Advances in Additive Manufacturing Using Magnesium Alloy Powders

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Abstract

Magnesium based alloys offer unique opportunities from an additive manufacturing (A/M) perspective because of their low density, good tensile and fatigue properties along with high relative stiffness. A/M of magnesium alloys have been investigated since 2009 and early studies have evaluated the processing behavior of magnesium powders, and identified challenges due to material and powder characteristics. The two main a/m processes that have been investigated include the powder bed fusion and directed energy deposition (DED). A powder bed fusion process can be used to design and fabricate magnesium parts with a high degree of complexity and result in additional weight savings. By comparison, a DED process can be used for manufacturing and repair/refurbishment of metal parts such as aerospace castings. Recently, an Elektron® MAP 43 alloy (Mg-4Y-3Zr) powder was developed for the DED process and builds up to 15.24 cm x 5.08 cm x 1.27 cm were fabricated by optimizing parameters such as laser power, scan speed, and chamber oxygen to minimize porosity and produce desirable build microstructures. It was possible to achieve near-theoretical densities along with mechanical properties that compared favorably with cast and heat treated Elektron®WE43 alloy. A laser powder bed fusion process was also investigated using the Elektron® MAP 43 alloy in which it was possible to achieve a yield stress of 194 MPa, UTS of 312 MPa, and elongation of 14%, which is superior to typical as-cast and heat treated alloy. This presentation will provide an overview of the magnesium additive manufacturing progress and include powder manufacturing, unique process challenges, and potential applications using directed energy deposition and laser powder bed fusion.