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Analytical Investigation on Regression Rate of 3D-Printed Polylactic Acid Doped with High Entropy Alloys Additives in Hybrid Rocket Motor

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Abstract
This study investigates the regression rate of hybrid rocket motors (HRMs) using 3D-printed polylactic acid (PLA) infused with high entropy alloys (HEAs). Traditional HRM fuels have low regression rates and combustion instability, according to studies. HEAs, which are high-temperature stable and mechanically strong, have not been extensively integrated with PLA. The study examines how geometric configurations and HEA concentrations affect PLA-HEA propellant combustion efficiency, regression rate, fuel grain length, and specific impulse to fill this gap. Analysis analyzes how geometric configurations and HEA concentrations affect PLA-HEA propellant performance. Regression rate, fuel grain length, and specific impulse are examined in metal-infused 3D-printed PLA HRMs. HRMs with wagon wheel ports have the largest regression rate, 5.99 mm/s for high HEA concentrations, compared to 1.03 mm/s for cylindrical ports. Wagon wheels' 146.03 s specific impulse beat cylindrical ports' 57.81 s. Wagon wheel design reduces fuel grain lengths to 0.22 m at higher HEA concentrations, the study found. Analytical results show that wagon wheel ports improve hybrid rocket specific impulse, fuel grain length, and regression rate. Due to intense combustion, the wagon wheel port has the highest regression rate and shortest fuel grain. A high specific impulse value shows the port can convert propellant energy into thrust.

Author Keywords
Fused deposition modeling (FDM); High entropy alloys (HEAs); Hybrid rocket motor (HRM); Polylactic acid (PLA); Regression rate

Index Keywords
Boosters (rocket), Cylinders (shapes), Manganese alloys, Propellants; Alloy concentration, Deposition modeling, Fused deposition modeling, High entropy alloy, High entropy alloys, Hybrid rocket motor, Hybrid rocket motors, Polylactic acid, Regression rate, Wagon-wheels; High-entropy alloys

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