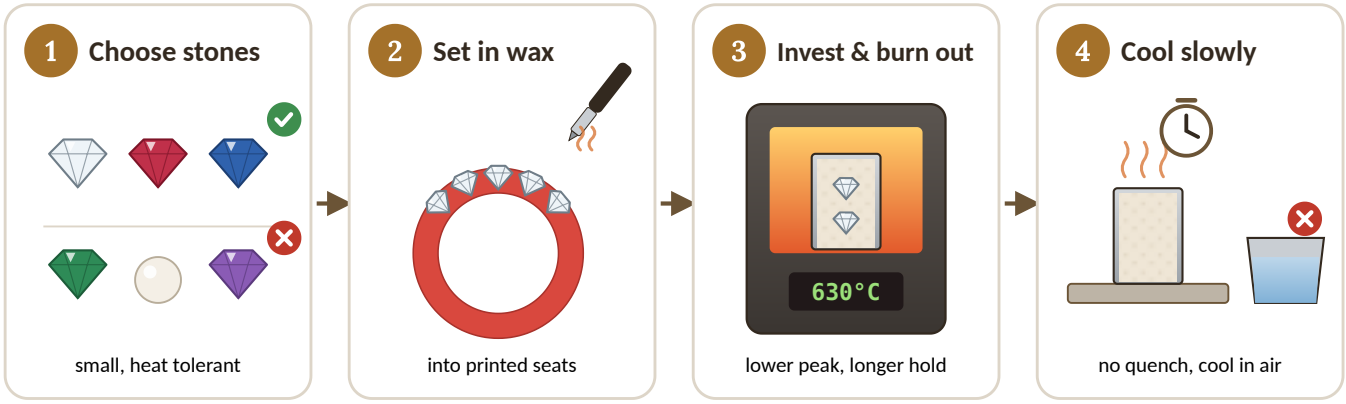
STONE-IN-PLACE CASTING GUIDE

# Set the stones in the wax, cast the metal around them.

Stone-in-place casting, also called wax setting, puts small stones into the wax pattern before it is invested. The metal is cast around them, so the pieces come out of the flask already set. Printed seats sized for calibrated stones suit it well, and it saves setting time on small stones. It only works if you choose the right stones and protect them with a cooler burnout and slow cooling.




## THE NUMBERS AT A GLANCE

**Up to 2 mm**
stone size in most stone-in-place work

**630°C max**
burnout with diamonds (Gold Star, SRS), not the usual 730°C

**450 to 600°C**
flask when you cast, the range across sources

**2/3 or more**
of the stone width: the hole under each stone

**No quench**
cool in air until the flask is cold to the touch

## WHAT YOU NEED

- **Calibrated stones** — one lot, suited to casting
- **Heated wax tool** — fine tip, low heat
- **Programmable kiln** — with accurate control
- **Stone gauge** — or micrometer, 0.01 mm
- **Stone-in-place investment** — or the maker's additive
- **Pressure washer** — or water jet for devesting
- **Loupe or microscope** — to check every seat
- **Vacuum investing** — mixer and chamber
- **Magnetic pin finisher** — gentle near set stones

### Before you start

- **Test with inexpensive stones first.** Run a trial tree of low value stones of the same type through your whole process.
- **Plan a separate cycle.** These flasks need their own investment, burnout and cooling, so they cannot share a kiln cycle with normal flasks. If a caster does your casting, agree the process first.
- **Record every temperature:** kiln, flask and metal, so you can repeat a good result exactly.

### WHERE IT MAKES SENSE

- **Many small stones.** Pavé, channel, bead and prong settings. Most stone-in-place work uses stones up to about 2 mm. Flashforge gives a range of about 0.33 to 10 points.
- **Repeat pieces.** Setting in wax needs less force than setting in metal, the metal is never hammered, and the time saved adds up over a run.
- **Heat tolerant stones** of good quality, bought calibrated.

### WHERE IT DOES NOT

- **Large or valuable stones.** The risk to the stone outweighs the saving. Set them after casting.
- **Heat sensitive, treated or included stones.** See the lists below.
- **No way to run a separate cycle.** Without the right investment, burnout and cooling, the stones pay for it.

## 1 Choose the stones

### Generally suitable



**Diamond, natural or lab-grown**
Well cut, few inclusions. Test colour-treated lab-grown stones first.



**Ruby and sapphire**
Natural or lab-grown. Not fracture-filled or dyed.



**Garnet**
Keep it away from hydrofluoric acid.



**Cubic zirconia**
No boric acid in the investment. Cool larger CZs extra slowly.



**Some lab-grown coloured stones**
Check with your supplier and test first.

### Leave these out



**Emerald***
Heat extends fractures and spoils fillers.



**Quartz: amethyst, citrine**
Change colour with heat.



**Topaz, including blue topaz**
Changes colour with heat.



**Tourmaline*, peridot*, aquamarine***
Heat sensitive in most sources.



**Opal, turquoise, lapis, jade**
Crack, burn or change colour.



**Pearl, coral, amber**
Organic. They burn.

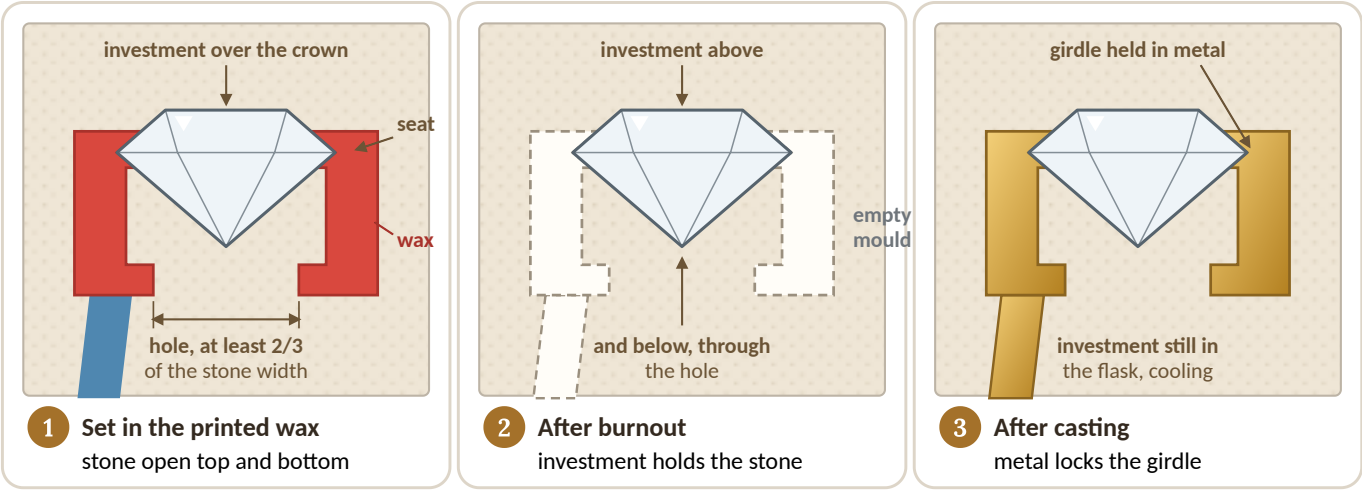


**Treated, heavily included or fractured stones**
Crack, cloud or change colour.

* Sources disagree on these. One Santa Fe Symposium paper lists emerald, aquamarine, tourmaline and peridot as castable, while Hoover & Strong list all four as unsuitable and Rio Grande and Flashforge each list three of them. Unless your caster has proven them, leave them out.

- **Quality first.** Stones with inclusions tend to turn milky or frosty in the flask, and better quality diamonds are less prone to damage. Leave out heavily included or fractured stones.
- **Ask for untreated stones.** Treated stones can change colour in the flask. Fracture-filled and dyed ruby and sapphire can be damaged even by mild acids, so pickling is a risk as well.
- **Lab-grown diamond behaves like diamond.** GIA says its physical properties correspond very closely to natural diamond, so treat it the same way. Some coloured lab-grown diamonds, pink ones especially, get their colour from treatment after growth. Test coloured ones first.
- **Cubic zirconia casts well, with two cautions.** Boric acid in the investment can discolour it, and larger CZs can crack because the girdle heats faster than the centre.
- **Diamond's main enemy in the flask is oxygen at high heat.** In a burnout that runs too hot, the surface frosts or turns milky, and the damage is permanent. Step 3 covers the limits.

# 2 Set the stones in the wax




**1 Set in the printed wax**
stone open top and bottom

**2 After burnout**
investment holds the stone

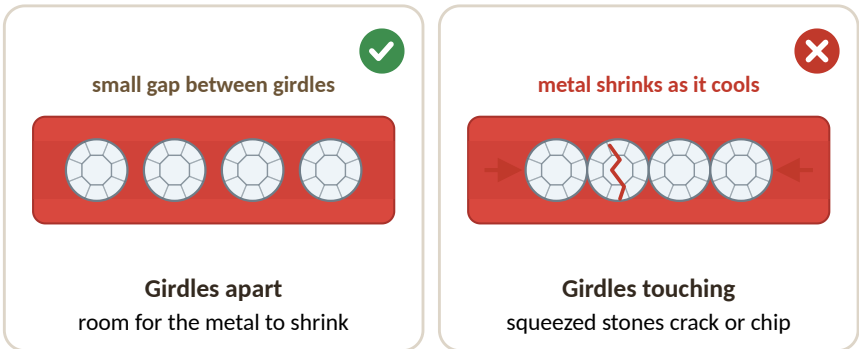
**3 After casting**
metal locks the girdle

## IN THE CAD FILE

- **A seat for every girdle.** Model a groove in the setting for each girdle, so the stone sits level and is held above and below it. Prongs or beads should be fractionally smaller than the stone.
- **Open top and bottom.** Rio Grande calls exposure to the investment above and below the stone absolutely required. Make the hole under each stone at least 2/3 of its width, and give every stone its own through hole.
- **Keep girdles apart.** Metal shrinks as it cools and closes the gaps. Corners of square and baguette stones must not touch either.
- **Scale for the alloy.** Alloys shrink by different amounts and can crush the stones. With printing that means a scaled file per alloy, proven by a test casting.
- **Least metal contact, most security.** Sharp cornered stones need extra care in the design so the cooling metal does not break them.

## AT THE BENCH

- **Measure the stones.** One stone supplier quoted by SRS calibrates 1 to 3 mm stones to ±0.05 mm (CZ ±0.02 mm), and Flashforge specifies the WaxJet 51C to ±0.04 mm per 20 mm. Print a test strip of seats and fit your actual stones first.
- **Never force a stone.** Injection wax guides rely on the wax flexing and springing back. Do not assume printed wax behaves the same. Flashforge softens the prongs with a heated wax tool so they close around the girdle. Practise on a spare print.
- **Check each stone under magnification:** level, table up, fully in its seat. Then tap the pattern lightly. A stone that moves now will move in the flask.
- **Clean stones, clean hands.** Grease or wax left on a stone is replaced by metal. Rio Grande dips the set tree in denatured alcohol. Try that on a spare printed pattern first.
- **Short tree, sprue into the heaviest section,** away from the stones. Hoover & Strong recommend trees that fit a flask of 6 inches (about 150 mm) or shorter.

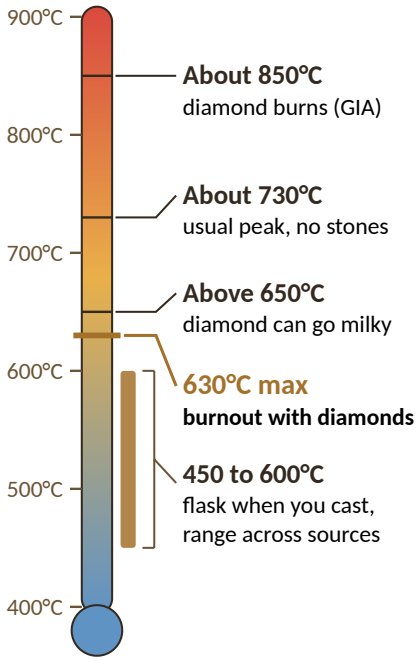



**Girdles apart**
room for the metal to shrink

**Girdles touching**
squeezed stones crack or chip

## 3 Invest and burn out

- **Use an investment made for stone-in-place,** such as Gold Star GemSet or SRS Stonecast, or your maker's stone additive. These usually rely on boric acid, which helps protect diamonds from oxidation but can discolour CZ. Casting CZ? Ask the maker first.
- **Do not dose boric acid yourself.** Added to a normal investment it thins the slurry, cuts setting expansion and makes breakout much harder.
- **Mix to the maker's ratio and vacuum invest.** Dewax the way the maker says: Rio Grande and SRS steam dewax, while Gold Star says never steam dewax GemSet.
- **Lower the peak.** Gold Star, SRS and a Santa Fe Symposium paper put the ceiling at 630°C with diamonds. Rio Grande allows up to about 650°C in a properly modified investment, Shor peaks at about 565°C and Hoover & Strong at about 430°C. Follow your investment maker.
- **Hold it longer.** At a low peak the carbon from the wax is harder to clear, and leftover carbon means gas porosity. In SRS tests, 4 hours at 630°C was not enough and 6 hours was.
- **Cast into a cooler flask.** Sources range from about 450°C (Jeweler's Alloy) through 490 to 530°C (Schuster) to 600°C (SRS). Hoover & Strong burn out at about 430°C and never let the flask go above about 454°C. Hold it there first: at least 1 hour (Gold Star), or 3 to 4 hours depending on flask size and load (Rio Grande).

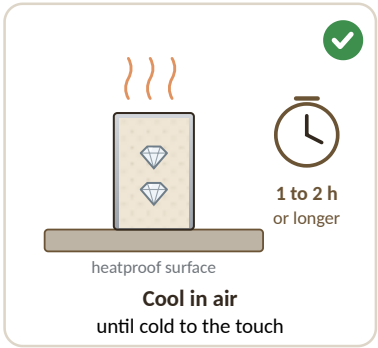



Shor: diamonds can turn milky above about 650°C in an oxidising burnout. GIA: diamond burns at about 850°C.

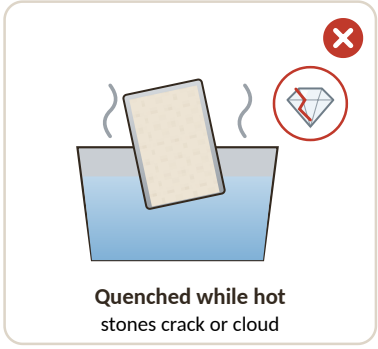
## 4 Cast, then cool slowly

- **Metal no hotter than the alloy maker says.** Too hot turns diamonds white and leaves dark rims around stones. Rio Grande's starting point is 70 to 80°C over the liquidus for gold, 80 to 100°C for silver.
- **A fluid alloy and a strong, fast vacuum.** Palladium or low nickel white golds, yellow and red golds, and silver are all used. The stones soak up heat, diamonds most of all, and the flask is cooler, so fluidity matters.
- **Never quench.** Quenching a hot flask shatters or clouds the stones. Let it cool in air until it is cold to the touch: at least 1 hour (Jeweler's Alloy) or 2 hours (Shor), longer for big flasks and bigger stones.
- **CZ:** Jeweler's Alloy puts the flask back in the kiln, switches it off and lets them cool down together.

**You may read about quenching after 20 to 30 minutes.** An SRS paper notes this is possible with small stones, but says flasks are normally left to cool completely. Start there.




**Cool in air**
until cold to the touch



**Quenched while hot**
stones crack or cloud

# After casting

- **Devest gently.** Tap around the flask with a rubber mallet, then wash the investment out with a pressure washer. Expect it to break out harder than normal.
- **Pickle with care.** Diamond shrugs off virtually all acids, fracture-filled or dyed stones do not. Jeweler's Alloy skips pickling and uses magnetic tumbling instead. Never use hydrofluoric acid: it attacks garnet and is extremely dangerous.
- **Check every stone under magnification** for cracks, cloudiness, colour change and movement. Tighten loose stones by conventional means.
- **Finish gently.** No high energy mass finishing or aggressive abrasive media near the stones. Magnetic pin finishing works well around them.

## RISKS AND HOW TO REDUCE THEM

| WHAT YOU SEE | LIKELY CAUSE | WHAT TO DO |
|---|---|---|
| **Diamonds milky or frosted** | Too hot, or a normal investment | Cooler burnout and metal, the right investment |
| **Cracked or chipped stones** | Stones touching, fast cooling, flaws | Gap between girdles, slow cooling, clean stones |
| **Colour change** | Heat sensitive or treated stones | Untreated stones from the suitable list |
| **CZ discoloured** | Boric acid in the investment | Ask the investment maker which product suits CZ |
| **Dark rim around stones** | Unsuitable alloy, or metal too hot | Stone-in-place alloy at the maker's temperature |
| **Metal over the back of a stone** | Hole under the stone too small | Hole at least 2/3 of the stone width |
| **Stones loose, moved or lost** | Stones not matched to the seats | Measure stones, test-print seats, tap test |
| **Gas porosity** | Carbon left after a cool burnout | Longer hold at the peak, dewax as the maker says |
| **Incomplete fill** | Cooler flask, stones soaking up heat | Fluid alloy, sprue into the heaviest section |

## BEFORE THE FLASK GOES IN THE KILN: CHECKLIST

- [ ] Suitable stones, untreated, clean
- [ ] No girdles or corners touching
- [ ] Burnout within the maker's limit
- [ ] Seats test-printed for your stones
- [ ] Every stone level, firm after a tap
- [ ] Metal at the alloy maker's figure
- [ ] Hole under each stone, 2/3 width
- [ ] Stone-in-place investment
- [ ] Cool in air, no quench

### Expect some losses

Even with everything right, some stones crack, cloud or change colour. Flashforge says manufacturers with strict process control typically keep breakage to about 1 to 2%. Price jobs with that in mind, and set large or precious stones after casting.

### SAFETY

- Investment contains respirable crystalline silica. Mix with extraction or a suitable respirator.
- Boric acid may damage fertility or the unborn child (H360FD). Follow its Safety Data Sheet.
- Flasks stay hot for hours. Use tongs and heat resistant gloves.

3D WERK

Local Flashforge WaxJet support in Sydney

Questions about your wax patterns?

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