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Additive Manufacturing Via Digital Light Processing of Durable Ceramic Porous Structures for Application to Combustion Systems

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Combustion in porous media leverages heat transfer between the reacting gas and the solid structure to enable enhanced combustion properties. By internally recirculating heat released from the combustion products upstream to the reactants via an inert solid matrix, porous media burners (PMBs) enable the reliable utilization of lean fuel/air mixtures and reduce pollutant emissions. The local porous structure of PMBs directly affects the total heat transfer across a porous material. However, conventional fabrication methods for the ceramic structures applied in PMBs produce locally random pore geometries and sizes within a range of global parameters. In this research, we demonstrate fabrication of porous ceramics with predefined and reproduceable microstructures to enable tailored PMBs.

The computational geometries of the porous structures are first carefully architected for fine control of the burner performance, then additively manufactured using digital light processing. These printed structures are then integrated in PMBs for testing where the thermal and mechanical properties of the structures as well as burner performance are characterized. Thermal cycling and shock are limiting factors for the lifespan of additively manufactured ceramic PMBs; to address this, triply periodic minimal surface (TPMS) structures make up the porous media, minimizing stress concentrations compared to foam based porous media and beam-based lattices. The thermal shock performance and thermal conductivity of various ceramic TPMS structures and slurry compositions is quantified. Further structural refinements to TPMS structures, such as tailored cell size and porosity grading, are incorporated into the design and fabrication of subsequent PMBs based on these characterizations.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

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