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Machine Learning-Assisted Wear Behavior Evaluation of P/M Ti-Matrix Hybrid Reinforced Composites

Friday, 12 December 2025 14:00 (15 minutes)

Titanium is widely used as a matrix material in composites because of its favorable mechanical, physical and chemical properties, yet its cost and limited wear resistance and high-temperature performance restrict some applications. Ceramic-reinforced titanium matrix composites offer a practical route to improve wear behavior.

This study focuses on powder-metallurgy titanium-matrix composites with varying amounts of Al_2O_3, CeO_2 and few-layer graphene, and on how composition and grain size affect wear under 1–3 N loads and 10 m / 50 m sliding. Using the available lab measurements (volume loss, density and hardness), we will compute physics-based summaries such as the Archard wear coefficient and build conservative, interpretable predictive models. Given the modest dataset, we will treat machine learning as a decision-support tool: Gaussian Process Regression for uncertainty-aware prediction, tree-ensemble methods for ranking influential factors, and simple linear or regularized models as baselines. Models will be cross-validated and interpreted with partial-dependence and Shapley-value analyses. In this phase microscopy is not available, so recommendations will rely on measurable metrics and model interpretation. Surrogate-model suggestions will guide a short list of compositions for targeted experimental validation. All analysis will be performed in MATLAB and reported with quantified uncertainty.

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