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TOUGH PRO PLA Technical Data Sheet

General Information

American Filament Tough Pro PLA+ Filament delivers improved heat resistance and high impact strength to FDM 3D printed parts. This engineered grade attains thermal and mechanical properties similar to ABS, thereby providing a bio-based alternative to styrenic-based materials. It possesses excellent 3D printing characteristics such as precise detail, good adhesion to build plates, less warping or curling, and low odor. Tough Pro PLA+ is manufactured using virgin Natureworks Ingeo 3D870 PLA – a product that is Made in the USA!

PHYSICAL PROPERTIES (1)	3D870	ASTM METHOD
Specific Gravity, g/cc	1.22	D792
MFR, g/10 min (2)	45550	D1238
Peak Melt Temperature, °C	165-180	D3418
Glass Transition Temperature, °C	55-60	D3418

(1) Typical properties; not to be construed as specifications.
(2) 210° C/2.16 kg

MECHANICAL PROPERTIES (3)	XY AXIS	YX AXIS	ZX AXIS	ASTM METHOD
Tensile Strength, psi (MPa)	5,802 (40)	4,641 (32)	3,481 (24)	D638
Tensile Modulus, kpsi (MPa)	416 (2,865)	355 (2,447)	359 (2,477)	D638
Flexural strength, psi (MPa)	10,588 (73)	7,106 (49)	6,672 (46)	D790
Flexural modulus, kpsi (MPa)	350 (2,414)	287 (1,979)	341 (2,352)	D790
Notched Izod Impact [amorphous], ft-lb/in (J/m)	2.99 (160)	2.26 (21)	2.04 (109)	D256
Notched Izod Impact [crystalline], ft-lb/in (J/m)	4.37 (233)	3.74 (200)	1.19 (64)	D256
Heat Distortion Temperature (°C) 66 psi (0.45 MPa)	75-85			E2092

(3) All 3D printed parts printed at 100% infill and annealed at 110°C/20 min unless otherwise noted. Bars printed and tested by a 3rd party.

TEMPERATURE PROFILE (4)	METRIC
3D Printing Temperature	205-220°C
Print Bed Temperature	45-60°C
Annealing Temperature	110-120°C

(4) Starting points only. May need to be optimized depending on your FDM printer.

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Annealing Printed Parts

Ingeo 3D870 is formulated to crystallize when annealed post-printing. Crystallization is a simple, effective route to improve the thermal performance and further enhance the impact properties of Ingeo 3D870. The recommended anneal temperature range is 110°C-120°C. Annealing can be carried out in an oven or some other medium of heat-transfer, such as a hot-water bath. Make sure to follow safety procedures that are appropriate for working around elevated temperatures.

1. Pre-heat oven to an anneal temperature range of 230°C - 248°C (110°C-120°C).
2. Measure temperature at various locations in the oven to ensure absence of hot/cold spots. Uneven heating can lead to unexpected warpage and sub-optimal performance of the part
3. Place printed part in oven and start timer. Typical time to anneal parts with wall-thickness of 0.125 in (~3.18 mm) is around 20 minutes, but this time is dependent on wall thickness.
4. For large dimension parts, it is common to use support fixtures (e.g.-aluminum jigs) during the annealing process
5. Once removed from the oven, let the part cool in ambient conditions. Minimize handling, as inside of the part will likely remain at elevated temperatures longer than the outside.
6. If using a water-bath to anneal, the part may have to be at temperature for a slightly longer time to crystallize (since the water-bath cannot be at 110°C-120°C).
7. Measure dimensions of the part prior to annealing and again after, to determine shrink.

To mitigate warpage, the part may be buried in a sand bed in a suitable container (metal or glass) prior to placement in the oven. The recommended procedure is as follows:

1. Use an oven-safe container, such as a glass or metal bowl, that is larger than your 3D-printed part and provides at least two inches of space around it on all sides (including the top).
2. Add a layer of fine sand at least two inches thick to the bottom of the container, then place your part on top. Carefully pour sand around the part, ensuring it fills all gaps and voids. Keep pouring until the part has at least two inches of sand on top.
3. Preheat your oven to 110–120°C (230–248°F) and let it maintain the set temperature for about 10 minutes to stabilize and prevent temperature overshooting.
4. Place the sand-filled container in the oven and allow it to heat for one hour. This ensures the sand has sufficient time to fully heat and transfer evenly to the part.
5. Once the hour has passed, turn off the oven and leave the container inside, allowing the sand and part to cool gradually to room temperature before removing them.