Making Medals by Making Metals: A Nexus of Science and Art

Summary
The activity uses elemental tin metal or Onion's metal low-melting fusible alloy, or a mixture of the two, to produce molten metal which can then be cast into a graphite mold to create a uniface medal.

Materials

1. Tin metal (or Onion's fusible alloy, available from Flinn Scientific or other science supply house)
2. Hot plate
3. Crucible
4. Tongs
5. Graphite block, 3-in^3 (Information on a source given below)
6. Carving tools, such as wood carving tools or screwdrivers
7. Beaker with cold water (optional, only if molten metals are mixed)

Safety Suggestions

- Safety Goggles Required
- Protective clothing suggested
- Caution hot liquids
- Do not eat or drink any of the materials used in this activity

Procedure

1. Optional preliminary preparation work by the teacher: Cut a circle 3 – 5 mm deep in one face of a three-inch, cubic graphite block. This can be done with a hole-saw mounted on a drill or drill press, with the central bit removed. Figure 1, left, below, shows this. Figure 1, right shows a block being carved by a student where the circle was not desired for the design. If this is not possible, a block with no carving can be used – and modeling clay can be used to make a dam around the area where metal will be poured.
   - Graphite can be purchased at: Graphite Products Corporation, 1797 E. 10 Mile Rd., Madison Heights, MI 48071, phone: 248-548-7800, graphiteproductscorp.com
2. Using a three-inch, cubic graphite block, carve a design in one face of it. Set this aside until molten metal is ready.
3. Melt elemental tin metal or Onion's metal in a crucible. Recommended, 300 – 500 grams of metal.
4. Pour the metal into the graphite mold, being careful not to spill over the edges of the design.
5. Allow to cool, approximately 1 minute.
6. Carefully grasp the graphite block, turn it to a side, and tap on a hard surface. The medal should fall out.
7. If the medal radiates any heat (which is uncommon), grasp it with tongs and place it in a beaker of cold water, or in a sink of cold water. In only a few seconds, it will be cool to the touch.

Alternate possibilities:

8. If the design of the medal then needs to be changed, or did not turn out as the student-artist wished, the mold can be further carved, and the metal re-melted.
9. If tin is used and the metal does not flow well, tin can be mixed with Onion's metal fusible alloy, producing a metal alloy with a very low melting point. Proportions are not exact. Students often find it is fun (and educational) to try different alloy compositions, and to make them for themselves.

Where's the chemistry? (See Figures 2 and 3)

1. Phase changes:
   This experiment shows phase changes of metals from solids to liquids. Phases and phase changes are discussed at the beginning of many general chemistry textbooks. The reason tin or Onion's metal are used is that both melt at relatively low temperature, and therefore are very easy to handle for people at any level of expertise or experience.

2. Making mixtures / alloys:
   Mixtures are usually discussed at the beginning of general chemistry classes, as part of the discussion and comparisons of elements, compounds and mixtures. Alloys are a sub-set of mixtures, and few students at this level have seen an alloy, such as Onion's metal, that actually melts in boiling water. Tin can be melted on a hot-plate, or added to molten Onion's metal while it is in water.
3. Heat transfer. The concept of ΔH is discussed in many general chemistry textbooks, but just where the heat "goes" is often not. Graphite can absorb a significant amount of heat, which makes the graphite black suitable to dissipate the heat of the molten metal poured into it. Since it is very soft and easy to carve, graphite becomes both mold and heat sink, a convenient phenomenon.

What did you see?

The following have been noted when this experiment has been performed in Benvenuto's general chemistry, first semester laboratory class:

1. Metal will sometimes spill, either through accidental student mis-handling, or through an accidental breaking of a crucible. Instruct students to simply let the metal go where gravity takes it. It solidifies almost instantly, and can be peeled off bench tops or floors, folded up, and re-used in another crucible.
2. Do not make designs in molds too deep, or they become difficult to remove. 1 – 3 mm carving depth is good.
3. When carving letters or images that are not symmetrical, suggest to students they draw a design on paper, turn it backwards while up to a light, then carve that image. It prevents backwards letters in the final medal. If this mistake is made, but the design is otherwise good, a student can fill the backwards letters with modeling clay, then re-carve as needed.
4. If desired, some dam made of clay or even wadded paper can be used to make a raised edge for the medal. Simply taping a paper dam around the edge of a mold design allows students some leeway when pouring.
5. If a medal does not come out looking like a student wishes, it can be re-melted and re-cast. Some students in a 3-hour lab period have done this several times.

References

One publication on this has appeared in the arts journal *Médailles* :

Mark Benvenuto, Shelby Maurice, and Bryan Paulsen. The Nexus of Art and Science: Cast medals graphite molds, *Médailles*, **2016**, pp.153-156.


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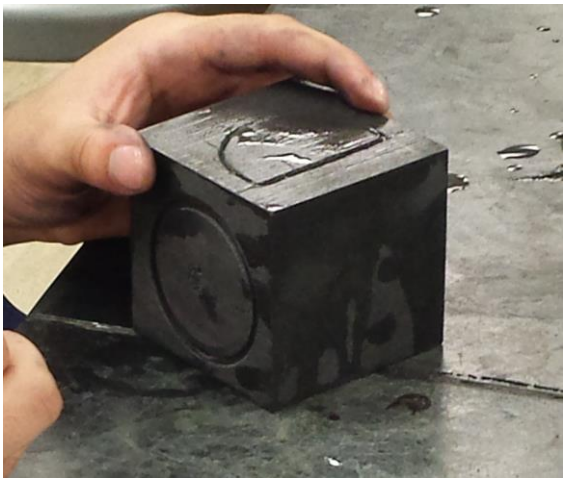


Figure 1 (Both photographs were taken by Mark Benvenuto)

Figure 2. Diagram of an elemental metal, below, atoms in a solid arrangement.

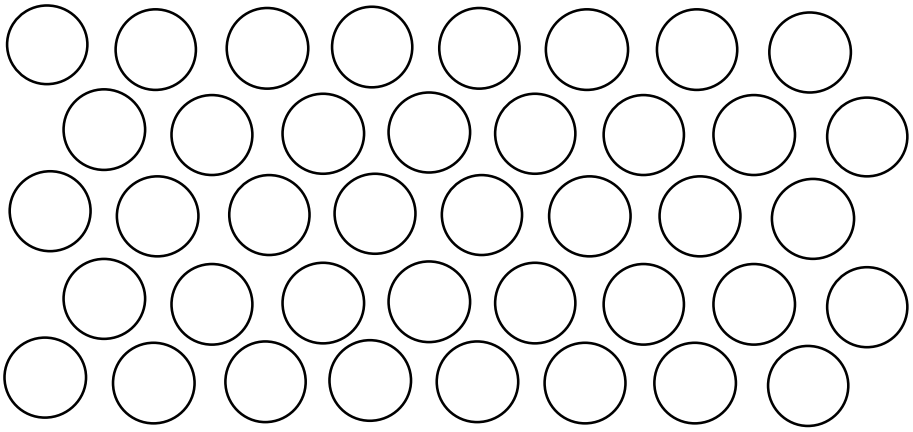
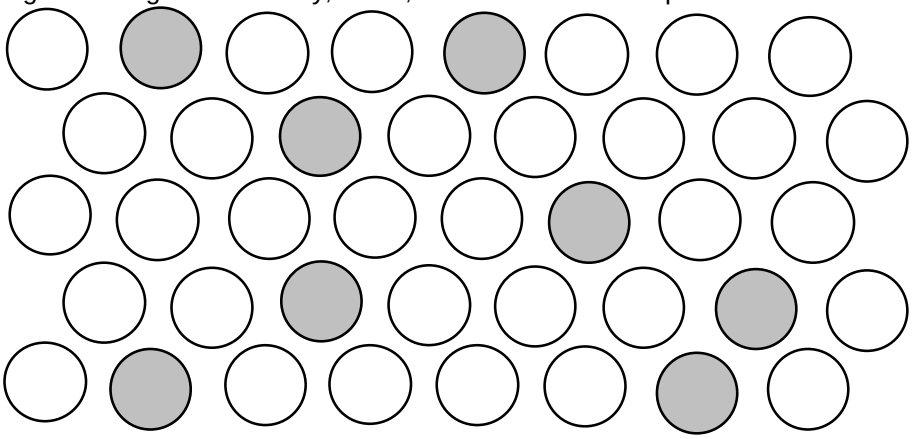


Figure 3. Diagram of an alloy, below, second element interspersed with first:



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