



VIR KARAN

Indian Institute of Technology, Madras, India

☎ +91 8008873918 • ✉ virkaran123456@gmail.com • 🌐 vir-k01.github.io

Education

Indian Institute of Technology Madras

B.Tech, Metallurgical and Materials Engineering

2019-23

CGPA: **9.25/10**, Department Rank: **1**

Scholastic Achievements

- Awarded the prestigious **MITACS Globalink Fellowship** to perform a fully funded 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)
- "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

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 PINNs to solve interface propagation problems governed by complex PDEs, such as the Allen-Cahn equation and a Ginzburg-Landau problem coupled to linear elastic mechanics, to model microstructure evolution during stress-induced martensitic phase transformations, without the use of any additional simulation data.

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 based framework to solve the inverse problem of generating 2-phase microstructures with target properties, and applied the same towards reducing damage susceptibility of DP Steels. This framework employed a StyleGAN2 to generate the microstructures, a Pix2Pix GAN to predict local stress fields given the microstructure and a Bayesian Optimization algorithm to locate the correct morphology that would have the least susceptibility to the formation of stress concentration sites.

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, and a Random Forest regressor to predict the damage initiation stress of microstructures under stress triaxiality. This was followed by an analysis of the generated microstructures with studies using the learned latent space, physical property (damage initiation stress under triaxiality) and statistical similarity metrics.

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 Generative Adversarial Network (GAN) Architecture using Convolutional-LSTM layers for solving coupled temporal PDEs by training on phase decomposition sequences of Binary and Ternary alloys, and analyzed the efficiency, scalability and 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

- Formulated the free energy of the Al-Zn system using Grand Potential Density approach, and used the thermodynamic properties of the Al-Zn system from the pyCALPHAD library to build the potential well. This was followed by simulation of microstructural evolution by solving the coupled phase-field PDEs numerically for the cases of phase separation and precipitate growth.

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

- Performed a survey of existing patents relating to the physical vapour deposition of metals onto organic substrates to design experiments for the same. Presently working on performing DC magnetron sputtering of silver onto SiO₂ substrates to maximize the optical transparency and the electrical conductivity of the deposited metal film.

Academic Projects

Solution of a Poisson Problem using the Finite Element Method

(October 2022 - Present)

Guide: Dr. Parag Ravindran, 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)

Guide: Dr. Tarak K Patra, 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 over 99%.

First Principles Modelling of FCC Aluminium

(September 2021 - October 2021)

Guide: Dr. Satyesh Kumar Yadav, Atomistic Modelling of Materials Course

- Applied DFT codes written in VASP to model primitive cell and unit cell of FCC-Aluminium, to calculate 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)

Guide: Dr. Prathap Haridoss, Materials in Renewable Energy Tech. Course Project

- Estimated the power demanded by taking the IITM 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 mechanical 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

* - Ongoing, c - Certified Online Course

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

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 Fitness, 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