

Dr. ATUL SINGH RAJPUT

Faculty Fellow

Indian Institute of Technology Guwahati, India

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EDUCATION

Indian Institute of Technology Guwahati, India

Ph.D., Department of Mechanical Engineering

2019 - 2023

CGPA - 9.0/10.0

National Institute of Technical Teachers' Training and Research, India

M.Tech., Manufacturing Technology

2017 - 2019

CGPA - 8.98/10.0

Haldia Institute of Technology, India

B.Tech., Department of Mechanical Engineering

2013 - 2017

CGPA - 8.52/10.0

RESEARCH INTERESTS

Additive Manufacturing, Surface finishing, Biomaterials, **Computer-aided manufacturing**, **Computer-Aided Process Planning**, Biocompatibility analysis, Simulation work, Optimization, Characterization of materials, Strengthening of Materials, Tribology

RELEVANT EXPERIENCE

Fabrication and post-processing of additively manufactured biomedical implant

2019-2023

Ph.D. Thesis; Supervised by Dr. Manas Das and Dr. Sajan Kapil

(IIT Guwahati)

- Developing post-processing methods for surface quality improvement of the hip implant made of Ti-6Al-4V fabricated through Selective laser melting for enhanced functionality.
- The chemical etching was followed by *Hybrid-Electrochemical Assisted Magnetorheological (H-ECMR)* finishing process to reduce the surface defects of the SLM fabricated femoral head (i.e., loosely bonded powders, stair casing, balling melts, semi welds, etc.).
- The *H-ECMR* finishing tool was retrofitted with a 5-axis CNC milling machine to have a higher degree of freedom during the polishing operation. Moreover, an efficient surface mapping toolpath strategy, namely the *Trochoidal toolpath*, was developed to provide a uniform surface quality over the polished surface with reduced polishing time compared with convention toolpath strategies (i.e., spiral, zig-zag, Hilbert, and peano).
- The developed *H-ECMR* finishing process reduced the surface roughness of the femoral head to 32.30 nm. Furthermore, the electrochemical reaction between the Ti-6Al-4V and electrolytes produced a uniform and thick TiO₂ on the surface of Ti-6Al-4V as analyzed through XPS, SEM, and EDX. The modified oxide layer helps enhance the polished surface's corrosion resistance.
- The pin-on-disc and corrosion tests suggested that the wear and corrosion resistance of the SLM fabricated femoral head improved after the post-processing.

Design and development of invisible aligners through Fused Deposition Modelling

2021-2022

Supervised by Dr. Manas Das and Dr. Sajan Kapil

(IIT Guwahati)

- Design and development of cost-efficient invisible aligners made of Glycol-modified Polyethylene Terephthalate (PETG) through the Fused Deposition Modeling (FDM).
- Chemical Vapor Smoothing is performed to enhance the surface quality of the invisible aligners with different solvents, namely methylethylketone (also known as 2-butanone), toluene, and cyclohexanone.
- The maximum percentage change in Ra was 92.733%, while the lowest was 73.062%, as cyclohexanone is used as the solvent during the surface finishing process compared to the other solvent.

Computer-aided process planning to enhance the surface quality of the additively manufactured bone plate

2021-2022

Supervised by Dr. Sajan Kapil and Dr. Manas Das

(IIT Guwahati)

- A *Computer-Aided Process Planning (CAPP)* was developed for super-finishing flat surfaces with pockets through Magnetorheological Finishing (MRF) process. The MRF process was incompetent to reduce the surface irregularities of the workpiece having a hole and pocket features, as the MR fluid gets trapped inside the holes or pockets.
- A *Feature-based hybrid MRF Planning System (FHMRF-PS)* was developed to overcome the abovementioned problem related to the MRF process. Herein, the paraffin wax was deposited inside holes and pockets before the MRF process with the assistance of the newly developed external deposition modular.
- FHMRF-PS is developed with an external deposition module, which helps deposit paraffin wax over the holes or pockets with the nearest neighbor algorithm of the *Travelling Salesman Problem (TSP)* to avoid repetition during deposition.

- The bone plate's average surface roughness (R_a) value was reduced to 21.56 nm from its initial value of 324.12 nm with the proposed FHMRF-PS.

Design and development of Chemo-Magnetorheological Finishing (C-MRF) the process to enhance the surface quality of the tungsten carbide cutting tool

2019-2020
(IIT Guwahati)

Industrial project; Supervised by Dr. Manas Das and Dr. Sajan Kapil

- A novel method, namely the *Chemo-Magnetorheological Finishing (C-MRF)* process, is developed where Murakami's reagent is used as the Magnetorheological (MR) Fluid carrier medium. The proposed surface finishing process is capable of producing the surface roughness (R_a) in the range of the nanometer as required for the better adhesion of the coated material on the WC-Co cutting tool.
- The inclusion of Murakami's reagent enhances the process efficiency. The change in surface roughness with and without Murakami's reagent in the MR fluid is 88.97% and 43.12%, respectively, for a constant finishing time.
- The developed apparatus to perform the Chemo-Magnetorheological Finishing process produced the desired external magnetic field (0.86 T to 0.52) in the polishing zone, sufficient enough to perform the surface finishing process.
- The minimum and maximum surface roughness (R_a) of 34.50 nm and 79.39 nm are achieved on the workpiece's cutting edge and flute surface, respectively.

Experimental investigation and computational analysis into Rotational-Magnetorheological Abrasive Flow Finishing (R-MRAFF)

2018-2019
(NITTTR, Kolkata)

M.Tech. Thesis; Supervised by Dr. Arpan Kumar Mondal and Dr. Dipankar Bose

- Design and development of cost-efficient Rotational-Magnetorheological Abrasive Flow Finishing (R-MRAFF) to enhance the surface quality of stainless steel.
- A computational analysis was performed in the Ansys fluent 12.0 to analyze the impact of the abrasive flow finishing on the surface irregularities of the substrate.
- An in-house experimental setup was developed to perform the surface finishing operation on the workpiece to enhance its surface quality.
- The impact of mesh size of the abrasive particles on the final surface quality of the finished workpiece is analyzed during the experiments.

Static loading analysis of connecting rod used in Four-wheeler (SUV) by FEA

2017-2018
(NITTTR, Kolkata)

Industrial project; Supervised by Dr. Arpan Kumar Mondal and Dr. Dipankar Bose

- Computer-aided designing of connecting rod for enhanced engine functionality in Solidworks 16.0.
- Computational analysis on the Ansys workbench 16.0 was performed to analyze the stresses generated in the connecting rod of the SUV while applying the static load.
- A comparison was made between the different materials to evaluate the less deflection in the connecting rod due to static loading.

Design and development of a pneumatic controlled aluminium can crusher

2016-2017
(HIT, Kolkata)

B.Tech thesis; Supervised by Dr. Tarun Kanti Jana

- Design and development of slider-crank mechanism based pneumatic controlled aluminium can crusher to reduce the area covered by the recycled can in the beverage industries.
- Computational analysis was performed on the Ansys 16.0 to analyze the force required to operate the proposed mechanism.
- A pneumatic circuit was developed to crash a can with a single push button.
- Different variants of the models were developed to have a smooth piston motion during the operation.

PUBLICATIONS

Journal Publications

- Atul Singh Rajput**, Ambrish Singh, Sajan Kapil, and Manas Das "Investigations on the trochoidal toolpath for processing the biomaterial through magnetorheological fluid assisted finishing process." *Journal of Manufacturing Processes* 76: 812-827. (**Impact factor: 6.2**) <https://doi.org/10.1016/j.jmapro.2022.02.055>
- Atul Singh Rajput**, Ambrish Singh, Manas Das, and Sajan Kapil, "Investigations on the Toolpath Strategies for CNC Magnetorheological Fluid Assisted Finishing (MFAF) Process." *Journal of Advanced Manufacturing and Technology* 1-18. (**Impact factor: 3.4**) 121 <https://doi.org/10.1007/s00170-022-09307-9>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Characterization of Wear Resistance and Corrosion during Magnetorheological Fluid Assisted Finishing (MFAF) of Ti-6Al-4V and Duplex Stainless Steel for enhanced biocompatibility." *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering*. June 2022. (**Impact factor: 2.4**) <https://doi.org/10.1177%2F09544089221107990>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Investigations on a Hybrid Chemo-Magnetorheological Finishing process for the freeform surface quality enhancement." *Journal of Manufacturing Processes* 81 (2022): 522-536. (**Impact factor: 6.2**) <https://doi.org/10.1016/j.jmapro.2022.07.015>

- Sajan Kapil, **Atul Singh Rajput**, and Ritam Sarma, "Hybridization in Wire Arc Additive Manufacturing." *Frontiers in Mechanical Engineering* 8:981846. (Impact factor: 2.3) <https://doi.org/10.3389/fmech.2022.981846>
- Ambrish Singh, **Atul Singh Rajput**, Sajan Kapil, and Manas Das "Parameter Sensitivity Analysis of Centrifugal Spreaders for Dispersing Metallic Powders and Material Property Calibration for DEM Simulation." *Powder Technology*. (Impact factor: 5.2) <https://doi.org/10.1016/j.powtec.2022.117958>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "A comprehensive review of the magnetorheological assisted finishing process." *Machining Science and Technology* 26:3 (2022), 339-376 (Impact factor: 2.15) <https://doi.org/10.1080/10910344.2022.2129982>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Surface Properties and Biocompatibility studies on Bone Plate by the Magnetorheological Finishing (MRF) process." *Surface Engineering* (2022): 1-10 (Impact factor: 2.45) <https://doi.org/10.1080/02670844.2022.2154006>
- Atul Singh Rajput**, Sajan Kapil, and Manas Das, "Investigation on Biotribology of Post Processed Additively Manufactured Biomaterial through Magnetorheological Fluid Assisted Finishing process". *Wear* 522 (2023): 204684. (Impact factor: 5.0) <https://doi.org/10.1016/j.wear.2023.204684>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Computer-Aided Process Planning (CAPP) System for Super Finishing of Flat Surfaces with Pockets through Magnetorheological Finishing (MRF) process." *International Journal of Computer Integrated Manufacturing* (2023): 1-17. (Impact factor: 4.42) (03/2023) <https://doi.org/10.1080/0951192X.2023.2189313>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Optimization of Surface Roughness Parameters in Chemo-Magnetorheological Finishing (C-MRF) Process using Response Surface Methodology and Genetic Algorithm." *Proceedings of the Institution of Mechanical Engineers, Part C* 2023;0(0). (Impact factor: 2.0) <https://doi.org/10.1177/09544062231175783>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Investigation on tribological behavior of additively manufactured bone plate polished through Magnetorheological Fluid Assisted Finishing process." *3D Printing and Additive Manufacturing* (2023). (Impact factor: 3.1) <https://doi.org/10.1089/3dp.2023.0028>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "A post processing technique to achieve nanofinishing for functionality enhancement of Ti-6Al-4V femoral head fabricated by Laser Powder Bed Fusion." *CIRP Journal of Manufacturing Science and Technology* 45 (2023): 99-112. (Impact factor: 4.8) <https://doi.org/10.1016/j.cirpj.2023.06.006>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Investigations on Chemical Vapor Smoothing Process for Surface Enhancement of Additively Manufactured Clear Aligners." *Journal of Mechanical Behaviour of Biomedical Materials* (Impact factor: 3.9) <https://doi.org/10.1016/j.jmbbm.2023.106003>
- Atul Singh Rajput**, Ambrish Singh Manas Das, and Sajan Kapil, "Nanofinishing of Directed Energy Deposited Topologically Optimized fixation plates." *Materials and Manufacturing Processes* (Impact factor: 4.8) <https://doi.org/10.1080/10426914.2023.2289676>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "A Hybrid-Electrochemical Magnetorheological (H-ECMR) Finishing Process for the Surface Enhancement of Biomedical Implants." *Journal of Manufacturing Science and Engineering* (Accepted) (Impact factor: 4.0) <https://doi.org/10.1115/1.4064737>
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, "Machine-learning-based optimization of hybrid electrochemical magnetorheological finishing process to achieve nano finishing on additively manufactured biomaterial." *Journal of Adhesion Science and Technology* (Under review)
- Atul Singh Rajput**, Phul Babu, Manas Das, and Sajan Kapil, "Influence of Toolpath Strategies during Surface Enhancement Additively Manufactured Biomaterial through Laser Polishing" *Progresses in Additive Manufacturing* (Under review)

Patents

- Atul Singh Rajput**, Manas Das, and Sajan Kapil, 2021, " *Method and Apparatus for Magnetorheological Fluid-Assisted Finishing (MF AF) of Cemented Carbide Based Cutting Tool*", Indian Patent, Application Number: 202231006807
- Atul Singh Rajput**, Sajan Kapil, and Manas Das, 2021, " *An Apparatus for Enabling Magnetorheological Fluid Assisted Finishing (MF AF) Process*", Indian Patent, Application Number: 202131048986
- Atul Singh Rajput**, Sajan Kapil, and Manas Das, 2021, " *A Method for Performing Magnetorheological Fluid-Assisted Finishing (MF AF) on a Product having a Hole Feature*", Indian Patent, Application Number: 202231032416
- Atul Singh Rajput**, Asbhishek Patil Sajan Kapil, and Manas Das, 2021, " *An Apparatus for Enhancing Surface Quality of Invisible Aligners Fabricated by Additive Manufacturing*", Indian Patent, Application Number: 202231044563
- Ritam Sarma, **Atul Singh Rajput**, Sajan Kapil, and Manas Das, 2022, " *A System and Method for Fabricating Density-Based FGM using H-WAAM*", Indian Patent, Application Number: 202231014151
- Atul Singh Rajput**, Sajan Kapil, and Manas Das, 2021, " *Method and apparatus for chemical etching of the additively manufactured head manufactured from Ti-6Al-4V* ", Indian Patent, Application Number: 202231064595
- Atul Singh Rajput**, Manas Das, and Sajan Kapil, 2023, " *Chemical Flow based chemical vapor smoothing of FDM fabricated parts*", Indian Patent, Application Number: 202331048237
- Harsh Rana, **Atul Singh Rajput**, and Sajan Kapil,, 2023, " *A Dual 5-bar on circular track robot for Additive Manufacturing (AM)* ", Indian Patent, Application Number: 202331060330

Book Chapters

- Atul Singh Rajput**, Sajan Kapil, and Manas Das, "Methods for Surface Superfinishing of Prosthesis." *Advanced Micro-and Nano-manufacturing Technologies*. Springer, Singapore, 2022. 335-360
- Atul Singh Rajput**, Sajan Kapil, and Manas Das, "Computational Techniques for Predicting Process Parameters in the Magnetorheological Fluid-Assisted Finishing Process." *Advanced Computational Methods in Mechanical and Materials Engineering*. CRC Press, 2021. 125-146
- Atul Singh Rajput**, and M. Hamza, Static Loading Analysis of Connecting Rod Used in Four-Wheeler (SUV) by FEA. In *Advances in Materials and Manufacturing Engineering*, Springer, 2020: pp. 441-447

- Atul Singh Rajput**, Deokant Prasad, Arpan Kumar Mondal, and Dipankar Bose, 2D Computational Fluid Dynamics Analysis into Rotational Magnetorheological Abrasive Flow Finishing (R-MRAFF) Process, In *Advances in Materials and Manufacturing Engineering*, Springer, 2020: pp. 67–73
- Arpan Kumar Mondal, **Atul Singh Rajput**, Deokant Prasad, and Dipankar Bose (2020) Magnetic Field Assisted Finishing Processes. In: *Advances in Abrasive Based Machining and Finishing Processes*. Springer, pp 211–234
- Doloi, S., **Atul Singh Rajput**, Kapil, S., Das, M. (2023). Hybrid Additive Manufacturing of Knee Joint Implant: Possibilities and Challenges. In: Ramesh Babu, N., Kumar, S., Thyla, P.R., Sripriyan, K. (eds) *Advances in Additive Manufacturing and Metal Joining. Lecture Notes in Mechanical Engineering*. Springer,
- Atul Singh Rajput**, Sajan Kapil, and Manas Das, "Post-processing methods for surface enhancement of Additively Manufactured parts" *Nanofinishing of Materials for Advanced Industrial Application*. CRC Press, 2023.

Conference Papers

- Atul Singh Rajput**, Sajan Kapil, and Manas Das, "*A Machine Learning Genetic Algorithm (ML-GA) Approach to Optimize Process Parameters of Trochoidal Toolpath During Hybrid-Electrochemical Magnetorheological (H-ECMR) Finishing.*" Proceedings of the ASME 2023 18th International Manufacturing Science and Engineering Conference. Volume 2: Manufacturing Equipment and Automation; Manufacturing Processes; Manufacturing Systems; Nano/Micro/Meso Manufacturing; Quality and Reliability. New Brunswick, New Jersey, USA. June 12–16, 2023. V002T06A032. ASME.

Conferences

- Atul Singh Rajput** and Mohammad Hamza – Static Loading Analysis of Connecting Rod Used in Four-wheeler (SUV) by FEA, International Conference on Advances in Material and Manufacturing Engg. (ICAMME), KIIT-India (2019)
- Atul Singh Rajput**, Deokant Prasad, Arpan Kumar Mondal, and Dipankar Bose – 2D Computational Fluid Dynamics Analysis into Rotational Magnetorheological Abrasive Flow Finishing (R-MRAFF) Process, International Conference on Advances in Material and Manufacturing Engg. (ICAMME), KIIT-India (2019)
- Sayan Doloi, **Atul Singh Rajput**, Sajan Kapil, and Manas Das – Hybrid Additive Manufacturing of Knee Joint Implant: Possibilities and Challenges, All India Manufacturing Technology, Design and Research. (AIMTDR), PSG College of Technology -India (2021)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – Hybrid Additive Manufacturing of Knee Joint Implant: Possibilities and Challenges, 2nd Virtual International Tribology Research Symposium, SRM University, India (2021)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – Surface Enhancement of Additively Manufactured biomedical implants through Hybrid-Electrochemical Magnetorheological (H-ECMR) finishing, International Conference on Precision, Micro, Meso and Nano Engineering (COPEN), IIT Kanpur, India (2022)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – Investigation on tribological behavior of additively manufactured bone plate polished through Magnetorheological Fluid Assisted Finishing process, IndiaTrib, IIT Delhi, India (2022)
- Rinku Mittal, **Atul Singh Rajput**, Ritam Sarma, and Sajan Kapil – Investigation of Chatter Vibration on Wire Arc Additive Manufactured Products during the Milling Operation, International Conference on Vibration Engineering and Technology of Machinery (VETOMAC 2022), Institute of Engineering, Nepal (2022)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – Post Processing of Additively Manufactured Biomedical Implants, Wear, Alberta, Canada (2023)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – Surface Enhancement of Additively Manufactured Biomedical Implants through H-ECMR Finishing, MAMC 2023, Vienna, Austria (2023)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – A Machine Learning Genetic Algorithm (ML-GA) Approach to Optimize Process Parameters of Trochoidal Toolpath During Hybrid-Electrochemical Magnetorheological (H-ECMR) Finishing, ASME 2023 18th International Manufacturing Science and Engineering Conference, New Jersey, USA (2023)
- Atul Singh Rajput**, Sajan Kapil, and Manas Das – Post Processing of Additively Manufactured Biomedical Implants, AM Aero 3D 2023, MSRIT, Bengaluru, India (2023)

PROJECTS

Establishment of Centre of Excellence for Mission Hydro Safety

Sponsored by: IIT Guwahati Technology Innovation and Development Foundation, **PI:** Dr. Pankaj Biswas **Co PI:** Dr. Atul Singh Rajput, Dr. Sajan Kapil, and Prof. N R Mandal, **Amount:** 20 lakhs

PROGRAMMING LANGUAGES AND SOFTWARE

- Computer-aided Design: Solidworks, Powershape
- Computer-aided manufacturing: , Powermill, Unigraphics
- Coding: Matlab
- Statistical analysis: Design Expert, origin
- Computational analysis: Comsol, Ansys, Altair EDEM

Technical Skills: Wire Arc Additive Manufacturing | Stereolithographic apparatus | Fused deposition modeling | Selective laser melting | Tensile Testing Machine | 5 axes and 3 axes CNC milling | Vicker's Hardness Machine | Rockwell hardness | Optical Microscope | Optical profilometer | SEM | AFM | XRD | XPS

ACHIEVEMENTS AND CO-CURRICULAR ACTIVITIES

- Received **Young Tribologist Award** and prize money of 500 USD during **IndiaTrib-2022** (11th International Conference on Industrial Tribology (ICIT)) organized by IIT Delhi.
- Received **runner up award for oral presentation** during **IndiaTrib-2022** (11th International Conference on Industrial Tribology (ICIT)) organized by IIT Delhi.
- Received 1st prize in oral presentation during Research and Industrial Conclave (RIC'23) at IIT Guwahati.
- **Teaching Assistance** in Dr. Sajan Kapil's lecture in the National Programme on Technology Enhanced Learning (NPTEL) on Fundamentals of **Additive Manufacturing Technologies**.
- **Teaching Assistance** in Dr. Manas Das's lecture in the National Programme on Technology Enhanced Learning (NPTEL) on **Advanced Machining Processes**.
- Successfully proposed and obtained a **PG scholarship** All India Council for Technical Education (AICTE) for dissertation research (**INR 1,48,800** per annum for 24 months during M.TECH).
- Successfully proposed and obtained a grant in New Generation Innovation and Entrepreneurship Development Centre (**NewGen IEDC**) at IIT Guwahati amount of **INR 2,50,000** (2021-2022) for the development of the invisible aligner through Fused deposition modeling.
- Attained a financial assistantship during the Ph.D. course from the All India Council for Technical Education (AICTE) (**INR 4,20,000** per annum).

Lectures

Lecture on **Learning sessions on CAM package** in short-term courses on **Micro Manufacturing Process** sponsored by TEQIP III at IIT Guwahati.

Lecture on **Learning sessions on CAM package** in short-term courses on **Advanced Manufacturing Processes** sponsored by TEQIP III at IIT Guwahati

Lecture on **Fundamental of 3D printing** at National Institute of Technical Teachers' Training and Research Kolkata (NITTTR Kolkata)

Reviewer

Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science
Journal of Micromanufacturing

REFEREES

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