Direct Ink Writing to Fabricate Complex Metal Structures from Titanium Alloy

Three-dimensional printing of lightweight metal components is currently implemented at aerospace manufacturing companies to significantly diminish fuel consumption and space travel costs. However, the three-dimensional printing techniques presently used to fabricate complex metal structures result in high manufacturing costs, high energy consumption, and residual thermal stresses within the printed parts. This work proposes a direct ink writing method using titanium alloy-based ink to print complex metal structures at room temperature. After printing, a multi-step heat treatment process is used to produce metal structures without residual thermal stresses. The developed self-supporting ink is comprised of titanium-6 aluminum-4 vanadium (Ti64) particles, bentonite yield-stress additive, ultraviolet curable polymer, and photo-initiator. The rheological properties and printability of the ink at differing concentrations of Ti64 and bentonite were systematically investigated. Additionally, the printing parameters, geometrical limitations, and maximum curing depth were examined during and after printing. Lastly, lattices, honeycomb, and cup structures were successfully printed/fabricated to validate the effectiveness of the proposed printing method and ink material.