Robotfactory

3DLPrinter

3DLPrinter-HD

3DLPrinter-HD 2.0

3DLPrinter-HD 2.0+

Technical Note 08/15

Good practices for resin investment casting

Rev-4.03 February 2016

Technical measures regarding castable models of 3DLPrinter series printers

One of the most frequent problems that may arise during the casting of the resin models is due to the fact that the resin tends to swell within the investment mold in the burnout cycle. In fact, unlike wax that softens and drains out of the flask very quickly, the resin remains in the mold for a longer time, expanding for the effect of heat and, in some cases, even swelling for the effect of the same water absorbed through the investment. In this case, if the mold is not strong enough to withstand all this expansion and swelling, it may crack and lead issues in casting.

The solution to this problem it is the use of special type of investments

The first important thing it is strengthen the investment material: one way to do this could be using a special type of investments (low-cristobalite), that are specifically developed to handle greater-than-normal expansion issues. It was promoted the **use of a low cristobalite**, high calcium-sulfate, investment, primarily because of the strength that calcium sulfate (CaSO4) could provide at the beginning of the burnout process. But some detailed tests have demonstrated that these type of investments don't have any advantages, don't improve the casting results of resin-based models.

Strengthened investment with boric acid

Another way is to strengthen the usual investment material. To strengthen the usual investment material, you can add **water-soluble boric acid** to your investing water. This one will migrate to the inner and outer surfaces of the investment mold during the drying process, forming a very thin but concentrated layer.

To do that, dissolve 1.5 – 2.0 **percent boric acid/weight of investment powder** into water used for investment.

You can also adjust your investment's water-to-powder ratio and its setting time. With most gypsum-bonded investments for wax models, you normally have a 40 percent water-to-powder ratio. After being poured into the flask, the mixture would then typically sit for 2 hours before the flask was put into the oven. For resin models, try lowering your water-to-powder ratio down to **between 37 and 38 percent**, and **increase the setting time to a minimum of 4 hours**. This will not only strengthen the investment, but also thicken it and shorten the total work time of the investing procedure. However, make sure doing at first some tests.

Clean, Cure, and Clean Again

A strong investment is important, but it's only the final step; actually another important thing is to eliminate the acid present in the model. All resins are based on some form of methacrylic acid and also a printed model typically contains uncured resin, for this reason when the resin heats during burnout, the acid is expelled and weakens the mold, thus making needless all your efforts to obtain a good result by investment casting.

To prevent this problem it is important, clean very well the printed parts using **RF Cleaner - CL01** (or **Isopropyl Alcohol**) as we recommend also in our previous Technical-Note_07-15_EN and in

manuals of our printers. Make two or three step of cleaning process, in which each successive (or at least the last) step using fresher **RF Cleaner - CL01** or **Isopropyl Alcohol**.

After a thorough cleaning, you have to dry **as well as possible** with light compressed air the pieces and finally cure the parts in **UV Oven**. The better result in casting investment can be obtained if and only if you will never place uncured resin in the burnout oven. Only starting from **well cleaned** pieces your models will result much more castable.

Notice: Isopropyl alcohol, also called isopropanol, is a colorless, flammable chemical compound with a strong odor. If you don't use the **RF Cleaner - CL01**, we advise to use a composition at least with 91 vol% of isopropyl alcohol.

Some detailed information for 'strengthened investment'

Going back now about how the addition of boric acid can strengthen casting investments, improving the casting results of resin-based models.

It is recommended a high cristobalite investment (for example **Ultra-Vest Maxx by Ransom & Randolph**, but others might work as well) in a 38 percent water-to-powder ratio.

In addition, we advise to add **boric acid** to investing water, **from 15 grams to 20 grams of boric acid per liter of water used for investment**. Try heating only 25 percent of your investing water to 85 °C / 180 °F, dissolving the full amount of boric acid into that, then adding the remaining water back to cool down the mix.

Besides 'strengthened investment', another great advice is to getting enough oxygen into the flask during burnout, for fully combustion of resin parts. We have to generate oxygen inside the flask. To do that, we also add **20 grams of calcium nitrate** [2Ca(NO3)2] per liter to boric-acid-and-water solution.

Quality calcium nitrate can be purchased from chemical supply companies in a crystalline form. It's sold as calcium nitrate tetra-hydrate and it absorbs water quickly, so we advise to keep your crystal container tightly closed.

Calcium nitrate starts to decompose during burnout at around 500 °C (932 °F) (by the following equation: $2Ca(NO3)2 \rightarrow 2CaO + 4NO2 + O2$). **A great deal of oxygen is set free during that reaction**.

Another thing: Let your resin parts cook at 500 – 550 °C (932 – 1,022 °F) for at least 90 minutes during your burnout cycle and you should have cleaner results. Because the cristobalite expansion phase-change take place between 200 °C and 300 °C, and the investment's quartz expansion phase-change take place around 500 °C (932 °F), the investment (especially with the addition of boric acid) is the strongest you can get.

Here is the other big benefit you get with these changes: Your top burnout temperature can now climb to 850 °C (1,562 °F) without fear of damaging your investment mold — and that additional heat really helps to remove any remaining residue of resin in your mold. Make your temperature changes up and down at about 2.2 °C (4 °F) per minute, but do not cast your parts at this temperature. Always cast at the lowest metal and flask temperatures possible to properly fill the

mold. Also, try blowing a stream of air across (not down into) the button hole of your flask just before casting — this will help to draw out minor ash residue.

If you follow these suggestions and, as recommended before, cure and clean your parts well properly, your casting of resin materials should improve.

Complete information on the used materials are available on the website of Ransom & Randolph:

- **http://www.ransom-randolph.com/**

From the following link, instead, you can download a document, on influence of burn-out and processing parameters for 'direct casting' of the resin models produced with stereolithography 3D printers:

- **http://www.ijesit.com/Volume%203/Issue%202/IJESIT201402_64.pdf**

In order to improve and grow the product, we ask that you inform us of any possible malfunction or improvements, sending an email to robot@robotfactory.it with the much detail as possible description about the problem when it occurs or the required improvement.

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