



VIR KARAN

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Education

Indian Institute of Technology Madras

2019-23

B.Tech, Metallurgical and Materials Engineering

CGPA: 9.25/10, Department Rank: 1

Scholastic Achievements

- Awarded the prestigious **MITACS Globalink Fellowship** to take up an international research project in Canada (2022)
- Selected for the coveted **Young Research Fellowship** at IIT Madras amongst **200+** applicants (2021-2022)
- Nominated for the **OP Jindal Engineering & Medical Scholarship** for meritorious students (2019 & 2022)
- Secured a percentile of **99.85%** in Joint Entrance Exam Main among **1.4 million+** candidates (2019)

Publications

- "Accelerated Solutions of Coupled Phase Field Problems Using Generative Adversarial Networks"
Vir Karan, Maruthi Indresh, Saswata Bhattacharya, *Computational Materials Science* (under review) [[Pre-print](#)]
- "Quantification of similarity and physical awareness of microstructures generated via Generative Models"
Sanket Thakre, **Vir Karan**, Anand K Kanjarla, *Computational Materials Science* (under review)

Research Experience

Learning the Structure of Small-Atom Clusters at Metal/Ceramic Interfaces

(October 2022 - Present)

Guide: [Dr Satyesh Kumar Yadav](#), Materials Design Lab, IIT Madras

- Applied reinforcement learning based methods to optimize the structures of Zinc clusters in a hemispherical potential
- Working on understanding how the structure changes when moved into the voids of a nano-corrugated Ru-Silica interface

Studying Interface Propagation using Physics-Informed Neural Networks

(May 2022 - Present)

Guide: [Dr. James D Hogan](#), Centre for Design of Advanced Materials, University of Alberta

- Applied Physics-Informed Neural Networks to solve interface propagation problems governed by Ginzburg-Landau equations
- Simulated microstructure evolution during stress-induced martensitic phase transformations using the developed framework
- This work was done in collaboration with the *U.S Army*; a manuscript fit for a journal article is being prepared for the same

Morphology Optimization in DP Steels using Deep Learning

(September 2021 - May 2022)

Guide: [Dr. Anand K Kanjarla](#), Mechanics of Microstructures Group, IIT Madras

- Developed a deep learning framework to solve inverse problems of generating DP Steel microstructures with target properties
- This framework employed a StyleGAN2 to generate the microstructures, a Pix2Pix GAN to predict local stress fields of the microstructure and a Bayesian Optimization algorithm to locate the correct morphology with most tensile damage resistance

Quantification of awareness of GAN Generated Microstructures

(December 2020 - March 2022)

Guide: [Dr. Anand K Kanjarla](#), Mechanics of Microstructures Group, IIT Madras

- Implemented a StyleGAN2-ADA to generate two-phase microstructures of 6 morphologies using only 300 training samples
- Achieved an R^2 score of 90% using a Random Forest regressor to predict the damage initiation stress of microstructures
- Statistically analysed the generated microstructures with studies using the learned latent space and damage stress predictions

Accelerated Solutions of Coupled Phase Field Problems Using GANs

(July 2021 - February 2022)

Guide: [Dr. Saswata Bhattacharya](#), Computational Materials Science Group, IIT Hyderabad

- Built a Custom GAN architecture using Convolutional-LSTM layers for solving coupled PDEs, such as the phase-field equations
- Set a Benchmark MSE of 0.0002% for a non-physics informed solution to the coupled Cahn-Hilliard equations in ternary alloys
- Analyzed the efficiency, scalability & accuracy of the trained model as a replacement for conventional numerical solvers

CALPHAD-Coupled Phase Field Modelling of Al-Zn Alloys

(May 2021 - August 2021)

Guide: [Dr. Abhik Choudhary](#), Materials Modelling Group, IISc Bangalore

- Used the thermodynamic properties of the Al-Zn system from the pyCALPHAD library to build the potential well
- Simulated microstructural evolution by solving the coupled phase-field PDEs numerically

Bachelor's Thesis

Design of Ultra-Thin-Metal Films for Opto-Electronic Applications

(August 2022 - Present)

Guide: [Dr Satyesh Kumar Yadav](#), Materials Design Lab, IIT Madras

- Surveyed existing patents on physical vapour deposition of metals onto organic substrates to design experiments for the same
- Studying effect of annealing and substrate roughness on Ag-SiO₂ thin films deposited using DC Magnetron sputtering

Key Academic Projects

Solution of a Poisson Problem using the Finite Element Method

(October 2022)

Course: ME5204 - Finite Element Analysis

- Applied the Bubnov-Galerkin method using the deal.ii finite element library in C++ to solve a 2D Poisson equation on a hyper-ball geometry with a non-linear source term, and visualized the outputs using VisIt

Insightful Classification of Crystal Structures using Deep Learning

(March 2022 - May 2022)

Course: CH5650 - Molecular Data Science and Informatics Course Project

- Implemented a Convolutional Neural Network as described in the paper by the same name, to classify the crystal structures of pristine and defected crystals into 8 possible crystal systems, attained an accuracy of > 99%

First Principles Modelling of FCC Aluminium

(September 2021 - October 2021)

Course: MM5003 - Atomistic Modelling of Materials Course

- Applied DFT codes written in VASP to model primitive cell and unit cell of FCC-Aluminium; calculated the lattice parameter, bulk modulus, vibration frequency, and visualized the computed structure using VESTA

Theoretical Design of Wind Turbines for Powering a Campus of 10,000 Students

(May 2021)

Course: MM5030 - Materials in Renewable Energy Tech. Course Project

- Estimated the power demanded by taking the IIT Madras campus as reference, used weather data from around Chennai in the wind turbine power equation to calculate the dimensions required for the turbine
- Performed a simplified analysis of stresses on the tower and blades and suggested materials to be used in the turbines

Technical Skills

- **Programming Languages:** Python, C, MATLAB, JavaScript (*Fundamentals*)
- **Frameworks and Libraries:** Tensorflow, Keras, NumPy, Sci-kit Learn, Open-CV, SciPy
- **Materials Modelling:** VASP, Abaqus(*Fundamentals*), DREAM.3D, pyCALPHAD, VESTA, ParaView
- **Scientific Tools:** GNU Octave, L^AT_EX

Relevant Courses

G - Graduate Level Elective, c - Certified Online Course

- **Computation:** Finite Element Analysis^G — Atomistic Modelling of Materials^G — Introduction to Programming — Computational Materials Engineering Lab — Data Structures and Algorithms^c
- **Materials Science:** Thermodynamics of Materials — Transport Phenomenon — Phase Transformations — Materials in Renewable Energy Tech^G — Physics of Materials — Non-Metallic Materials
- **Data Science:** Machine Learning^c — Deep Learning^G — Reinforcement Learning^G — Practical Machine Learning in TensorFlow^c — Molecular Data Science & Informatics^G
- **Experiment & Characterization:** Statistical Design and Analysis of Experiments^G — Materials Characterization — Advanced Transmission Electron Microscopy^G
- **Mathematics:** Functions of Several Variables — Probability, Statistics and Stochastic Processes — Series and Matrices — Linear Algebra for Engineers — Process Optimization^G

Co-Curricular Activities

- **Teaching Assistant** for the course “MM3110: Computational Materials Engineering Lab” at IIT Madras
- Attended the Canadian Society of Mechanical Engineers (CSME) 2022 at the University of Alberta, Edmonton

Extra-Curricular Activities

- **Co-Founder & Head, Behavioural Insights Club** (IIT Madras): **Founded** the first independent behavioural science club in a technical institute in India, to foster the development of a community of enthusiasts and connect the student body of IITM to experts in the field via research and industrial projects
- **Head, Shaastra¹ Mind Trials** (*Shaastra 2021-22, IIT Madras*): **Headed** a team of 8 to host awareness initiatives and a case-study competition on the application of Behavioural Sciences into solving pressing societal issues such as Sanitation, Road Safety, Nutrition and was responsible for managing a **budget of INR 1,00,000**
- Part of the **Editorial Team** of the MME department magazine, **ETCH**: Co-authored scientific articles on Sustainable practices in alloy design and processing, and on the Undergraduate Research culture
- **Student Mentor** (*Avanti Fellows 2019-20*): **Mentored** a student from JNV Pondicherry to prepare for the JEE Main and Advanced examinations, as part of the Avanti Fellows Pondicherry Chapter

1. Shaastra is the annual technical fest of IIT Madras