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Multi-material Level Set based Topology Optimisation of Convectively Cooled Heat Sinks

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This paper studies the application of Level-set based Topology Optimisation to a convectively cooled multi-material heatsink design problem. The study is relevant because of the rapid development taking place in additive manufacturing is enabling multi-material manufacturing, with spatial variation in material properties achieved through selective deposition. Topological optimisation techniques can be utilised to determine the optimal distribution of material within a design space within a prescribed set of constraints. Such optimisation studies typically result in designs that appear organic in nature and are therefore challenging to manufacture with conventional methods. The combination of Topological Optimisation and Additive Manufacturing presents a means to profoundly improve the performance of mechanical designs.

Sigmund [1], used the density method based Topology Optimisation for the design of three phase thermal expansion materials. MY Wang [2] and Y Wang [3] presented different methodologies for Level set based multi-material Topology Optimisation, applied to structural mechanics problems. This study progresses the state of the art by extending the work of [3], using dual level set functions and HJ equations with regular re-initialisation to examine the design of a two-material heat sink at a number of different fluid-solid conductivity ratios and, additionally, at a number of different solid volume fractions. Results obtained from this study exhibit low thermal compliance levels and the shapes resemble expected organic tree-like shapes.

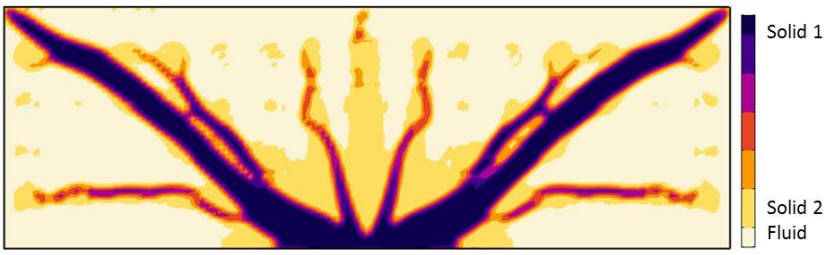

Figure 1 Optimised two-material convectively cooled heat sink design

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