Adapting topology optimization to various metal additive manufacturing technologies: Harnessing projection-based and multiphase schemes to generate print-ready designs

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ABSTRACT

Additive manufacturing (AM) presents itself as an excellent tool to solve defense-related problems, whether that be simple supply chain risk mitigation through direct part replacement, or, more intestingly, manufacturing of redesigned parts and systems to meet the new requirements in the field. This second situation tenders an exciting challenge and opportunity to efficiently redesign components and systems at the "point of need." In addition to the typical "on demand" engineering in the field, there are significant efforts in formulating robust, adaptable, and powerful requirements-driven computational design schemes to solve these problems. The primary design tool of interest is topology optimization (TO). Typical parts of interest are often metals, so the focus herein will be on metals AM. However, many of the design schemes are applicable and adaptable to AM with polymers and other materials.

This presentation will primarily focus on approaches for clearly pairing TO to metal AM technologies, including powder-bed and powder-fed systems with various energy sources. In addition to generating optimal topologies adhering to the typical self-supporting design requirement [1, 2], other design schemes explore eliminating the occurance of parasitic mass in enclosed pores, and designing for 5 axis manufacturing systems (e.g. blown powder directed energy deposition, or cold spray). The design rules are typically imposed implicitly through projection-based [3] and multiphase [4] TO schemes. Some thoughts are provided on the difficulties or opportunities encountered when combining multiple design schemes (e.g. simultaneous design for overhang angle and parasitic mass removal). Results are shown to be printable, with varying degrees of performance degradation in comparison to free-form TO schemes, as expected.

REFERENCES

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