

AISI H13 Hot Work Tool Steel Produced by Laser Powder Bed Fusion

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By now, additive manufacturing (AM) is more commonplace in the field of materials research, as many authors explore possibilities of given materials and expand our knowledge on the application of AM. However, despite these great strides we made, a lot of research remains to be done, as each answered question tends to bring up several new ones.

AM has three main benefits: the ability to produce complex geometries, that you would not be able to manufacture with other means, the specific microstructure that is innate to the process and the ability to produce very low amounts of waste material. The two main drawbacks of the technology are high upfront costs and low production volumes. This is why AM is already quite popular in advanced technology sectors like aerospace and medicine, where it fills strictly defined niches for individual tailored parts, while other sectors have been slower in adopting AM as a method of production. One sector that could greatly benefit from AM is the tooling sector. As it currently stands, most tools are made with reductive processes, where their shape is achieved by removing material. This is somewhat limiting, as it creates large amounts of material waste in the form of shavings, and the design is limited to mostly straight channels. As the AM process builds the tool from the ground up, the cooling channels can be made to conform to the shape of the tool, optimizing the heat control and ensuring a longer service life of the tool. The shape of the tool itself can also be as complex or as simple as the job requires and the steel powder used in manufacturing the tool can be almost entirely recuperated, only needing a sieve, to take out any agglomerated particles.

AISI H13 hot work tool steel is already a common pick for tools, as it has excellent hardness and wear resistance at room and elevated temperature, paired with good softening resistance and an economical price, make it a shoo-in for many tool makers. While it has impressive mechanical properties given the relatively low amount of alloying, it tends to be difficult to weld, due to the fact that the steel hardens very quickly which causes it to be at risk of cracking. The same principles apply to manufacturing parts with laser powder bed fusion (LPBF) which is one of the main methods of AM. The high cooling and solidification rate inherent to the LPBF process induce a lot of residual stress in the produced parts, which make them brittle. This can be somewhat alleviated with the use of base plate preheating, which reduces the amount of residual stress build up in the parts.

In this work we aim to present a summary of all the stages of the LPBF production of H13 parts from the impact of the powder, to the printing parameters and the post treatment of samples. To facilitate this, we produced a variety of samples ranging in geometry, printing parameters and heat treatments. We analyzed the microstructure of these samples, and performed a variety of tests to measure their mechanical, physical and corrosive properties.