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Defects in Investment Casting from Wax and Castable Resin.

Let's discover together the main defects that can ruin a casting in jewelry making! We will see the most common causes, whether you are working with traditional lost wax or modern castable resins.

The full content of this article can be downloaded from the following link: https://www.bluecast.info/download#other-downloads

It is essential to emphasize that investment preparation is a critical step that is often taken for granted. It is recommended to meticulously follow the manufacturer's instructions, always using distilled water at a temperature no higher than 18°C. If using a manual mixer, it is preferable to operate at the lowest speed to avoid incorporating air into the mixture or overheating it. Furthermore, the flask must be allowed to rest for a minimum amount of time, so that the residual moisture is not so high as to cause it to explode during burnout. For more details, please refer to this video tutorial: https://www.youtube.com/watch?v=I4NcUwwH0RQ&t=134s

Correct model feeding is equally essential. As a good practice, the sprue channel should have a diameter equal to or greater than at least 25% of the largest cross-section of the reference model and a length between 0.5 cm and 2 cm. The quality of the joints between the models is also a priority to avoid unexpected defects. Please refer to this video tutorial for more details: https://www.youtube.com/watch?v=d9oOhSGV0Xs&t=17s

<u>This analysis assumes that the models have been properly washed and post-cured.</u>

List of the most common Casting Defects.

Defects due to incorrect feeding / spruering:

- Internal voids
- Punctual inclusions, often deep and sometimes with sharp edges.
- Large cavities and turbulence
- Metal shrinkage

Defects due to incorrect investment preparation:

- Flashing: excess alloy that escapes from the mold
- Rough surfaces often diffused over all parts of the model
- Gaseous inclusions (air bubbles)
- Investment collapse
- Flask explosion

- Geometric inclusions, sometimes very deep

Defects due to temperature errors:

- Incomplete castings in the case of too low temperatures (photo 7)
- "Orange peel" surfaces often only for the largest models or those positioned in the upper part of the tree (photo 8)
- Excessive oxidation, resistant to pickling solutions

Defects due to recycled alloy:

- Pieces that break
- Missing parts
- Surfaces with localized defects, spots of different colors and localized oxidation

Defects due to burnout errors

Although defects related to incomplete combustion are more frequent with resins, it is important to underline that the problems described above can also occur with traditional casting wax. The mistake is often made of attributing to resins defects that could be easily avoided by following the correct procedures.

- Small holes or black crusts
- Diffused surface defects

WITH ALL THIS IN MIND, LET'S NOW GO INTO DETAIL ON THE MOST COMMON DEFECTS, HOW THEY PRESENT, WHAT CAUSES THEM AND HOW TO SOLVE THEM.

Detailed look at the nature of defects and their resolution.

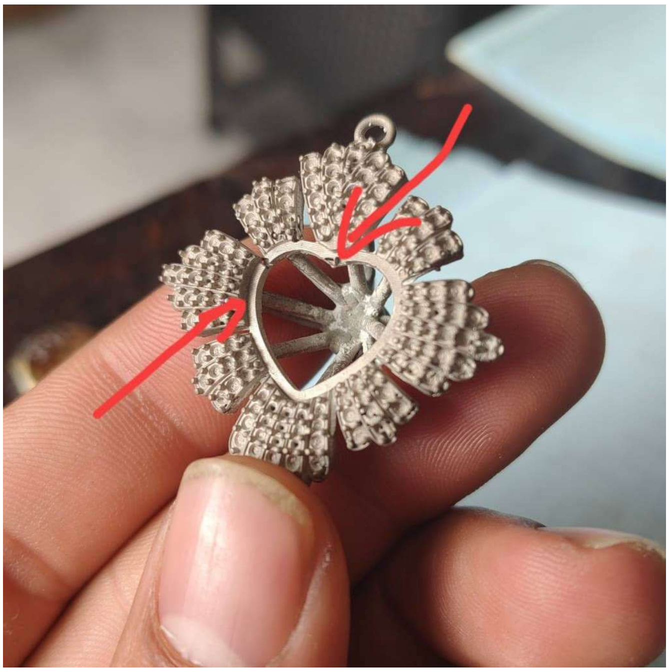
1 IMPROPER MODEL FEEDING AND POORLY WELDED SPRUES

Incorrect model feeding can prevent the metal from reaching and filling all parts correctly. As seen previously, the sprues should never have a cross-section smaller than 25% of the largest surface of the reference model. Furthermore, they must be in adequate number, never shorter than 5 mm and never longer than 20 mm.

If the joints between wax sprues and models are not well-rounded but have sharp edges, flow turbulence can be created, and voids can be created in their immediate vicinity, making the parts not compact. This can also happen if the sprues are too close to each other or are in a conflicting position.

Cold solder joints (joints with cracks, holes, or detached parts) increase the risk that during metal injection, parts of the investment may break and move around the mold, creating very pronounced holes in completely random positions. This happens because a huge amount of high-temperature metal, in a fraction of a second, hits very thin sections of the mold, causing them to break. Holes caused by poor connections can be very deep and often have a fairly geometric shape.

The simplest solution is to carefully make all the joints and leave adequate space between one model and another to allow for their finishing and control before performing the actual investment. This phenomenon should not be confused with typical defects from investment errors or incomplete burnout, as they are completely different phenomena with different possibilities for resolution.

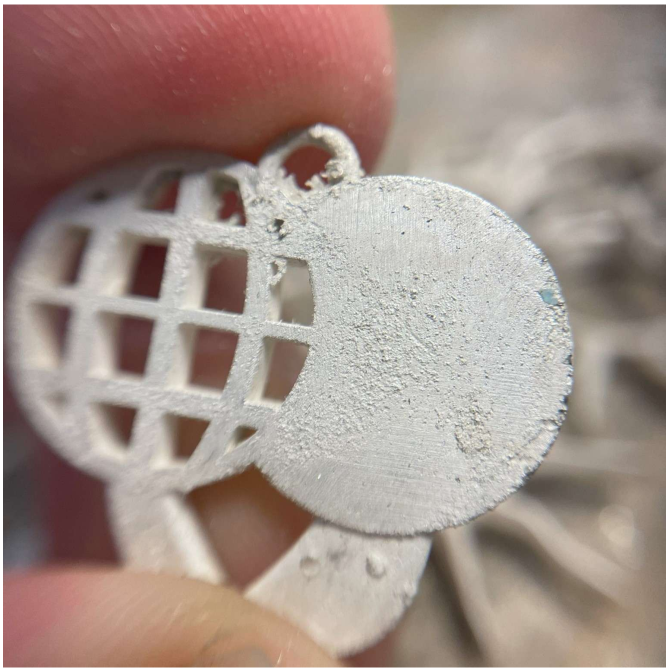


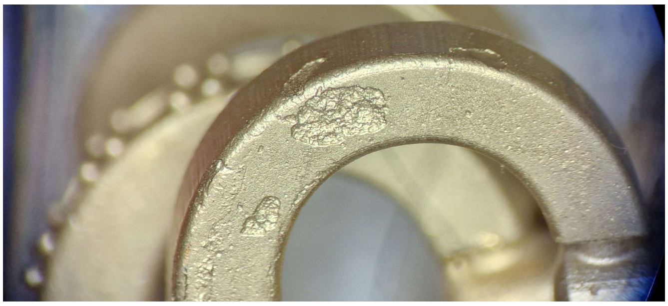
2 INVESTMENT ERRORS

A hasty or incorrect investment preparation is one of the most common causes of casting errors. It is essential to start with the correct amount of water and powder, using only and always distilled water. The mixing times play a fundamental role. Too long mixing times can lead to an investment that is too fragile or too dense. Too fast processing can lead to a non-homogeneous mixture that behaves differently in the various areas of the flask.

Also, moving or disturbing the flask before the investment has completely set is a practice to be absolutely avoided. This is the description of the defects that are attributable to flaws and errors in investment preparation. Rugged surfaces, sometimes in positive, widespread exfoliations accompanied or not by flashing phenomena and detachment of some parts of the investment that, moving inside the mold, create very deep inclusions.

To solve these problems, it is essential to scrupulously follow the manufacturer's operating instructions for both the investment and the castable resin.





3 INCORRECT TEMPERATURES

When the casting temperatures (of the metal or the flask) are too high, defects known as "orange peel" can be created. This texture is dense, of a neutral color, and manifests mainly on the upper part of the models, regardless of whether it is wax or resin. The dimensions of these pores and imperfections are smaller than those caused by an incomplete burnout. This happens because the calcium sulfate of the investment, hit by the too-hot alloy, releases heat, making the liquid metal "fry." High temperatures can also create areas of different colors.

Conversely, temperatures that are too low prevent the alloy from being fluid enough, not allowing it to completely fill every part of the model before it solidifies. This problem is recognizable by the rounded and blunt shape of the edges of the incomplete areas. In some cases, the surface of the model may appear as if it is crystallized.

The solution to these problems is very easy; one should simply verify the accuracy of the instrumentation used in setting and checking the temperatures. Torch melting is much more difficult because you cannot have accurate temperature control, and the repeatability of the result is mainly linked to the operator's experience.

Although each alloy and each casting equipment have specific optimal temperatures, the values reported here can be considered an excellent starting point. The geometry of the models and the size of the flask have a direct repercussion on a possible modification of these temperatures. It is always a good idea to also check the temperatures recommended by the alloy supplier.

SILVER 925	18KT GOLD	BRASS	PLATINUM
Alloy: 1020 °C Flask: 580 °C	Alloy: 1080 °C Flask: 600 °C	Alloy: 1000 °C Flask: 550 °C	Alloy: 1790 °C Flask: 840 °C


Temperature errors are a recurring issue in platinum casting, as the metal is often overheated to maintain its fluidity, which results in an "orange peel" surface texture.

4 RECURRING DEFECTS FROM USING TOO HIGH A PERCENTAGE OF RECYCLED ALLOY

An excessive percentage of recycled metal, or metal that has been recycled too many times, can compromise the quality of the piece. The most common defects include parts that are not compact and fragile, alterations in color, or the presence of irregular inclusions. Silver, gold, platinum, and palladium are part of the family of noble metals and are the basis of the most well-known alloys for making jewelry, such as 18kt yellow gold or 925 silver. Noble metals are generally less reactive than other elements. Their lower reactivity derives from the stability of their electronic configuration, which makes them less inclined to form chemical compounds. For this reason, they resist corrosion, oxidation, and the action of acids well, unlike most other metals. However, as we all know, commercial alloys include a wide quantity of other metals that can transform, become inert, or be consumed if the alloys are melted and remelted over and over again. During each melting cycle:

- Selective oxidation: The less noble metals within the alloy (such as zinc, copper, or tin) tend to oxidize more easily and form slag. This reduces their concentration in the alloy, altering its original chemical composition.
- Formation of impurities: The molten metal can absorb gas from the surrounding environment, creating porosity and fragility in the final casting.
- Alteration of properties: The loss of key components or the accumulation of impurities changes the properties of the alloy, making it more fragile, less malleable, les fluid and not able to fill the mold properly or changing its color.

Resolution: Never use more than 30% recycled alloy, and subject metals from models that are presumed to have been melted or re-melted more than a couple of times to refining.

5 INCOMPLETE BURNOUT.

Incomplete combustion problems can occur for various reasons:

- The furnace temperature is too low or the heating cycle is not long enough.
- Poor ventilation and a lack of oxygen inside the furnace, which prevent the complete combustion of wax or resin residues.

Localized porosity: Trapped air bubbles and unburned carbon residues create isolated cavities, often with blunt edges. Dark and rough inclusions: The residues that have not been eliminated are incorporated into the molten metal, giving rise to inclusions that appear as dark, crusty spots on the surface of the piece. To correct this problem, it is advisable to check the actual performance of the furnace by measuring temperatures with a probe. Often, in fact, the set temperature does not correspond to the actual temperature inside the heating chamber, especially in larger furnaces, where uneven thermal zones can be created. As a rule, the rear and upper areas of the furnace are hotter than the front ones, near the door. Once the temperature difference (the "delta") has been detected, it is possible to adjust the burnout cycle suggested by the manufacturer, increasing the set temperatures to compensate for this gap. The lack of oxygen can also be remedied by improving your casting results. Simply open the front door a couple of times during the burnout peak or turn the flask upside down (casting cone up) during the last hour of burnout. If you want to learn more about the various phases of an optimal burnout for castable resins, you can take a look at this article from our blog: https://www.bluecast.info/blog/the-burnout-cycle-for-castable-resins One last possible solution, if you are working with 3D printed models, is to use resins that contain a higher percentage of real casting wax: https://www.bluecast.info/x-wax-castable-resin

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