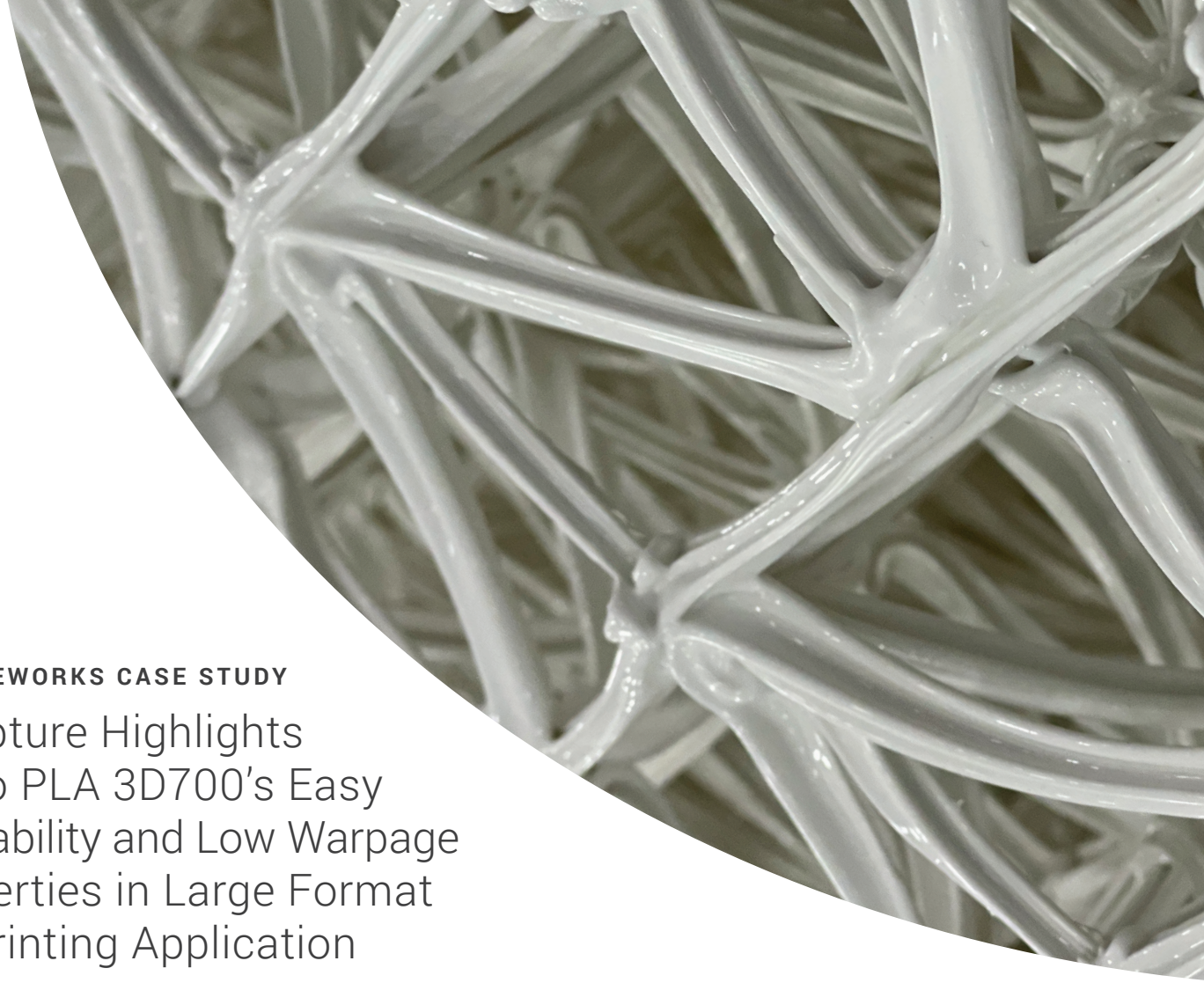

NATUREWORKS CASE STUDY

Sculpture Highlights Ingeo PLA 3D700's Easy Printability and Low Warpage Properties in Large Format 3D Printing Application

Situation: Costly Print Failures from Material Warping in Large Format 3D Prints

For years filament made from Ingeo PLA biopolymer has been the material of choice for a range of fused filament fabrication (FFF) additive manufacturing (AM) applications, from hobbyist desktop 3D printing to industrial applications such as medical prototyping or metal casting. Performance attributes like easy printability, low warpage, excellent interlayer adhesion, or even clean burning properties for investment casting have primarily drive the adoption of Ingeo-based filaments in a broad range of additive manufacturing applications. However, the sustainability of Ingeo biopolymer also makes it an attractive filament material for additive manufacturing; because Ingeo PLA is a 100% biobased, plant-derived polymer, it has a carbon footprint 84% lower than petrochemical-based plastic such as ABS.

As the 3D printing industry grows and develops new ways of leveraging additive manufacturing technology, large format applications have taken root as an exciting new way of bringing the benefits of 3D printing with Ingeo to new industries. From manufacturing and tooling to building and construction, large format 3D printing can offer material and process cost savings, expand custom design options and rapid prototyping, as well as sustainability benefits over incumbent processes.

A primary challenge with printing such large pieces, however, is dealing with the risk of warpage that can cause the material to pull away from the print bed or separate between layers of deposited material. For large format prints, such failed parts are costly, both from a material and productivity standpoint.

Solution: Developing an Ingeo PLA Biopolymer Grade for Large Format 3D Printing Applications

Noting a market need for materials that print reliably and perform across a variety of large format printers, NatureWorks applications development engineers focused on developing an Ingeo PLA grade specifically for such applications. This new grade, Ingeo 3D700, has an optimized microstructure and melt viscosity to allow for faster print speeds, higher throughput, and the potential to print at temperatures under 200˚C. To minimize part failures, Ingeo 3D700 is designed to warp and shrink less, resulting in higher accuracy parts, more precise prints, and improved gap filling.

Outcome: Ingeo Dyson Sphere Sculpture Demonstrates Inherent Strength and Printability of Ingeo PLA Biopolymer Filament

To showcase the properties of this newly developed grade, NatureWorks partnered with Branch Technology, A Tennessee based additive manufacturing construction company, on the design and print of a custom sculpture that would highlight Ingeo 3D700's properties of low warpage, high modulus (stiffness), improved tensile strength, and improved interlayer adhesion.

Branch Technology designed an open, twisted spherical sculpture and printed it using their proprietary robotic arm large format printer and custom open-cell BranchMatrix™ C-FAB process. Unlike FFF 3D printing technology, where filament is extruded layer-by-layer onto the build platform, the BranchMatrix™ technology builds up in an open lattice structure, where each strand of the open-cell structure is one pass of the extrusion head.

Named after the solar power megastructure thought experiment popularized by Dyson Freeman, the Ingeo Dyson Sphere was printed entirely from unreinforced Ingeo 3D700, meaning nothing additional was compounded into the polymer to increase its strength or printability, and the entire print was completed without any supports, which, combined with Branch's novel design, reduced overall material usage. This was the first time Branch Technology worked with unreinforced Ingeo 3D700 using this printing technology and were able to quickly fine tune the printing process to create the finished product. The entire process took approximately a month from concept design to finished print with the actual print time taking about 50 hours. The sculpture was printed in four sections and assembled post-production.

Branch Technology found the superior bonding quality and high modulus of 3D700 gave greater node strength within the matrix pattern than other materials they had used. Each node was able to withstand over 45 pounds of force, significantly greater than the approximately 30 pounds of force per node of carbon fiber reinforced ABS.

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