CASTING DEFECTS GUIDE

Read the defect, fix the stage it came from.

A failed casting is frustrating, but it is also evidence. The shape and position of a defect point back to the stage that caused it, and that stage is often well before the pour. This guide helps you name what you see, find the likely cause and change the right thing on the next flask.

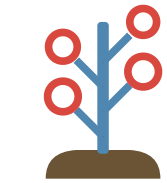
1 Pattern



DEFECTS THAT START HERE

- Bubbles, pits
- Distorted pieces
- Leftover support
- Rough wax surface

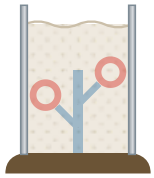
2 Tree



DEFECTS THAT START HERE

- Shrinkage porosity
- Misruns
- Inclusions at joins
- Short pours

3 Invest



DEFECTS THAT START HERE

- Nodules
- Fins
- Rough surface

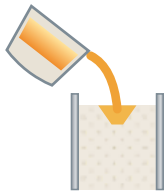
4 Burnout



DEFECTS THAT START HERE

- Fins
- Gas porosity
- Pits, grey residue
- Stained surface

5 Melt & pour



DEFECTS THAT START HERE

- Gas porosity
- Misruns, cold shuts
- Inclusions
- Cracks, brittleness

THE NUMBERS AT A GLANCE

30%+
of investment casting defects start in the mould, by alloy maker Progold's count

One change
per flask when you test a fix, so you know what worked

About 730°C
top of a standard gypsum burnout cycle. Never above your powder's maximum

50%+
fresh metal in every melt, with any reused metal cleaned first

Clean white
investment at breakout. Grey means carbon was left behind

WHAT YOU NEED

- **Loupe or microscope** — 10x or more, and good light
- **Jeweller's saw** — to cut a reject open at the sprue join
- **Casting log** — flask, times, temperatures, metal mix
- **Data sheets** — for your investment, alloy and wax
- **Second thermometer** — to check the kiln reads true
- **Digital scale** — for the metal and the investment

Before you change anything

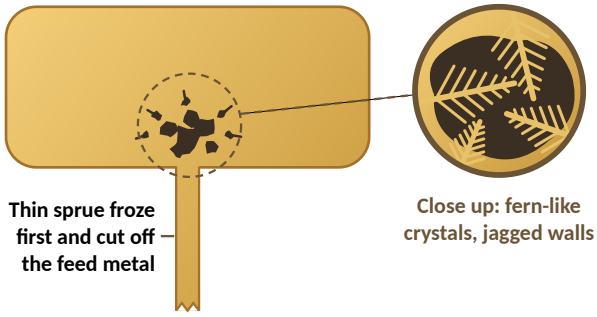
- **Look before you guess.** Under magnification, note the shape, size and exact place of the defect. Is it on every piece, or only one part of the tree? One flask, or every flask this week?
- **Walk back up the chain.** Pattern, tree, investing, burnout, then melt and pour. The pour is the last step, not always the cause.
- **Check the equipment early.** A worn thermocouple, a leaking vacuum seal or old pump oil can cost you a whole run of castings.

1 Gas or shrinkage? Read the hole

Porosity comes in two main kinds, and they have different fixes. Look at the holes under magnification, or saw a reject through the worst spot, before you change anything.

Shrinkage porosity

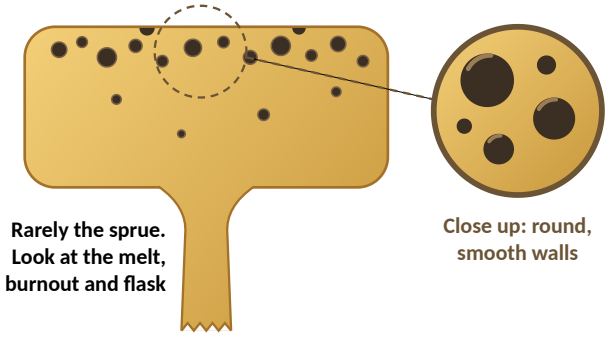
The metal ran out of feed as it froze



Jagged, spongy or fern-like holes
in the heaviest part or at the sprue join

Gas porosity

Gas was trapped as the metal froze



Rounder, smooth-walled holes
often in groups, at or just under the surface

Shrinkage porosity TREE BURNOUT

- **Looks like:** jagged, spongy or worm-like holes. Under magnification the walls show fern-like crystals.
- **Where:** in the heaviest section or right at the sprue join, the last metal to freeze.
- **Why:** metal shrinks as it freezes. If the sprue freezes first, no liquid metal is left to feed the piece.
- **Fix at the tree:** sprue to the heaviest section, a little thicker than the part, short and flared. Add a sprue where a heavy area sits beyond a thin one, and keep pieces clear of the button.
- **Then the flask:** a flask that is too hot can make it worse. Try a cooler flask within your data sheet range.

Gas porosity MELT & POUR BURNOUT

- **Looks like:** rounder, smooth-walled holes, often in small groups. Polishing opens them up as pits.
- **Where:** often at or just under the surface, and in corners such as where prongs meet.
- **Why:** gas trapped as the metal froze. It comes from the melt, from carbon left in the mould, or from investment that got too hot.
- **Fix at the melt:** the lowest metal temperature that fills, a reducing flame, half or more fresh metal, and scrap cleaned of investment.
- **Fix at the burnout:** the full hold at top temperature with good air flow, and never above your investment maker's maximum.

Not sure which one you have?

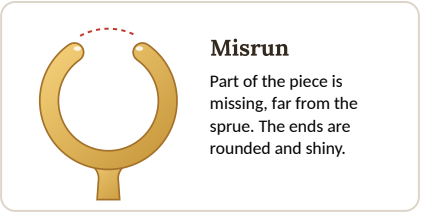
Look at where the holes are. Holes only at the sprue join or in the thickest part point to shrinkage, usually a spruing problem (see the Casting Tree guide). Holes spread over thin and thick areas alike point to gas. You can have both in one casting.

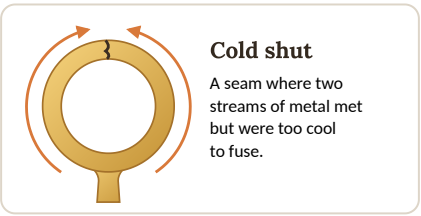
Fix one thing at a time

Change one thing per flask and write it down. Lower the metal temperature, resize the sprue and change the burnout all at once, and a good casting will not tell you which change worked. When you can, run a few test flasks, each with a single difference.

2 Metal that did not arrive

- **Misrun.** Part of the piece is missing, usually far from the sprue, with rounded, shiny edges. The metal froze before it got there.
- **Cold shut.** A seam with rounded edges where two streams of metal met but were too cool to fuse. Look on thin or wide sections.
- **Poured short.** Not enough metal, or the pour stopped. Most printed waxes are lighter than the 1.00 that charts assume, so chart factors under-pour. Weigh every tree and use the formula in the Casting Tree guide.
- **Check temperatures first.** Metal or flask too cold. Raise one of them in small steps, within the data sheet range. Goldstar suggests the metal before the flask.
- **Then the tree and the machine.** A sprue too thin or too long, a thin section far from its sprue, weak vacuum (check pump oil and seals), too little spin, or an incomplete burnout.
- **Then the design.** A feature not properly joined in the CAD model can leave a gap metal cannot reach. In one published case, two sprue changes failed and the fix was in the model.





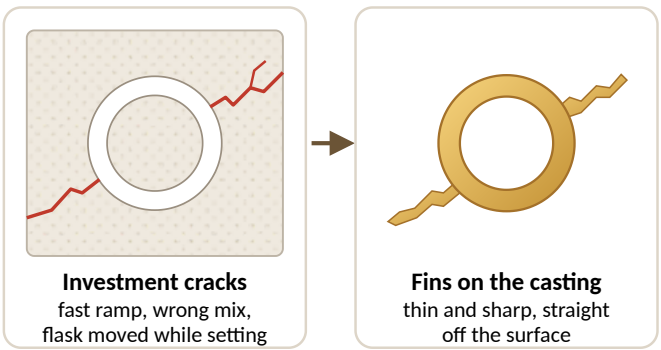
3 Metal where it should not be

Fins and flashing INVEST BURNOUT

- **Looks like:** thin, sharp sheets of metal standing straight off the surface, often with lacy edges.
- **Why:** the investment cracked and metal ran into the crack.
- **Causes:** a fast burnout ramp, the wrong water to powder ratio, a flask moved before it set, a flask left to dry out, patterns too close, or a flask cooled and heated again.
- **Fix:** weigh powder and water exactly, leave the flask alone for the full bench set (typically 1 to 2 hours, longer for big flasks), and follow the maker's ramp.

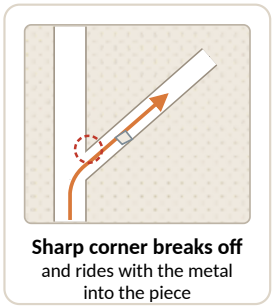
Nodules INVEST

- **Looks like:** small round balls of metal on the surface.
- **Why:** an air bubble clung to the wax and the metal filled it.
- **Causes:** poor vacuum (pump oil, leaks), no debubblizer, investment under or over mixed, or too little working time left to vacuum it.
- **Fix:** service the pump, use debubblizer and let it dry, and finish mixing, vacuuming and pouring well inside the working time.

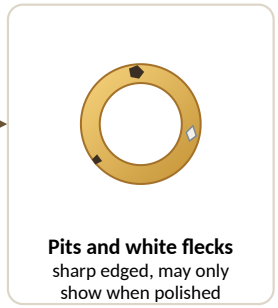


4 Rough, pitted or stained surfaces

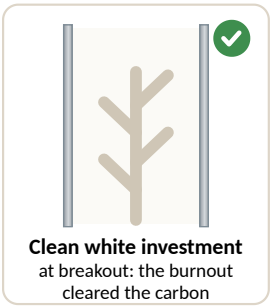
- **Rough or grainy all over** BURNOUT INVEST PATTERN
  The mould surface broke down: burnout started too soon after investing, heated too fast or too hot, or the wrong water ratio. Rough or dusty wax is copied into the metal too.
- **Sharp pits, white or grey flecks** TREE MELT & POUR
  Investment or slag in the metal: a sharp corner at a sprue join broke off, the mould eroded, or an old crucible shed. They may only show once you polish.
- **Pitted surface, grey investment** BURNOUT
  Carbon and ash left by a short burnout. Give the full hold at top temperature, with good air flow.
- **Stain left after pickling** BURNOUT MELT & POUR
  Investment that got too hot, in the kiln or from very hot metal, frees sulphur that reacts with the metal. Stay under your powder's maximum.
- **Purple or copper stain after polishing** MELT & POUR
  Firescale, copper oxide in silver and gold alloys. Keep air off the metal as it melts and cools. Abrasion removes it, pickle will not.



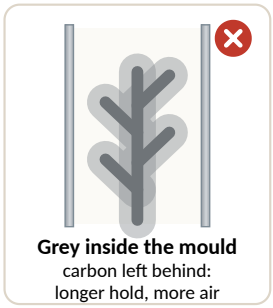
Sharp corner breaks off
and rides with the metal into the piece



Pits and white flecks
sharp edged, may only show when polished



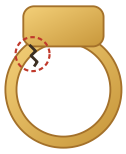
Clean white investment
at breakout: the burnout cleared the carbon



Grey inside the mould
carbon left behind: longer hold, more air

5 Cracks and brittle metal

- **Hot tear.** A jagged crack where thick meets thin or at a sharp inside corner. Soften sharp changes in the design, feed the heavy section, use clean metal, and avoid too much spin or pressure.
- **Quenched too soon.** Wait until the red glow has left the button. Many casters wait 10 to 30 minutes. Some red and rose golds are meant to be quenched early, so your alloy data sheet has the final word.
- **Flask or metal too cold.** Can crack castings and leave prongs brittle.
- **Dirty or tired metal.** Investment on old sprues, oxides, repair solder, or metal remelted too often. Use 50% or more fresh metal.
- **Handled while hot,** or brittle white gold that needs the alloy maker's heat treatment.



Hot tear
A jagged crack where thick meets thin, in the last metal to freeze.



Brittle metal
A prong snaps when you bend it. Check the flask temperature, the metal and the quench.

PRINTED WAX: WHAT TO WATCH

- **Same rules apply.** Printed wax does not prevent casting defects.
- **Support fully gone.** Support left under a prong or in a gallery burns out too and comes back as extra metal.
- **Clean and dry.** Re-rinse any white haze and let the IPA evaporate before spruing.
- **No shortcuts on the ramp.** Wax swells as it warms. In a 2024 lab test, a solid sample of one FDM printing wax pushed about twice as hard as an injection wax, though its porous printed parts did better. The WaxJet's wax was not tested, so keep the full bench set and your maker's ramps.

SYMPTOM FINDER

WHAT YOU SEE	LIKELY CAUSE	FIX AT	WHAT TO DO
Jagged, fern-like holes at the sprue join or in the heaviest part	Shrinkage: sprue too thin, too long or in the wrong place, or flask too hot	TREE	Sprue to the heaviest part, a little thicker, short and flared. Try a cooler flask
Round, smooth holes at or just under the surface	Gas: metal overheated or oxidised, too much reused metal, carbon in the mould	MELT & POUR, BURNOUT	Cooler metal, reducing flame, 50%+ fresh metal, full burnout with good air
Piece missing far from the sprue, or a seam with rounded edges	Misrun or cold shut: metal or flask too cold, sprue too small, weak vacuum	MELT & POUR, TREE	Raise metal or flask temperature in small steps, bigger or extra sprue
Small button or none, pieces unfilled	Poured short: not enough metal, or the pour stopped	TREE	Weigh the tree and use the metal formula with your printed wax density
Thin, sharp fins standing off the surface	Cracked investment: fast ramp, wrong ratio, flask moved or dried out, patterns too close	INVEST, BURNOUT	Weigh exactly, full bench set, maker's ramp, 3 to 5 mm between patterns
Small metal balls on the surface	Air on the wax: poor vacuum, no debubblizer, mix under or over worked	INVEST	Service the pump, use debubblizer, finish inside the working time
Rough or grainy surface all over	Mould surface broke down: burnout too soon, fast or hot, wrong ratio, dusty wax	BURNOUT, INVEST	Maker's bench set and cycle, correct ratio, clean wax stored away from dust
Sharp-edged pits, white or grey flecks	Investment or slag: sharp corners at joins, eroded mould, old crucible	TREE, MELT & POUR	Fillet every join, clean or replace the crucible
Pitted surface, grey investment at breakout	Carbon and ash left by a short burnout	BURNOUT	Full hold at top temperature, good air flow through the kiln
Stained surface that pickle will not shift	Sulphur from gypsum investment that got too hot, in the kiln or from very hot metal	BURNOUT, MELT & POUR	Kiln at or under the powder's maximum, metal no hotter than it needs
Cracks, or prongs that snap	Hot tear, quenched too soon, flask or metal too cold, dirty or tired metal	MELT & POUR, TREE	Wait for the glow to leave the button, check temperatures, clean fresh metal
Distorted piece, flaws copied from the wax, drips or bridges	Pattern damage, heat, leftover support, or a hot wax pen	PATTERN, TREE	Inspect under magnification, store cool, build the tree from the top down

BEFORE THE NEXT POUR: CHECKLIST

- [ ] Patterns inspected, support gone, fully dry
- [ ] Sprues on the heaviest part, flared, joins filleted
- [ ] Tree weighed, metal worked out
- [ ] Half or more fresh, clean metal
- [ ] Powder and water weighed to the maker's ratio
- [ ] Mixed, vacuumed and poured in the working time
- [ ] Full bench set, flask left alone
- [ ] Maker's burnout cycle, never above its top
- [ ] Flask and metal at data sheet temperatures
- [ ] Quench only when the alloy allows
- [ ] Only one change from the last flask
- [ ] Everything written in the casting log

3D WERK

Local Flashforge WaxJet support in Sydney

Questions about your wax patterns?

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