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Porous metal by topology optimization and additive manufacturing

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Abstract

Porous metals are recently utilized in many engineering applications due to its light weight, high impact absorption or large surface area characteristics etc. However, although its performance depends on its microstructure shape, its control in manufacturing are very difficult because conventional fabrication methods of porous materials are based on foam formation.

On the other hand, microstructural shape optimizations of material are very active topic in the field of topology optimization (TO) from the early stage. However, the complicated shape of the hard to be implemented by conventional manufacturing techniques. Thus, few experimental verification was performed which is crucial for putting these material to practical use.

Recent development of additive manufacturing enable the detailed 3D manufacturing even in 0.01 mm scale which is enough for realizing topology optimized material microstructure. As the source material, even metals such as steal, titanium and aluminium can be used. Thus, utilizing both such additive manufacturing technology and TO technique, porous metals having optimized microstructure and performance could be realized.

Based on the above, in this research, we study the topology optimizations of porous material aiming the maximization of isotropic thermal conductivity and bulk modulus respectively. The optimality of the results is confirmed based on the Hashin-Shtrikman bound. The optimal results were fabricated of using metal additive manufacturing technique. We then finally perform some experiments to confirm the optimal extremal results could certainly be realized.