Additive Manufacturing Annealing Guidelines

Components formed from Additive Manufacturing Victrex materials can be printed amorphous or crystalline.

If printed amorphous, post-processing annealing is recommended for reaching high level of crystallinity, high mechanical performance, and high chemical resistance. For components printed directly crystalline, optimum crystallinity can be reached under appropriate filament extrusion conditions and secondary annealing will not be necessary in the majority of applications.

Some applications will require annealing to increase levels of crystallinity, remove any thermal history, limit subsequent dimensional changes at high temperatures, or to remove stresses. It is standard practice in the AM community to use sand-like materials as mechanical restrictions for annealing printed parts. The purpose is to minimise geometrical distortion in post-processing. The appropriate annealing procedure will depend on the objective of the process as detailed below.

Please contact Victrex Technicccal Support with questions on your specific part and process.

ANNEALING FOR OPTIMUM CRYSTALLINITY

Increasing crystallinity within a component may be necessary if the material does not reach an adequate level of crystallinity during melt processing or if it has been printed amorphous. In natural-coloured grades, a crystalline part is characterised by beige matte colour, while an amorphous part or region is characterised by a brown colour with some level of transparency. To reach the proper level of crystallinity, the following cycle is recommended:

a) Allow the component to heat up until an equilibrium temperature of at least 200°C is reached.
b) Hold the part at the annealing temperature. The holding time for components is dependent on section thickness; as a general guide, hold parts at temperature for 1 hour for each millimetre of wall thickness.
c) Allow the component to cool at 10°C per hour until the system falls below 140°C. Slow cooling is critical to minimise residual stresses in the material.
d) Switch off the oven and allow the component to cool down to room temperature.

Increasing the temperature and holding time will affect the level and type of crystallinity developed in annealing. A holding temperature at least 20°C greater than the maximum service temperature is recommended. Annealing temperatures in the range of 200 – 250°C are widely used. Annealing temperatures up to 300°C and higher may be used to maximise crystallinity, which can improve some mechanical properties (e.g., strength and modulus) and chemical resistance for 450G™ filament. However, these effects may be accompanied by a significant decrease in ductility in unfilled grades. Surface oxidation or yellowing may also occur because of the high annealing temperature. A maximum annealing temperature of 280°C is suggested for VICTREX AM™ 200 filament.

Please contact a Victrex technical support Victrex Technical Support if assistance is needed.

ANNEALING TO REMOVE STRESSES

Post-processing machining operations may add stresses to a component. These stresses reduce the physical performance of devices and may be removed by annealing the sample as described above, with a holding temperature up to 230°C for filaments; 450G™ and 220°C for VICTREX AM™ 200.

ANNEALING FOR DIMENSIONAL STABILITY

Components of Victrex materials exposed to high continuous service temperatures may experience post-crystallisation and/or internal stress relaxation which result in dimensional changes. Components may be annealed to remove distortion effects or thermal history and prevent shrinkage or other dimensional changes to the component while in service. Anneal the sample as described above, with a holding temperature at least 20°C greater than the maximum service temperature. If the part is machined, annealing should be done prior to the final machining step.