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SINTERING OF 3D PRINTED COPPER-STEEL FUNCTIONALLY GRADED MATERIAL

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Over the past several years, additive manufacturing has continued to expand and advance toward more promising responses to high-performance multi-functional applications. One such response is the utility of functionally graded materials (FGMs). In an FGM, the composition and structure gradually change over the volume as, in the simplest form, two different material ingredients change from one to the other. Incorporating a gradient pattern essentially eliminates the need for dissimilar metal welds and joints opening the applicability of such technology to fields such as structural, aerospace, biological, electrical, and others. Manufacturing of these FGMs has been previously studied with a variety of metals and ceramics combined with a variety of production methods, including many additive manufacturing techniques. Many of these, however, present complex and costly procedures utilizing high power lasers and high-cost machines. A newer method being studied for 3D printing metal parts is using a metal filament. This filament is a combination of pure metal powder and PLA which can be used in common, off-the-shelf 3D printers, making it a low cost and easy alternative.

There is a great interest in manufacturing FGMs using copper and steel for applications such as steel-copper die casting. However, by simply depositing copper onto steel, problems at the interface occur with formation of undesirable phases causing cracking and an ineffective tool. By using copper and stainless-steel metal filament, an FGM can be printed quickly with a controllable gradient change and infill density while providing an economically viable option while diminishing this interface. As compared to the conventional homogeneous, isotropic materials, these multi-material samples however, do not behave uniformly under thermal alteration. Therefore, they require optimization of post-processing sintering parameters. This project focuses on the control of the optimized sintering conditions and parameters and analysis of the microstructure of the final copper-steel FGM proving a successful gradient pattern with low porosity.