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Application of Finite Element and Machin Learning for Improving the Thermomechanical Performance of Architectured Ceramics

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A new framework for improving and tuning the thermomechanical performance of topologically interlocked ceramics is presented using Machine Learning (ML). Topologically interlocked architectures can transform brittle ceramics into tough materials while making the material design procedure a cumbersome task. One of the challenges in designing is considering the whole architectural design space based on the interlocked architecture strategy because modeling the whole design space is not computationally efficient and, to some degrees, is not viable. Herein, a framework using machine learning algorithms is adopted to generate topologically interlocked materials with higher thermomechanical performance compared to the brittle pristine ceramics. The ML is trained by Finite Element modeling data. Improvement is observed in newly generated designs using ML, and finally, the accuracy of the ML predictions is verified by comparing with the results of finite element simulation. This research indicates a new approach for exploring new designs with improved characteristics. This algorithm can be applied to composite materials and other bioinspired structural materials for applications in aerospace, automotive, transportation, and energy sectors.

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