

NuPlon™

NuPlon™ Resin

Technical Application: Toys/Machining

Background

Nuplon is an environmentally-friendly, biodegradable, thermoset plastic which can be used in a wide variety of applications. The liquid precursor can be cured by heating 130 – 170 °C to form ester crosslinks which convert the liquid into a hard plastic that can be used for a variety of commodity and disposable applications. Over the course of 2-3 months of water exposure these links break down eliminating the environmental impact of Nuplon.

Goal

Evaluate ability for Nuplon to be machined/cut to form a variety of consumer products including toys as well as evaluate other mechanical properties.

Water-Jet Cutting

When put into a high-pressure water-jet cutter, the Nuplon M317 sliced cleanly (cutting done by McKinney Corp.).



Setup for cutting



Water-jet cutting

Figure 1. High-Pressure water-jet cutting image series.

Impact Disposition

To test the impact disposition of the Nuplon sheet, a piece of 8 x 5 x $\frac{3}{4}$ inch thick Nuplon sheet (type M317) was made and then shot with a 0.22 caliber firearm. The piece shattered into large chunks on impact indicating that in conditions of rapid/hard impact the failure mode for Nuplon is fracture.



0.22 mm round in clip.



$\frac{3}{4}$ inch sheet of Nuplon type M317



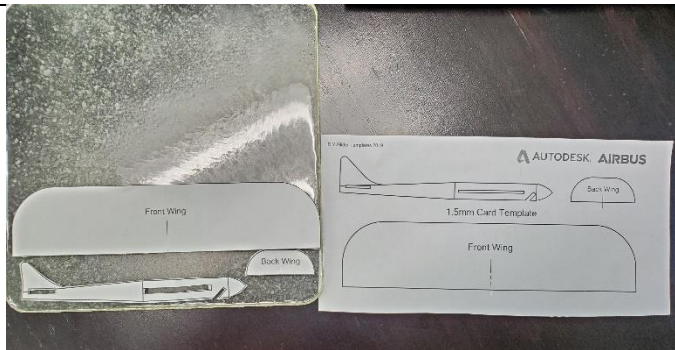
Impact shatter

Figure 2. High-Impact testing image series.

Similarly tests with punch-cutting Nuplon indicated that the material shatters with hard impact. In the future, a more flexible design of the polymer may enable shear-cutting but for the current Nuplon type M317 impact cutting/machining is not suggested and processing should be performed by abrasion-type cutting (sawing, drilling, etc.).

Toy Manufacture

A sheet of Nuplon type M317 (~3 mm thick) was cut along a template (obtained from Autodesk Airbus) using a conventional band-saw (Performax) to generate the general shape of a glider. The interior cuts were milled out using a drill-press (Craftsman) mounted with a rotor bit. The wing was sanded down along the upper edges to provide for some lift. Although it tended to tumble after a distance of flight, it was still confirmed to be fun to play with by children indicating a general proof-of-principle (**Fig 3**).



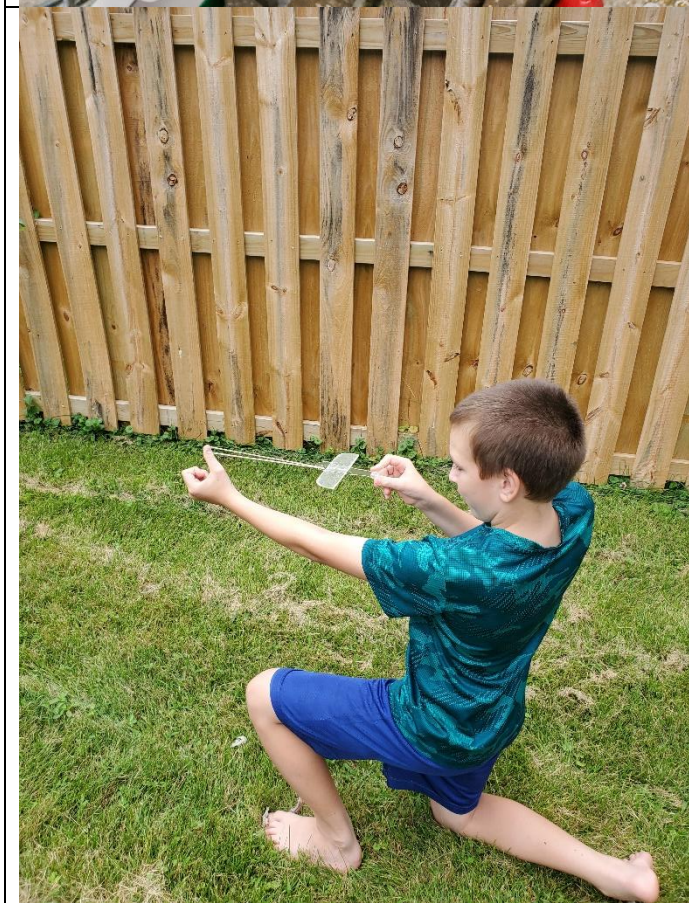
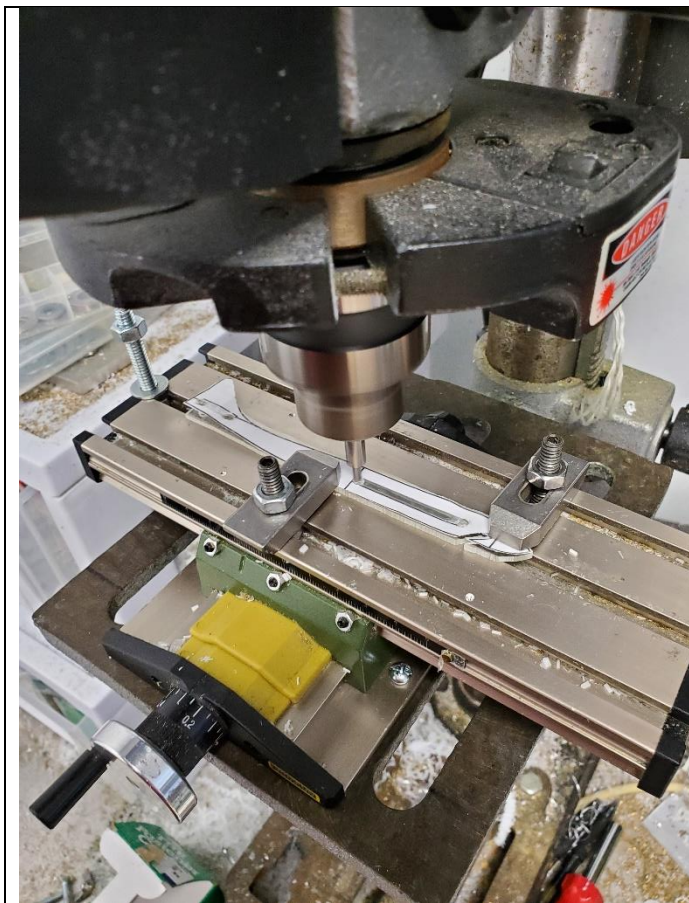


Figure 3. Image series of generating toys from Nuplon Type M317.

Acknowledgements

We would like to thank McKinney Corp. (4710 Fastline Drive Lafayette IN 47905, www.mckinneycorp.com) for assistance with machining tests on the Nuplon pieces. We would like to extend appreciation to Calvin Hill for assisting with the impact-testing. We would also like to thank Daniel Garner and Anna Garner for play-testing the glider toy.

Conclusion

The Nuplon product can be used for generating electrical circuits or as an insulative layer for electrical applications. The ability of electrical components to be directly cured into the resin itself as well as the degradable nature of the plastic makes it well suited for applications towards disposable electrical/electronic materials. Additionally, Nuplon's heat resistance allows for direct soldering on top of the plastic without need for a protective layer.

Customizability

Incorporation of varying additives can be used to modify the NuPlon™ materials properties to provide for a wide array of properties. Contact John Garner (jg@akinainc.com) to discuss customization opportunities to meet your needs.

Licensing Considerations

The NuPlon™ platform technology is PATENT PENDING with a priority date of filing established from provisional filing on June 25, 2020. The user's guide presented here contains information from laboratory testing at Akina, Inc. In no way does it represent all the potential uses and considerations for the NuPlon™ material. Contact John Garner (jg@akinainc.com) for joint development and licensing opportunities.