Test results for HP 3D HR PA 12

Table 3 shows the values that have been obtained for HP 3D HR PA 12 in the HP Jet Fusion 4200 3D Printing Solution, with the Balanced PA 12 print profile, with Type I tensile specimens following the ASTM D638 standard.

HP 3D HR PA 12[i ii iii]	Average (XY)	Average (Z)	Test Method
Tensile strength (MPa)[iv]	50	50	ASTM D638
Tensile modulus (MPa)[iv]	1700	1900	ASTM D638
Elongation at yield (%)	12	8	ASTM D638
Elongation at break (%)	17	9	ASTM D638
Impact strength (kJ/m^2)[v]	3.7	3.8	ASTM D256
Density (g/cm^3)	1.01		ASTM D792

i. Based on internal testing and measured using the HP Half_Commercial_Datasheet_Job. Results may vary with other jobs and geometries.

ii. Using HP 3D HR PA 12 material, 20% refresh ratio, Balanced print profile, natural cooling, and measured after bead-blasting with glass beads at 5-6 bars.

iii. Following all HP-recommended printer setup and adjustment processes and printheads aligned using semi-automatic procedure.

iv. Tensile strength typical variation (95% of parts) falls within the 45-55 MPa range, while tensile modulus values remain within the 1500 to 2100 MPa range.

v. Using the Izod test method A with notched @ 3.2 mm specimen according to the ASTM D256 standard.

Table 3. Results for HP 3D HR PA 12

Appendix 2: Key terms

- **Tensile strength** or Ultimate Tensile Strength (UTS) is typically measured in MPa or N/mm^2. It is the capacity of a material to withstand tension loads. Tensile strength is measured by the maximum stress that a material can withstand while being pulled before breaking.
- **Tensile modulus** (also Young's Modulus or E) is typically measured in MPa or N/mm^2. It is a mechanical property that measures the stiffness of a solid material. It defines the relationship between stress and strain in a material in the linear elasticity regime. Since thermoplastics have a very short linear elasticity zone, it is calculated as the slope of the stress-strain curve very close to zero. Tensile modulus is required as an input for mechanical FEA simulations.
- **Elongation** measures the deformation that a part undergoes given a certain stress. For thermoplastics, it is typically expressed as a percentage (%) of the deformed amount versus the original part length.

  Elongation at yield in thermoplastics is the deformation corresponding to the tensile strength point, so where the stress-strain curve reaches its maximum.

  Elongation at break is the deformation corresponding to the fracture point of the part.
- **Impact strength** measures the impact resistance of a material or the amount of energy absorbed by a material during fracture associated with its toughness. The units are typically kJ/m^2 (energy per unit area). There are two standard methods to measure impact strength: the Izod and the Charpy. Notched and unnotched specimens are used on the specific pendulum testers to determine the impact strength and the notch sensitivity.
- **Stress** is the force density (quotient of internal force and effective area) prevailing in every area element. There are two types of stresses depending on their direction to the cross-sectional plane studied: normal stress and shear stress.
- **Deformation** refers to any stress on a solid body that generates strain. A distinction is made between elastic and plastic deformation. Elastic deformations disappear once the imposed external load has been removed. Plastic deformations occur when the inner stresses exceed a certain limit that is intrinsic to the material. In this case deformations will remain after removal of the external load. Hence, plastic deformation is permanent and non-reversible.
- **Heat deflection temperature** is defined as the temperature at which a standard test bar deflects a specified distance under a load. It is used to determine short-term heat resistance. It is determined at different loads, for example, 1.8MPa (264 psi), which helps to determine maximum service temperature of parts, and 0.46Mpa, which provides an estimate of the service temperature a given polymer can withstand. Other settings like speed of the temperature increase or even part design will significantly influence the final thermal performance of an application.

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