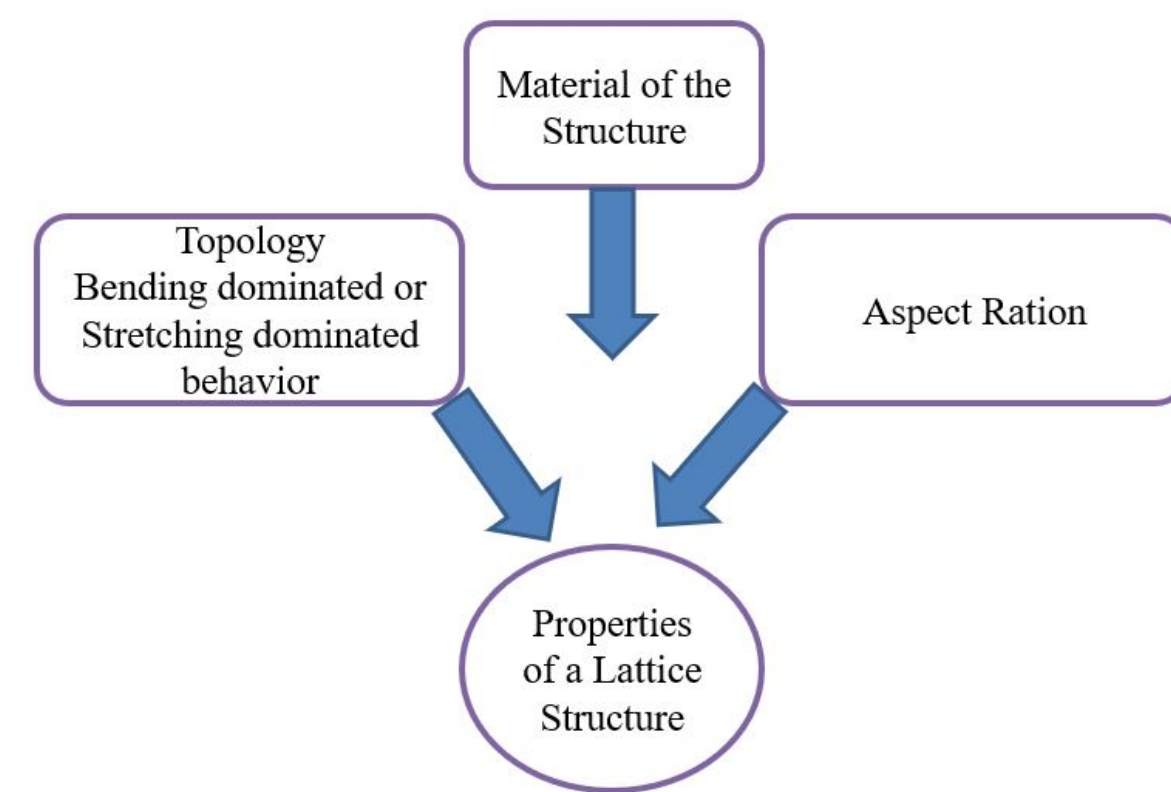


Abstract

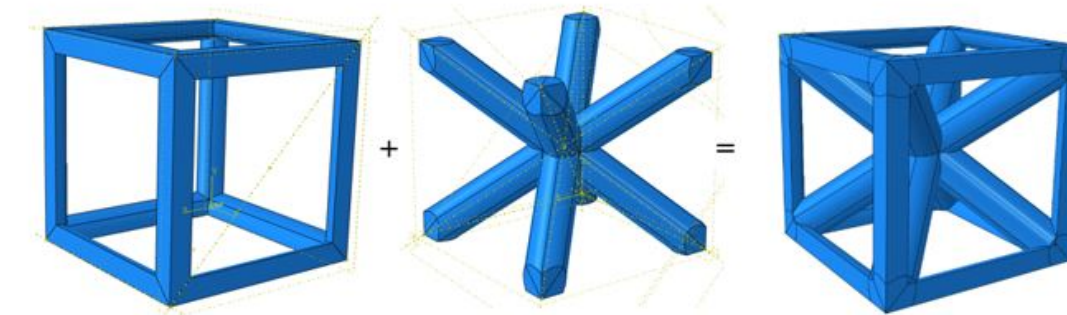
Finite element analysis (FEA) was employed to investigate the thermal behavior of additively manufactured polymer lattice-based thermal interface materials (P-TIMs) with different architectural configurations. Several lattice designs were generated by modifying a baseline polymer lattice through selective addition of vertical struts in uniform, alternating, and gradient arrangements to enhance through-plane heat conduction. Both open and closed-cell lattice configurations were considered, following the structural principles described by Ashby and Gibson, to evaluate the influence of unit-cell topology on thermal performance. Three-dimensional models of the lattice structures were analyzed using commercial FEA software (Abaqus). Steady-state and transient thermal simulations were conducted to determine effective thermal resistance, heat flux distribution, and temperature gradients under representative operating conditions. Contact interactions with the chip and heat sink were modeled to capture the effect of interface pressure on heat transfer. Results demonstrate that lattice architectures with vertical thermal pathways and optimized open/closed cell designs significantly reduce thermal resistance and improve heat transfer efficiency compared to baseline lattices. The simulations highlight that unit-cell topology and strut arrangement play a key role in controlling through-plane heat conduction, providing critical insights for the design of high-performance P-TIMs. This study confirms that FEA-guided geometry optimization is an effective strategy for tailoring additively manufactured (3D-Printed Technology) polymer lattice TIMs for advanced electronic cooling applications (Chips Die).

Properties of Cellular



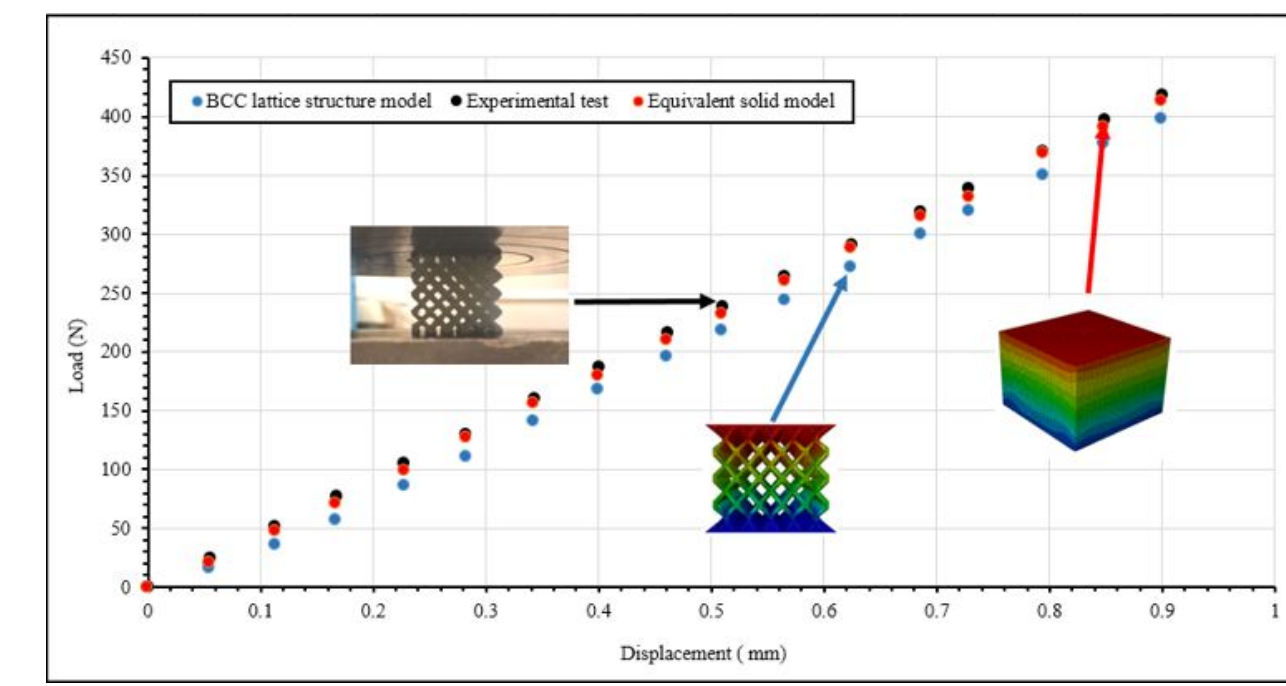
Gibson-Ashby Model

Combining InsideBCC



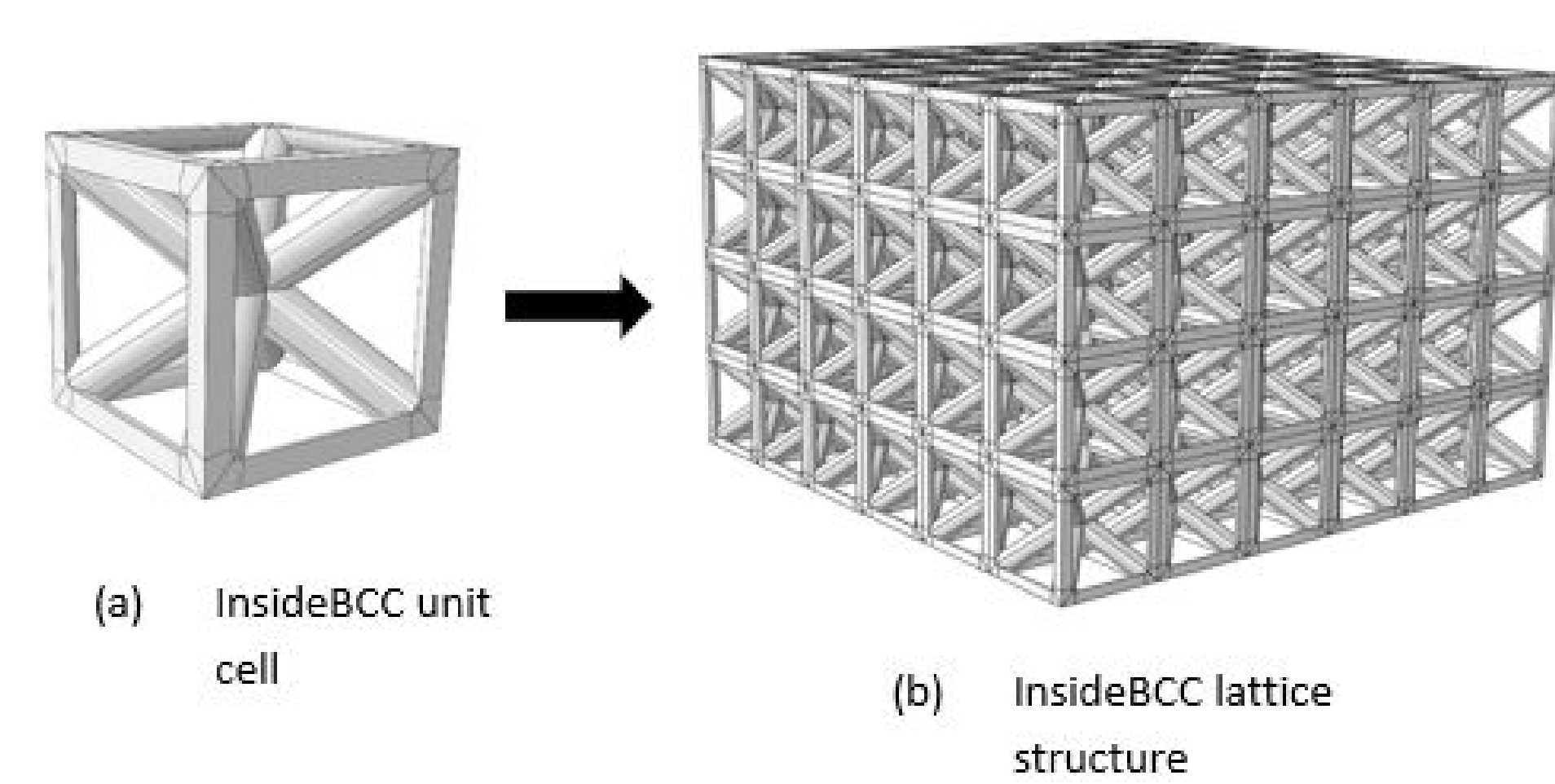
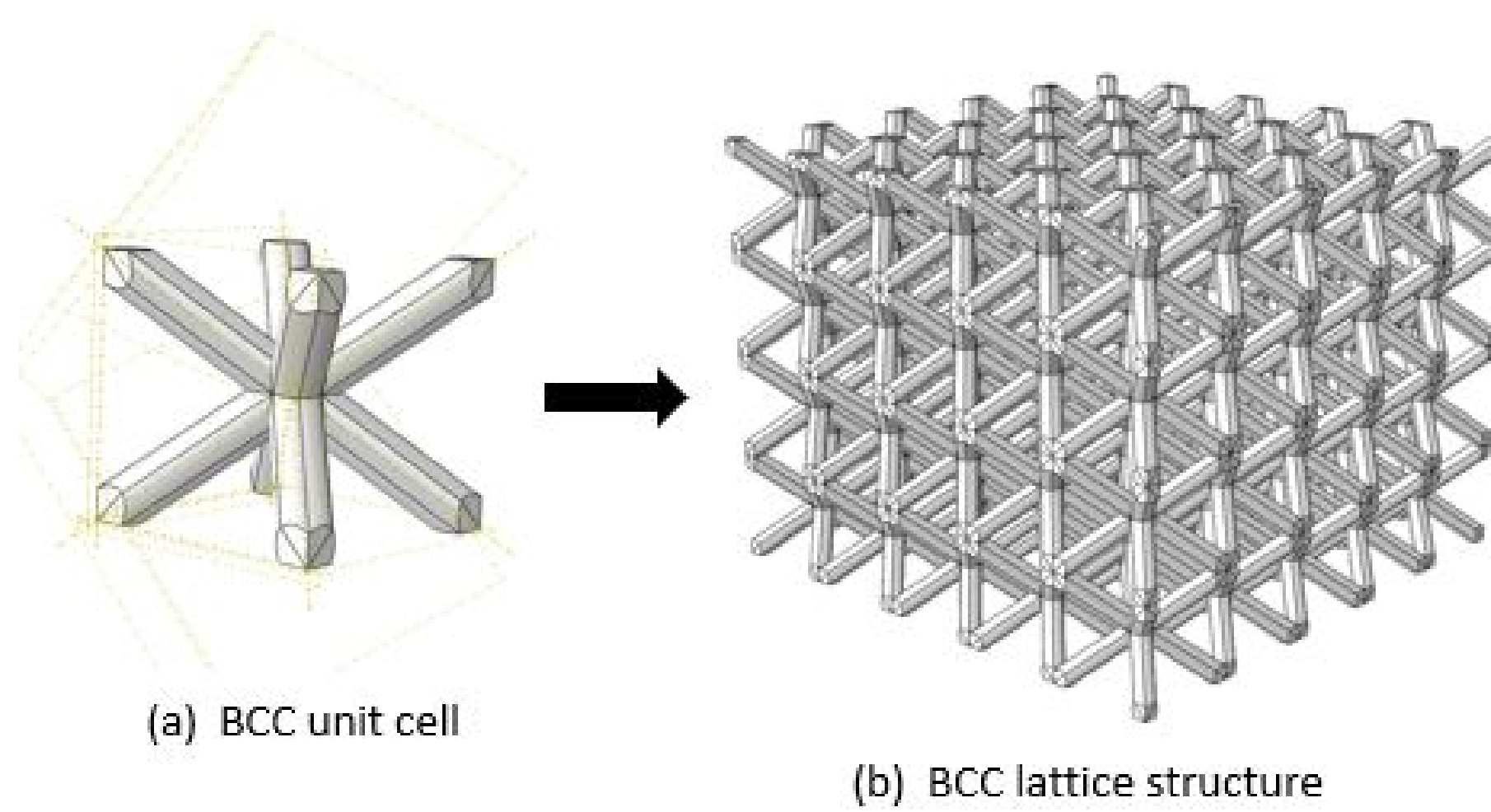
Body-Centered Cubic (BCC) unit cell + InsideBCC unit cell = Composite Structural (Combining)

Comparison of FEA

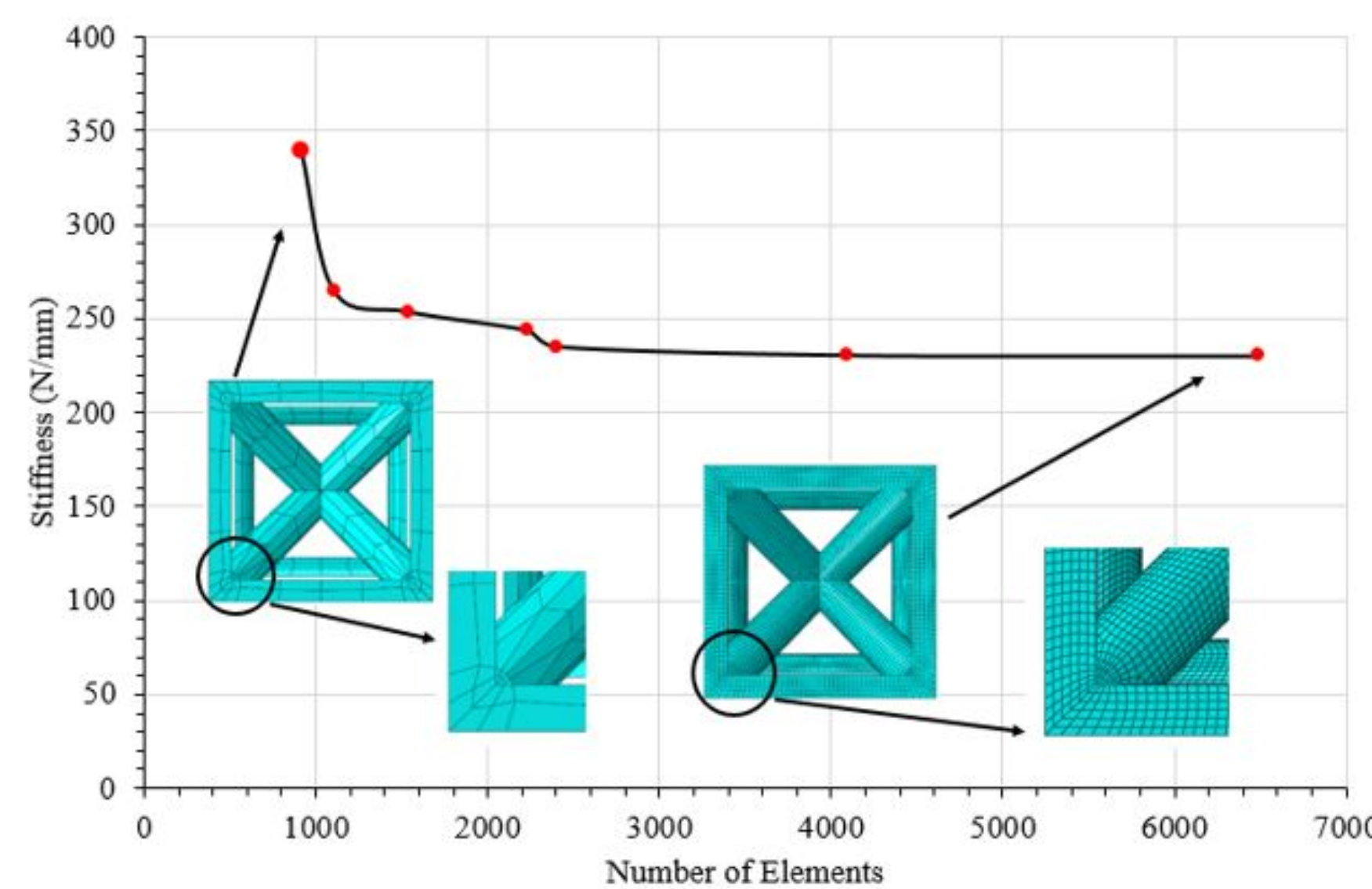


Comparison of the FEA simulation of LCS, experiment test and equivalent solid model

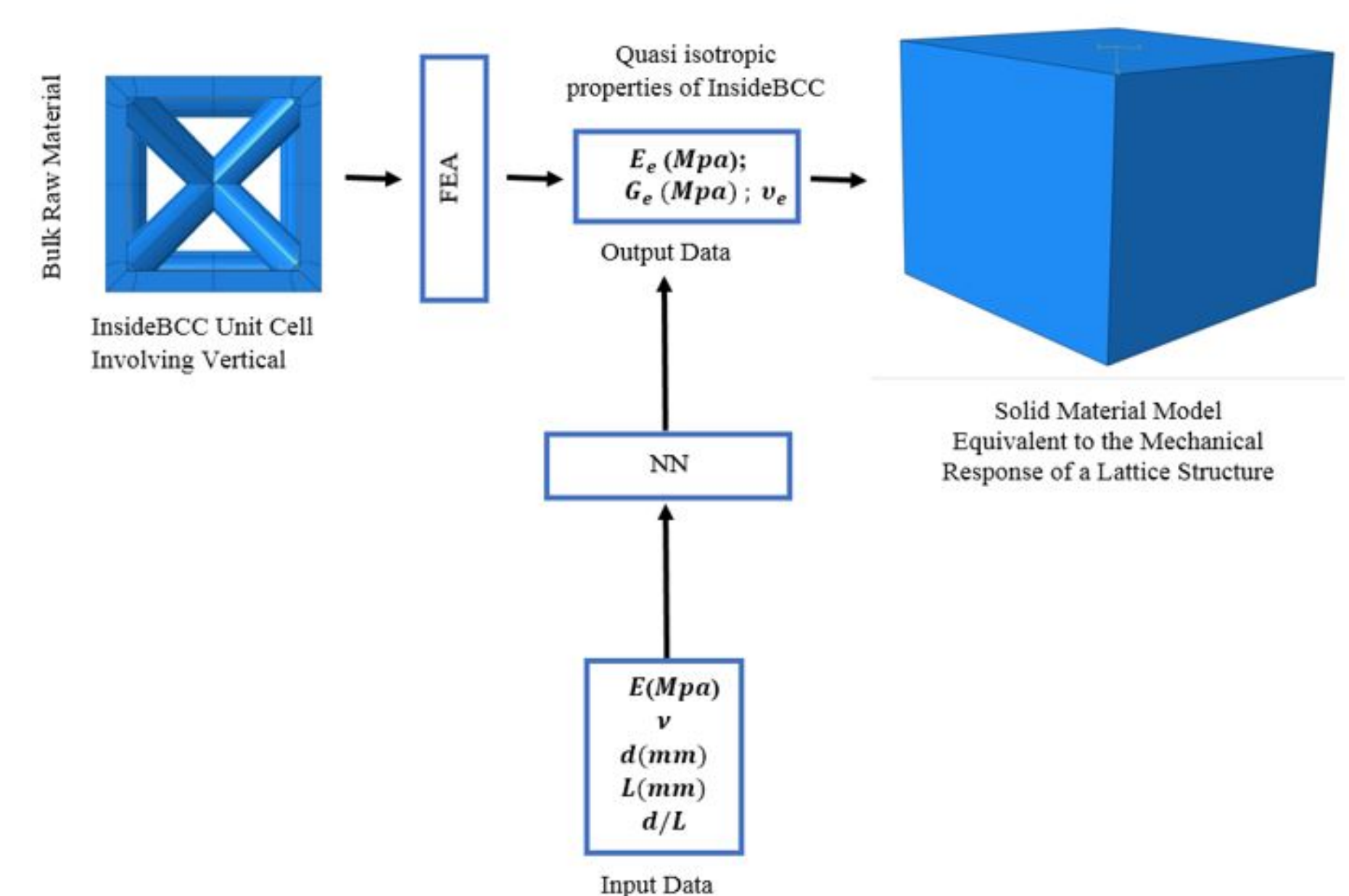
Micromechanics Technique Design



Design and Mesh Generation



FEA Model to NN Model



Design I-TIM

Micromechanics Technique DMT Using Abaqus CAE

Acknowledgments

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Methodology Strategy from FEA model to NN model

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- J. Li et al., Experimental Characterization of 3D Printed PP/h-BN Thermally Conductive Composites With Highly Oriented h-BN and the Effects of Filler Size. *Compos. Part A: Appl. Sci. Manuf.* **150**, 106586 (2021). <https://doi.org/10.1016/j.compositesa.2021.106586>
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Design of an Innovative Thermal Interface Material

