



Casting Safety

By Charles Lewton-Brain

Jewelers cast metals in various ways, from using molds made of dried sand to employing high-tech vacuum or centrifugal systems. Yet, as different as they may be, all these processes share one important characteristic:

Each can be dangerous if the proper safety precautions are not taken.

Think about it: Casting involves heat, with the attendant dangers of burns and damaging infrared and ultraviolet light. In lost-wax investment casting, the burnout process (which normally occurs in kilns) produces fumes that range from mildly to extremely toxic, and which in many cases are fairly polluting. Many alloys cast in the jewelry workshop—gold, silver, platinum, brass, tin, and zinc—may contain other metals that produce hazardous fumes, such as lead, cadmium, beryllium, arsenic, and antimony. Nickel, too, is considered a suspect metal now, and is often found in casting alloys. Manganese and chromium, often found in re-used metals, should also be avoided.

It's not just when the torch or casting machine is fired up that problems can occur, of course. The preparations for casting include solvent exposure, tool use, and mold making (those scalpels are sharp!), and the de-vesting and finishing operations pose their own hazards. But since covering every hazard in the entire process would take an entire book, this document will focus on the dangers present in the investing, burnout, and casting processes. This is a very brief introduction to safety issues when casting. It cannot hope to address the whole

gamut of problems, but it can serve to introduce some important principles.

Casting hazards can be divided into several types.

Chemical: The materials, waxes, metals, and investments we work with are all chemicals, and they can affect the body. The fumes from waxes during burnout are dangerous, as are metal fumes. Toxic metals such as cadmium can also be found in older metal that is remelted. And cristobalite from investment powders can lead to silicosis.

These chemicals can be absorbed into the body through inhalation, ingestion, and skin contact. Don't eat, drink, smoke, bite your nails, or apply makeup in the workshop as a matter of principle. Smoking, besides being bad for you in all the ways you ought to know about by now, seems to react synergistically with many chemicals and dusts that jewelers have been exposed to. In some cases, it dramatically multiplies the risk of damage.

Remember, too, that heat causes chemical reactions to accelerate and sometimes starts them, and heat is definitely part of the casting process.

Physical: These hazards include burns, cuts, crushings, electrocution, accidents, and radiation (ultraviolet and infrared light can damage the eyes). Noise doesn't pose much of a hazard for casters, although torches and other loud shop noises could cause hearing loss.

Ergonomic: These problems include working heights

that are too tall or too short, too few breaks in work, and repetitive movements. Make sure that you do not have to be positioned awkwardly at any point during the casting procedure or process. If you're casting as part of a production system, be sure to examine the ergonomic issues quite carefully.

Fire: When working with gases, torches, hot metals, and electric and gas kilns, you always run the risk of a fire or an explosion. Care and proper maintenance are especially critical when you use a hand torch: Keep all flammable materials and liquids away from any source of heat or spark, and make sure you have fire extinguishers on hand (as well as a fire plan).

In these four categories, the main dangers are silicosis caused by breathing in cristobalite (the primary ingredient in investment powders); dermatitis from repeated skin contact with investment, debubblers, and fluxes; lung damage or illness caused by breathing in metal fumes; eye damage caused by not using the right kind of eye protection against ultraviolet or infrared light, or by flying chunks of metal or investment; and burns and accidents with the electrical, gas, and mechanical equipment used for casting.

The next section lists the hazards present in each procedure, as well as some suggestions to help minimize them. For the most part, I consider the casting process to be very safe, but you should understand that possibilities for harm do exist—and I have by no means covered all the potential dangers. Safety is your responsibility, and it is up to you to consider safety in your own particular circumstances.

Investing

Chemical: Potentially hazardous chemicals include alkalis in investment, which can foster dermatitis with skin contact, and detergents and de-fatting agents in debubblers.

Physical: Common hazards include electrocution from electrical short circuits, accidents due to a tripping hazard or clutter in the workshop, and splashed investment in the eyes. Most critically, you must beware of inhaling cristobalite. The main investments used by jewelers are up to 60 percent cristobalite, a form of crystalline silica that is much more dangerous than ordinary silica and can lead to a serious risk of silicosis. It is also a possible carcinogen.

Ergonomic: Ergonomic injuries generally occur only in real production situations, though working height and stance should be considered in any job.

Fire: Fire hazards stem mainly from electrical wiring problems. Always make sure the fusing is correct for the demands on your electrical service. Check and maintain wiring on any electrical device.

Exposure routes: Eyes, inhalation (of silica), skin.

Safety precautions: Use local ventilation to suck the airborne investment particles away from where you are mixing and measuring. Wear a mask when investing, although a mask is no substitute for good local ventilation. Try to control dust by mopping floors and sponging surfaces with water. Use latex or vinyl gloves to protect your skin when touching the investment.

Burnout

Chemical: Potential hazards include wax and plastic fumes from burnout, and fumes from any gas heat source. If you use polyurethane or Styrofoam instead of wax for the positive mold, burnout can produce hydrogen cyanide and other toxic gases (Michael McCann, *Health Hazards*). Styrofoam also produces carbon monoxide when burned. Using Styrofoam in this way is not recommended.

“When ... waxes burn, they release many toxic and irritating compounds, including acrolein and formaldehyde. Acrolein is an exceedingly potent lung irritant, formaldehyde is a sensitizer and suspect carcinogen,” writes Monona Rossol. Burning organic chemicals like rosin, petroleum jelly, or mineral oil, which may be added to wax, “will release carbon monoxide and other toxic decomposition products” (Monona Rossol, *The Artist’s Complete Health and Safety Guide*).

Physical: Hazards in this category include electrocution from electrical short circuits (this happened to me once in Germany when I reached into a kiln); accidents due to tripping hazards or clutter in the workshop; burns while checking progress of burnout; and irritation from wax fumes. There is also the rare possibility of investment popping and hitting you while you’re inspecting it.

Ergonomic: Burnout does not involve many ergonomic issues, except for working heights, confined spaces, and access to equipment.

Fire: Electrical and gas kilns are the most obvious fire hazards. If the kiln is opened before the wax residue is gone, there may be a flare-up, and billowing flames can erupt. Just close the door to put out the

fire. (See the “Fire” section under “Casting,” below, for more possible hazards.)

Safety precautions: You should have eye protection when near the flasks and wear protective gloves and clothing when handling them. Use gripping tongs that do not slip to move the flasks during burnout.

Substitution options to reduce risk: Autoclaving can take care of some of the potential problems by removing the wax in a liquid form, which means you don’t convert the waxes into toxic fumes. Avoid Styrofoam and consider using waxes such as beeswax, which produces fewer toxic fumes than some of the plasticized waxes. And, of course, you can always outsource.

Casting

Chemical: Potentially hazardous chemicals include borax, boric acid, and possibly other casting fluxes, such as ammonium chloride or sodium chloride. Zinc is also a concern if you use it to de-gas a melt. Some alloys may contain hazardous metals, such as cadmium, beryllium, arsenic, and antimony. Metal fume fever causes flu-like symptoms, including fever, chills, and aches, usually two to six hours after exposure (Rossol). The symptoms last for 24 to 36 hours (Michael McCann, *Artist Beware*). Unless the metals are toxic, such as cadmium, those exposed seem to recover with no long-term effects.

Be particularly wary of using non-precious scrap metal for casting, as it may contain metals that will produce toxic fumes when melted. Scrap and reclaimed mystery metals may also be coated with lead- or cadmium-based paints, which produce poisonous gases when heated.

Physical: Like the other procedures, casting poses electrical hazards. (If you are using an induction melting crucible or electric kilns, then electrocution is a risk, as is fire.) Other considerations: accidents due to tripping hazards or clutter; injuries from mechanical parts cracking or smashing into a hand that is incorrectly positioned; and burns suffered while removing and preparing flasks for casting.

Accidents can also occur if your casting machine is not balanced correctly, or if you have not maintained and checked it properly before use. (Such carelessness can result in a worker's broken arm or in red-hot metal globs being splattered across the room.) Other dangers include the risk of an explosion if you're using gas torches, and the breathing in of investment dust, which is particularly present during centrifugal casting and can cause lung disease.

Ergonomic: In casting, such issues primarily involve working heights, movement positions, and a setup that doesn't require twisting and turning of your body. In a production situation, you would have to examine the workspace and the job very particularly to ensure that ergonomic issues are addressed.

Fire: When using electrical equipment as the heat source for melting, all issues of electrical safety must be addressed. These include current draw, fusing, wire conditions, maintenance, and the possibility of electrocution. When using gas kilns or torches, you must pay attention to such issues as checking for leaks, proper storage, and the proper use of equipment, such as flashback arrestors.

Exposure routes: Inhalation (wax and metal fumes, dusts of various kinds, fumes from fluxes, gas), skin (fluxes and other materials, burns), eyes (infrared

and ultraviolet radiation, and possibly sodium flare).

Safety precautions: Use local ventilation. You are dealing with hot objects, so the kiln and casting spot must be in a segregated, fireproof area. All flammable materials and liquids must be kept away from heat. Fireproof walls should surround the kiln area. A burn kit and ice should be on hand in case someone is burned. Ensure that you have a fire plan available. The casting area should be damp-wiped frequently to remove cristobalite dust.

The proper maintenance of all equipment, including the torch systems, is critical. You'll also want to be sure you have good ventilation, as well as eye protection from both particles and radiation (infrared, ultraviolet, sodium flare). Eye protection is particularly important when you're melting with an oxy-acetylene or oxy-propane torch system, since either emits significant amounts of ultraviolet light. (Note: Some cities forbid the use of acetylene or propane; check your local regulations.)

Use heat-protective gloves, a leather apron, and steel-toed boots with molten-metal splash-proof covers over the lace area to protect against spills. Place a shield around the casting machine to keep metal splashes segregated: The old washtub around the centrifuge is a reasonable shield.

Be familiar with all materials used—the fluxes, the metals, and the chemicals involved—as well as their effects. Make sure that copper, for instance, does not contain any beryllium. If you're not familiar with the possible safety hazards of a material, ask your supplier for a Safety Data Sheet (SDS).

Substitution options to reduce risk: Outsource. Switch to other types of manufacturing procedures, such as metal stamping, construction, milling, and

computer-aided design and manufacturing. Substitute materials are possible. For instance, it's apparently possible to use a non-cristobalite or lower-cristobalite investment for some casting purposes. Or try using waxes for burnout that do not contain multiple chemicals. Sand casting may substitute for investment casting.

Remember: No matter the size of your operation, always set things up so you can't hurt yourself. Make safety a habit, and it won't seem like work. If you

have an accident or a near miss, record it in an "accident book" and discuss it with employees, friends, or colleagues. Recording the event will help remind you to avoid doing the same thing again.

And to avoid unnecessary work, look for people who have solved the same kinds of safety problems you have experienced, and see if you can adapt some of their ideas and approaches for your own shop. There are role models all around you if you just take the time to look—and make safety a part of your regular thought pattern.

References

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