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MANUFACTURE OF TOOLS FROM 1.2709 BY MEANS OF HIGH POWER SELECTIVE LASER MELTING – HP-SLM

Task

Thanks to its high mechanical strength and toughness, the maraging tool steel 1.2709 (X3NiCo-MoTi18-9-5) is commonly used in the plastics processing industry to produce molds with complex freeform surfaces and in small quantities. The additive manufacturing process Selective Laser Melting (SLM) makes it possible to produce such complex freeform surfaces of otherwise series-identical materials such as 1.2709 due to its virtually unlimited design freedom. However, there is a considerable need to increase the speed of SLM manufacturing.

Method

To accelerate the production of the tools made by SLM, Fraunhofer ILT has increased laser power ($P_L \leq 2$ kW) in combination with an adapted process management (skin-core strategy). For this purpose, the component is divided into a skin area and a core area; the core area is produced with an increased focus diameter (about $720 \mu\text{m}$) in connection with laser powers of up to 2 kW. Thereby, the layer thickness (up to $180 \mu\text{m}$) and the track pitch (to $600 \mu\text{m}$) can both be increased, resulting in an increased build-up rate.

Result

In the manufacture of test specimens, it could be shown that the theoretical construction rate of $V_{th} = 3 \text{ mm}^3/\text{s}$ with conventional process control at $P_L = 300 \text{ W}$ can be increased up to $V_{th} = 18 \text{ mm}^3/\text{s}$ with the HP-SLM process control at $P_L = 2 \text{ kW}$. In the next step, the process parameters thus identified were used to produce a mold for profile extrusion. The production times, which also contain delay times in comparison to the theoretical build-up rate, were compared between conventional SLM production ($P_L = 300 \text{ W}$) and HP-SLM production. The HP-SLM process control at $P_L = 1 \text{ kW}$ enabled the production time to be reduced by 46 percent.

Applications

The work described here above took place within the scope of the Excellence Cluster »Integrative Production Technology for High-Wage Countries«. The results will be directly applied in the manufacture of functionally adapted extrusion tools for plastic injection molding or for profile extrusion.

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3 Photograph of the high power SLM process.
4 Profile extrusion tool manufactured by HP-SLM out of 1.2709.