Additive manufacturing (AM), also known as 3D printing, has demonstrated the ability to produce custom, complex engineering components from metallic alloys, not previously possible with traditional techniques such as subtractive machining of casted alloys. However, many desired lightweight metallic alloys such as high strength aluminum (Al) and magnesium (Mg) alloys, cannot be processed dense with AM due to the consequence of solidification cracking. Thus, a large knowledge gap remains in assessing already existing, and genesis of new alloys that can be processed dense by AM, without solidification cracking. The present work investigates the AM processing and solidification behavior of select Al- and Mg-alloys, as well as describe, formulate, and test a method for understanding the cracking tendency of metallic alloys during AM using Scheil solidification modeling to index crack susceptibility of alloys. In comparison with experimental results for binary Al-systems, the observed cracking severity was in good agreement with the prediction from the cracking susceptibility index. For further consideration, this method for predicting cracking susceptibility was utilized to assess the high strength Mg-alloy, WE43, important for application in lightweight, combat-ready armors for military applications, structural components in automobiles, and even for use as bioresorbable prosthetic implants. Through exhaustive demonstration, dense WE43 parts with good strength and ductility were repetitively produced with AM. Furthermore, complex WE43 lattice structures, intentionally designed with porosity, to lighten the material without sacrificing strength, were built with AM. Mechanical testing yielded high strength to weight ratios in the lattices, giving high potential for WE43 lattices to become the ultimate lightweight material.

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The public is welcome to attend.