorMittal Nippon Steel (AM/NS) India
Indien
2010 juni 1 → 2013 juli 1

Kvalifikationer

Metallurgical and Materials Engineering, Ph.D., Effect of Cr and Al on phase constitution and high temperature oxidation behavior of Al-Co-Cr-Fe-Ni high entropy alloys, Deakin University, Geelong
Tilldelningsdatum: 2023 dec. 15

Metallurgical and Materials Engineering, Master of Technology, High temperature oxidation behaviour of Al_xCoCrFeNi (x = 0, 0.3, 0.6, 1 mole) high entropy alloys, Indian Institute of Technology Madras
2013 juli → 2015 juni
Tilldelningsdatum: 2015 juli 24

Metallurgical Engineering, Bachelor of Technology, National Institute of Technology, Raipur
2006 juni → 2010 juni
Tilldelningsdatum: 2010 juli 12

Forskningsoutput

Dephosphorization of copper phosphide to copper

Rajashekar, P., Bhattacharya, R., Ek, M. & Lenrick, F., 2025 juni, *Brazing, high temperature brazing and diffusion bonding: LÖT 2025*. DVS Berichte uppl. Germany: DVS Media GmbH, Düsseldorf 2025, Printing by WirmachenDruck GmbH, Backnang, Vol. 399. s. 340-343 4 s. 4. (DVS Berichte; vol. 399).

Exploring the nanoscale mechanisms of Ni-P system to examine the suitability as joining material for high temperature applications

Bhattacharya, R., Rajashekar, P., Ek, M. & Lenrick, F., 2025 juni, *Brazing, high temperature brazing and diffusion bonding: LÖT 2025*. DVS Berichte uppl. Germany: DVS Media GmbH, Düsseldorf 2025, Printing by WirmachenDruck GmbH, Backnang, Vol. 399. s. 212-221 10 s. 1. (DVS Berichte; vol. 399).

Synchrotron X-ray study of vacuum brazed 316L stainless steel joints

Lenrick, F., Lazar, I., Rajashekar, P., Yondu, I., Bhattacharya, R., Slama, M., Knutsson, A. & Mikkelsen, A., 2025 juni, *Brazing, high temperature brazing and diffusion bonding: LÖT 2025*. DVS Berichte uppl. Germany: DVS Media GmbH, Düsseldorf 2025, Printing by WirmachenDruck GmbH, Backnang, Vol. 399. s. 114-119 6 s. 3. (DVS Berichte; vol. 399).

Phase-separated $Zr_{70-x}Al_{12.5}Fe_{17.5}Y_x$ ($x = 0-25$ at.%) metallic glasses with suitable mechanical properties for possible implant applications

Singh, D., Ramasamy, P., Jelinek, A. S., Maier-Kiener, V., Bhattacharya, R., Chen, Z., Sharifikolouei, E., Scalia, A. C., Najmi, Z., Cochis, A., Fellner, S., Yüce, E., Gammer, C., Zhang, Z. & Eckert, J., 2025 mars 1, I: *Journal of Materials Research and Technology*. 35, s. 6468-6484 17 s.

Exploring novel joining technique of Gas Actuated Bonding by utilizing In-situ Environmental-TEM

Bhattacharya, R., Ek, M. & Lenrick, F., 2024 okt. 17, *BIO Web of Conferences*. Qvortrup, K. & Weede, K. (red.). Les Ulis, France: EDP Sciences, Vol. 129. 2 s. 23004

Design and characterization of novel Zr-Al-Fe-Y metallic glasses with nanoscale phase separation

Singh, D., Ramasamy, P., Jelinek, A. S., Bhattacharya, R., Chen, Z., Fellner, S., Gammer, C., Zhang, Z. & Eckert, J., 2024 maj, I: *Materialia*. 34, 7 s., 102104.

Processing of high entropy alloys with exceptionally good high temperature oxidation properties

Murty, B. S. (uppfinnare), Bhattacharya, R. (uppfinnare), Kamaraj, M. (uppfinnare), Fabijanic, D. (uppfinnare) & Hodgson, P. (uppfinnare), 2023 okt. 26, IPC-nr 201641011314, Intellectual Property India, Patentnr 462116, 2016 apr. 7

Effect of Cr and Al on phase constitution and high temperature oxidation behavior of Al-Co-Cr-Fe-Ni high entropy alloys
Bhattacharya, R., 2023 juni, 285 s.

Optimal mechanical alloying and spark plasma sintering technique to obtain nanocrystallinity, minimal contamination and enhanced oxidation behaviour in AlCoCrFeNi high entropy alloys

Bhattacharya, R., Gammer, C., Eckert, J., Fabijanic, D. & Murty, B. S., 2023.

Evolution of phase constitution with mechanical alloying and spark plasma sintering of nanocrystalline $Al_xCoCrFeNi$ ($x = 0, 0.3, 0.6, 1$ mol) high-entropy alloys

Bhattacharya, R., Annasamy, M., Cizek, P., Kamaraj, M., Muralikrishna, G. M., Hodgson, P., Fabijanic, D. & Murty, B. S., 2022 feb. 28, I: *Journal of Materials Research*. 37, s. 959-975 17 s.

Effect of in situ oxide nano-dispersoids on thermal stability, hardness, and material degradation of high entropy alloys
Bhattacharya, R., 2022, (Unpublished).

Effect of microstructural attributes and phase constitution on the isothermal continuous oxidation of AlCoCrFeNi high entropy alloys

Bhattacharya, R., 2022, (Unpublished).

Influence of Al content on thermal stability of nanocrystalline $Al_xCoCrFeNi$ high entropy alloys at low and intermediate temperatures

Garlapati, M. M., Vaidya, M., Karati, A., Mishra, S., Bhattacharya, R. & Murty, B. S., 2020 maj, I: Advanced Powder Technology. 31, 5, s. 1985-1993 9 s.

Effect of Cr content on FCC phase fraction of nanocrystalline $AlCoCrFeNi$ high entropy alloys synthesized by mechanical alloying and spark plasma sintering

Bhattacharya, R. & Fabijanic, D., 2020. 1 s.

Influence of mechanically activated annealing on phase evolution in $Al_{0.3}CoCrFeNi$ high-entropy alloy

John, R., Karati, A., Garlapati, M. M., Vaidya, M., Bhattacharya, R., Fabijanic, D. & Murty, B. S., 2019 dec. 1, I: Journal of Materials Science. 54, s. 14588-14598 11 s.

Effect of Cr variation on FCC phase fraction in $AlCoCrFeNi(x=0-1)$ high-entropy alloys synthesised through mechanical alloying and spark plasma sintering [abstract]

Bhattacharya, R., Guruvidyathri, K., Fabijanic, D. & Murty, B. S., 2019, (Unpublished) s. 36-36. 1 s.

Effect of Aluminium content on oxidation behavior of arc melted $Al_xCoCrFeNi$ ($x=0,0.3,0.6,1$ mole) high entropy alloys exposed at $1150^\circ C$ and comparison with nanocrystalline $Al_{0.6}CoCrFeNi$ high entropy alloy

Bhattacharya, R., Murty, B. S., Fabijanic, D., Annasamy, M. & Hodgson, P., 2018. 1 s.

Effect of Al content on oxidation behavior of $Al_xCoCrFeNi$ ($x=0,0.3,0.6,1$ mole) arc-melted high entropy alloys

Bhattacharya, R., Murty, B. S., Fabijanic, D. & Hodgson, P., 2016. 1 s.

Effect of aluminium content and grain size on oxidation behavior of $Al_xCoCrFeNi$ ($x=0, 0.3, 0.6, 1$ mole) high entropy alloy

Bhattacharya, R., 2016.

Enhancement of microwave absorption properties of epoxy by sol-gel-synthesised ZnO nanoparticles

Thakur, S., Bhattacharya, R., Neogi, S. & Neogi, S., 2015 sep. 29, I: Indian Chemical Engineer. 58 (2016), 4, s. 310-324 15 s.

Phase evolution in $Al_xCoCrFeNi$ ($x=0, 0.3, 0.6, 1$ mole) high entropy alloys synthesized by mechanical alloying and spark plasma sintering

Bhattacharya, R., 2014, s. 361-361. 1 s.

Priser och utmärkelser

Best Oral Presentation Award

Bhattacharya, R. (Mottagare), 2016 nov. 14

Best Oral Presentation Award

Bhattacharya, R. (Mottagare), 2018 juni 12

DAAD Student Exchange Program Germany

Bhattacharya, R. (Mottagare), 2015 jan. 9

International Master student exchange Fellowship Australia

Bhattacharya, R. (Mottagare), 2015 jan. 6

Res-Part International Joint Ph.D. Fellowship Australia

Bhattacharya, R. (Mottagare), 2019 jan. 7

Aktiviteter

Exploring Gas Actuated Bonding (GAB) by Environmental-TEM In-situ Experiments at LÖT 2025 Aachen, Germany

Bhattacharya, R. (presentatör)

2025 juni 25

Presenting the annual research progress of the project titled 'Utveckling av Gas-Assisterad Fogning (UGAF)' at The Metalliska Material Program Conference 2025 Stockholm, Sweden

Bhattacharya, R. (presentatör)

2025 mars 14

Enhanced Oxidation Resistance of AlCoCrFeNi High Entropy Alloy Obtained by Annealing

Bhattacharya, R. (Första/primär/huvudhandledare)

2025 jan. → 2025 juni

Evaluating Oxidation Resistance of AlCoCrFeNi High Entropy Alloy

Bhattacharya, R. (Första/primär/huvudhandledare)

2025 jan. → 2025 juni

The Euro PM2024 Congress & Exhibition, Malmö, Sweden

Bhattacharya, R. (deltagare)

2024 okt. 1 → 2024 okt. 2

Online Poster Presentation at MSE 2024 International Materials Science and Engineering Congress, TU Darmstadt, Germany

Bhattacharya, R. (presentatör)

2024 sep. 26

Environmental-TEM In-situ Experiments for joining metals and alloys at EMC 2024 Copenhagen, Denmark

Bhattacharya, R. (presentatör)

2024 aug. 28

Optimal mechanical alloying and spark plasma sintering technique to obtain nanocrystallinity, minimal contamination, and enhanced oxidation behavior in AlCoCrFeNi high entropy at Joint RQ17 and ISMANAM27 Warsaw Poland 2023

Bhattacharya, R. (presentatör)

2023 aug. 20 → 2023 aug. 25

Metallography Contest for Electron Microscopists at NMD-ATM 2022 Hyderabad India organized by the Indian Institute of Metals

Bhattacharya, R. (medverkande)

2022 nov. 15

Effect of in situ oxide nano-dispersoids on thermal stability, hardness, and material degradation of high entropy alloys at NMD-ATM 2022 Hyderabad organized by Indian Institute of Metals

Bhattacharya, R. (presentatör)

2022 nov. 14 → 2022 nov. 16

Effect of microstructural attributes and phase constitution on the isothermal continuous oxidation of AlCoCrFeNi high entropy alloys at NMD-ATM 2022 Hyderabad organized by Indian Institute of Metals

Bhattacharya, R. (presentatör)

2022 nov. 14 → 2022 nov. 16

25th International Symposium on Metastable, Amorphous and Nanostructured Materials (July 2-6, 2018) at the Frentani Convention Centre, in Rome, Italy

Bhattacharya, R. (presentatör)
2018 juli 2 → 2018 juli 6

Best oral Presentation at the In-House Symposium 2018 (May11-12, 2018) at Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Madras "Comparison of the oxidation behavior of Nanocrystalline Al_{0.6}CoCrFeNi HEA with arc melted counterpart at 1000 and 1150 C."

Bhattacharya, R. (presentatör)
2018 maj 11 → 2018 maj 12

International Workshop on High Entropy Materials 2017 (March 11-12, 2017) organized by University of Hyderabad and Indian Institute of Technology Hyderabad

Bhattacharya, R. (presentatör)
2017 mars 12

Best Oral Presenter award for Effect of Al content on Oxidation behavior of Al_xCoCrFeNi (x=0,0.3,0.6,1mole) arc-melted High Entropy Alloys at NMD-ATM 2016 Kanpur organized by Indian Institute of Metals

Bhattacharya, R. (presentatör)
2016 nov. 11 → 2016 nov. 14

Effect of Al content and grain size on Oxidation behaviour of Al_xCoCrFeNi (x = 0, 0.3, 0.6, 1 mole) MA-SPS High Entropy Alloys at the first International Conference on High-Entropy Materials at National Tsing Hua University, Hsinchu, Taiwan

Bhattacharya, R. (presentatör)
2016 nov. 6 → 2016 nov. 9

Workshop on Atom Probe Tomography Technique 2016 organized by South Zone Chapter of the Electron Microscopy Society of India and CAMECA

Bhattacharya, R. (deltagare)
2016 feb. 1

Phase evolution in Al_xCoCrFeNi (x = 0, 0.3, 0.6, 1 mole) High entropy alloys synthesized by Mechanical alloying and Spark plasma sintering at NMD-ATM 2014 Pune organized by Indian Institute of Metals

Bhattacharya, R. (presentatör)
2014 nov. 12 → 2014 nov. 15