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Title: Beyond bespoke models: foundational vision transformers for microstructure representation and machine learning of microstructure-property relationships in alloys

Abstract: Machine learning is rapidly emerging as a powerful approach to establishing microstructure–property relationships in structural materials. Most existing machine learning efforts focus on the development of task-specific models for each individual class of materials and individual properties. To go beyond bespoke models, we propose utilizing foundational vision models for the extraction of task-agnostic microstructure features and subsequent lightweight machine learning. We demonstrate our approach on two case studies: stiffness of synthetic two-phase microstructures learned from simulation data and Vickers hardness of superalloys learned from experimental data. Our results show the potential of foundational vision models for robust microstructure representation and efficient machine learning of microstructure–property relationships without the need for expensive task-specific training or fine-tuning. We further explore the extension of this approach to include additional alloy information (composition, processing) besides the microstructure for multimodal representation and learning of alloy properties.

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