Sachin Poudel, Ph.D. Candidate

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Research Interests

- Multi-Principal Element Alloys
- Microstructural Evolution
- Phase Field Modeling
- Machine Learning
- Scale-Bridging Simulations
- Computational Materials Science
- Advanced Functional Materials

Education

Feb 2023 – Present
Ph.D. in Mechanical Engineering, Silesian University of Technology, Poland.
Thesis: *Scale-Bridging Computational and Data-Driven Design of Microstructures in Multicomponent Alloys for Advanced Functional Materials*

Aug 2020 – Sep 2022
M.Sc. in Mechanical Design and Manufacturing, Tribhuvan University, IOE, Thapathali Campus, Nepal.
Thesis: *Towards Accelerated Design of Multi-Principal Element Alloys with Optimized Hardness and Elongation Features by an Ensemble of Neural Network*

Nov 2014 – Oct 2018
B.E. in Mechanical Engineering, Tribhuvan University, IOE, Thapathali Campus, Nepal.
Project: *Design, Fabrication, and Testing of Banana Fibre Extraction Machine*

Skills

Computational Methods	Phase-Field Modeling, Density Functional Theory, Finite Element Methods, Multi-Scale Simulations, Non-linear Electrochemical Modeling
Machine Learning	Data Preprocessing & Featurization (Matminer, Pymatgen, Magpie featurization, PCA, Pearson Correlation), Neural Networks (TensorFlow/PyTorch), Ensemble Methods, Hyperparameter Tuning, MeshGraphNet
Programming Languages	Python (NumPy, SciPy, scikit-learn, Streamlit), MATLAB, C++, Fortran, Data Visualization & Analysis (Matplotlib, Plotly, Pandas)
Software & Frameworks	MOOSE, Elmer, Quantum Espresso, ANSYS, Git, Linux
Languages	Strong reading, writing, and speaking competencies for English, Nepali

Research Experience

Phase-Field Modeling & Multi-Scale Coupling

- Formulated and implemented multi-component phase-field models in MOOSE, integrating bulk, interfacial, and elastic energy contributions.
- Embedded DFT-computed temperature-dependent elastic constants and to simulate Al–Cu–Ni microstructure evolution, revealing 18.2% grain area deviation at 723K compared to 0K elastic constants.
- Developed non-linear electrochemical ion migration modules by coupling Butler–Volmer kinetics to phase-field evolution, elucidating Li-ion dendrite nucleation and growth mechanisms.

Research Experience (continued)

Piezoelectric Materials Fine-Tuning via ML, Crystallography & FEM

- Architected PiezoTensorNet: hierarchical neural classifiers for crystal point group identification and modular regression ensembles predicting piezoelectric tensors from dopant-enhanced crystallographic inputs.
- Integrated tensor predictions into FEM simulations of AlN MEMS devices to optimize dopant concentrations and Euler orientations, achieving 9.96× power density gains and >92% accuracy.

Data-Driven Materials Design Pipeline

- Aggregated, normalized, and featurized heterogeneous datasets of alloy compositions, processing parameters, and performance metrics; applied PCA and Pearson correlation for feature selection.
- Trained and optimized artificial neural networks and ensemble regressors, achieving cross-validated $R^2 > 0.88$ for hardness and elongation predictions.

Synergetic Optimization of MPEA Mechanical Properties

- Clustered manufacturing routes (casting, wrought, powder metallurgy, annealing) and employed scale-invariant normalization to identify dual-dopant synergies in multi-principal element alloys.
- Predicted and experimentally validated compositions yielding >15% concurrent gains in hardness and elongation for Ti-doped ZrHfNb and Cr0.5W0.3(VNbTa)0.2 alloys.

Hybrid Computational–Data & Web Frameworks

- Developed closed-loop pipelines coupling phase-field outputs with machine learning surrogates, accelerating parameter calibration and enhancing predictive fidelity.
- Deployed AlloyManufacturingNet and PiezoTensorNet as Streamlit web applications with RESTful back-ends, enabling real-time property forecasting, composition optimization, and interactive visualization.

Functional Device Applications in Energy Storage & Conversion

- Applied integrated modeling frameworks to design and optimize functional devices: simulated dendrite evolution for Li-ion batteries, and enhancing piezoelectric MEMS actuator voltage generation by alloying a crystallographic rotation.

Research Publications

Journal Articles

1. **S. Poudel**, N. Moelans, R. Thapa, A. Timofiejczuk, D. Panthi, and A. Kunwar, "Unraveling elastochemical effects in microstructural evolution of al–cu–ni system through dft-informed multi-phase field simulations," *International Journal of Solids and Structures*, vol. 300, p. 112 894, 2024. DOI: 10.1016/j.ijsolstr.2024.112894.
2. **S. Poudel**, U. Subedi, M. O. Hamid, *et al.*, "Alloymanufacturingnet for discovery and design of hardness-elongation synergy in multi-principal element alloys," *Engineering Applications of Artificial Intelligence*, vol. 132, p. 107 902, 2024. DOI: 10.1016/j.engappai.2024.107902.
3. **S. Poudel**, R. Thapa, R. Basnet, A. Timofiejczuk, and A. Kunwar, "Piezotensornet: Crystallography informed multi-scale hierarchical machine learning model for rapid piezoelectric performance finetuning," *Applied Energy*, vol. 361, p. 122 901, 2024. DOI: 10.1016/j.apenergy.2024.122901.

4. R. Thapa, **S. Poudel**, K. Krukiewicz, and A. Kunwar, "A topical review on ai-interlinked biodomain sensors for multi-purpose applications," *Measurement*, vol. 227, p. 114 123, 2024. DOI: 10.1016/j.measurement.2024.114123.

5. U. Subedi, **S. Poudel**, K. Gyanwali, Y. Amorim Coutinho, G. Matula, and A. Kunwar, "State-of-the-art review on the aspects of martensitic alloys studied via machine learning," *Metals*, vol. 12, no. 11, p. 1884, 2022. DOI: 10.3390/met12111884.

6. **S. Poudel**, S. Chapai, R. K. Subedi, T. R. Giri, and S. Adhikari, "Design, fabrication, and testing of banana fibre extraction machine," *Journal of Innovations in Engineering Education*, vol. 2, no. 1, pp. 165–173, 2019. DOI: 10.3126/jiee.v2i1.36668.

Conference Presentations

19 – 23 May 2024 — The 5th International Symposium on Phase-Field Modelling in Materials Science, Zhejiang University, Hangzhou, China.
"A computational model for examining the role of externally applied stress on dendrite growth pattern in solid state Lithium-ion batteries". (Oral Presentation)

3 – 7 Sep 2023 — Euromat23, Frankfurt, Germany "Phase field evolution in Ni-YSZ Fuel Cells with Temperature-Dependent Elasticity". (Oral Presentation)

19 – 22 Oct 2022 — 12th IOE Graduate Conference, Thapathali Campus, Nepal "Towards Accelerated Design of Multi-Principal Element Alloys with Optimized Hardness and Elongation Features by an Ensemble of Neural Network [ID: 12308]". (Oral Presentation)

05-06 April 2019 — Fifth Graduate Conference- Himalayan Knowledge Conclave 2019, Kathmandu University, Nepal. "Design, Fabrication and Testing of Banana Fibre Extraction Machine". (Poster Presentation)

Employment History

April 2023 – Present — **Graduate Researcher**, Silesian University of Technology.
Research team member in the National Science Centre (NCN), Poland, funded project.

Feb 2022 – Jan 2023 — **Lecturer**, COSMOS College of Management and Technology, Nepal.
Delivered lectures and instructed in laboratory on mechanical engineering subjects: Thermal Science (MEC 111) and Engineering Drawing (MEC 120).

Nov 2021 – Feb 2023 — **Teaching Assistant**, IOE, Thapathali Campus, Tribhuvan University, Nepal.
Teaching core mechanical engineering courses: Engineering Drawing I (ME401), Engineering Drawing II (ME451), Computer Aided Drawing (ME 505).

Jun 2019 – Nov 2021 — **Mechanical Design Engineer**, Calcgen Solutions, Nepal.
Conducted finite element analysis and stress analysis of pressure vessel components. Performed mechanical calculations and drafting of pressure vessels based on ASME Section VIII.

Sep 2018 – Dec 2018 — **Intern**, Nepal Airlines Corporation, Nepal.
Diagnosed aircraft vehicles. Assisted in the repair and maintenance of various aircraft models.

Professional Achievements and Engagements

Awards and Recognitions

2024 **Rector's Grant, Silesian University of Technology, Poland.** Pro-quality competition for rector's grants for highly scored publications, granted patents, acquired projects, or scientific and research work

2023 **University Grants Commission, Nepal.** University Grants Commission (UGC) Master Research Support Award (Award No: MRS-78-79-Engg-10)

Workshops and Events

2 Jan – 5 Jan 2019 **Swiss-Nepal Technology Transfer Workshop 2019.** Organized by the Nepalese Scientific Association in Switzerland (NepSas)

4 Feb – 6 Feb 2016 **MechTRIX 7.0.** 7th National Mechanical Engineering Exhibition 2073