




# RP Tempering Applications

Skill Level  Time  Cost 

## Overview

A new process called RP Tempering speeds up processing time, reduces costs, and produces a stronger RP part.

RP Tempering was presented by PAR3 Technologies Inc. engineer Earl Dunlap. "The process," he says, "spans three technologies to include Proto-Plasma-Rx™ and Hybrid-Temp-Rx™, depending on the mechanical property results you want to achieve. RP Tempering enhances impact strength, controls flexural modulus, improves torque and adds shelf life. Proto-Plasma-Rx will enhance temperature resistance, chemical resistance, and flexural modulus and produce minor improvements in impact, torque and other mechanical properties. Hybrid-Temp-Rx is a combination of both RP Tempering and Proto-Plasma-Rx." The technique creates internal plumbing in the shape of a sphere, which is engineered into the part design 3D files. Directions of the internal plumbing tubes are dictated by the parts design and required specifications. Stresses within the walls of the RP part can be redirected or even controlled to achieve the desired results.

"The secondary process," Dunlap says, "is to fill the internal plumbing tubes with RP Tempering compound. When the compound fills the plumbing tubes, a chemical reaction on a nanofusion level results. Nano-sized strands create branches extending from the internal plumbing spheres, increasing impact strength by 13 times while controlling the flex modulus."

"RP Tempering adds only about eight percent to the cost of producing a rapid prototype, and is completed quickly, increasing the strength of an RP part while controlling its flex modulus. This means the strength of the RP part is increased while keeping other mechanical properties the same, according to Dunlap. It can also give your part increased flex. When RP Tempering is used, the thermo-mechanical properties can be enhanced to include heat resistance of over 300° F (148° C).

Cured resins may weaken with age but parts that have undergone RP tempering can withstand drops without damage. This technology will work on most composites and with any RP resins and/or systems offered on the market today. To summarize, parts that have undergone RP Tempering can achieve enhanced physical, mechanical and thermo characteristics.



Figure 1. Applying Proto-Plasma-Rx spray

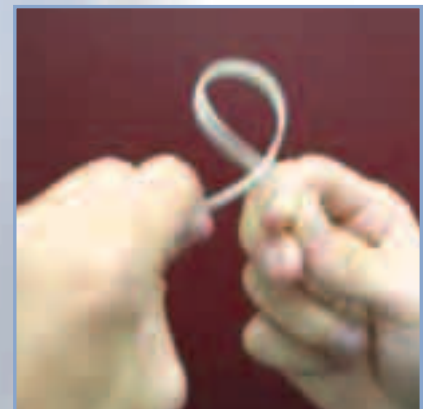


Figure 2. Nano-carbon fibers penetrated into Objet model



Figure 3. Improved flexural modulus and torque

# General Guide to RP Tempering Technologies

You have many options at your disposal when you use all the RP Tempering Technologies. You need to determine what are the critical functions of the part and it will lead you to what RP Tempering Technologies you need to use. Here are some examples:

- 1) If you have a screw boss or snap feature, then you know it needs to accept screws and not break. It would suggest that you use Hybrid-Temp-Rx, which uses tunneling with injected RP-Tempering compound, Proto-Plasma-Rx penetrating .003" (70 microns) thick spray coating and Proto-Seam™ reinforcement compound.
- 2) If you have a part that needs mainly heat resistance with some flexibility, increased impact strength and torque strength, we would recommend Proto-Plasma-Rx, which does not need tunneling. If you want extra strength on the part but without tunnelling, you can add Proto-Seam compound on the underside of the part.
- 3) If you have thin-walled parts made with any RP materials, then you can use “V” Groove technology, which is similar to the standard RP Tempering technique only instead of tunnels you will make “V” style grooves on one side of the part. You should gain about 80% efficiency compared to the tunneling method.
- 4) If you have parts that require strengthening in some areas only, then we suggest you use the RP Tempering tunneling where needed and then use Proto-Plasma-Rx for the rest of the part if required.

## Questions and Answers for RP Tempering Applications:

- **What is RP Tempering compound?** An engineered compound that can be applied in many different methods onto Objet’s models.
- **Can RP Tempering compound be used on the outside surface of a part?** Yes, in many cases, because is it four times stronger than Proto-Plasma-Rx, it is brushed on the core side or non-decorative side of the part.
- **Does RP Tempering compound come in colors?** Yes, it comes in blue, red, yellow, black and clear.
- **Can any of the RP Tempering technologies help with vibration applications?** Yes
- **What is Proto-Plasma-Rx spray?** It is an aerosol this is very capable of putting a depth-controlled penetrating compound with nano carbon fibers on a part.
- **How is it applied?** By spraying.



Figure 4. Enhanced stresses within RP part

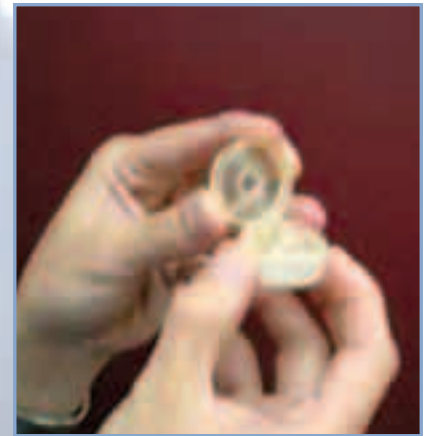


Figure 5. Improvement in impact and other mechanical properties



Figure 6. Add extra strength to a part with ProtoSeam

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## Questions and Answers for RP Tempering Applications (continued)

- **How does it adhere to the surface of Objet's parts?** Excellently – when the nano carbon fibers penetrate into the imperfections of the wall they cling on like adhesive.
- **How fast does it dry?** The parts dry within minutes and can be handled and shipped but they take 12 hours to cure.
- **How thick is the surface added to the part?**  
.003" to .004" thick +/- .001" (.076mm to .100mm +/- .02mm)
- **Does it bridge like paint?** No! It will attach and follow any shape, even sharp corners.
- **RP Tempering Process:** Before the part build apply the patented 3D CAD engineering technique. Mapping of the location of the required tunneling or other geometries may be required if the CAD person is not trained. After build apply the appropriate compounds suggested. Detailed information about other options is available but will be supplied only to RP Tempering licensees.
- **Proto-Plasma-Rx Process:** Where applicable, after the part is built, an aerosol spray is applied to any or all of the specified surface area. No 3D CAD file manipulation is needed unless the .003" thick +/- .001" (.076mm +/- .02mm) penetrating depth coating needs to be allowed for in a specific application. Four to six coats are usually needed to achieve recommended specifications.
- **Hybrid-Temp-Rx Process:** This process combines any or all of the following: the RP Tempering process, Proto-Plasma-Rx process and the use of Proto-Reinforcement™ compound in specified cross-sectional areas applied in any number of ways to include: brush, spray, wipe, inject, etc.
- **Tunneling or “V” Groove™ Process:** Either spherical shapes or cylindrical tunnels are placed strategically within the walls of a part design at 40% to 50% of the wall thickness. This engineering process is almost non-apparent to the end user. “V”Grooves are placed on the core or non-decorative side of the part.

# Resistance to Tunneling and Alternatives Explained

The RP Tempering Technologies include a tool chest of engineering techniques as well as additive and subtractive methods. Tunneling is the method that gives you the maximum strength in any type of RP part and/or composite. There has been a reluctance to tunnel parts so the Proto-Plasma-Rx spray coating and RP Tempering compound put on the out side of a part has become the most popular tempering methodology. These are very good methods for cost effectively increasing part durability, but tunneling, “V” Grooves, “U” wall technique and others can give you an even more dramatic improvement while still being cost effective and fast. The learning curve is minimal with a 400% improvement in overall part durability.

Early in the evolution of the RP industry, honeycomb interior structures were introduced. While a honeycomb shape within the walls of a composite part increases the impact strength in one dimension, the other two dimensions can actually get weaker. When tunneling a part, you work under the same principle of reducing mass, except with a tunnel you achieve a 3D result. This means you increase the impact strength in all three dimensions. Not only do you increase impact strength, you get benefits from the 3D engineering technique. The benefits include an increased 3 Point Flex by 800% (8x) and increased torsion by 300% (3x) while maintaining tensile or flexural modulus. The part will maintain the same stiffness. The tunneling technique can be altered to add drain portal slots and then filled back in with RP Tempering Nano-Carbon Compound. You will achieve the same results within a 3% range.

Other alternatives to the tunneling technique are “V”Grooves and “U” wall engineered geometries. These techniques do not need drainage or portals. They are easily applied in an STL file before the part is built. When using this technique, you will still achieve impressive improvements but, with the exception of torsion, the improvement will be approximately 15% less than if the part was tunneled. Torsion will increase by 200% (2x).



Figure 7: Tunneling the 3D CAD file



Figure 8: Injecting Proto-Reinforcement compound into printed mode



Figure 9: Cured compound of cross-sectional areas

Information is delivered for reference only. For more information, one may contact PAR3 Technologies, Inc., Mr. Earl Dunlap/P.E. Engineer [endunlap@manufacturingbydesign.com](mailto:endunlap@manufacturingbydesign.com), [www.RPTempering.com](http://www.RPTempering.com)

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