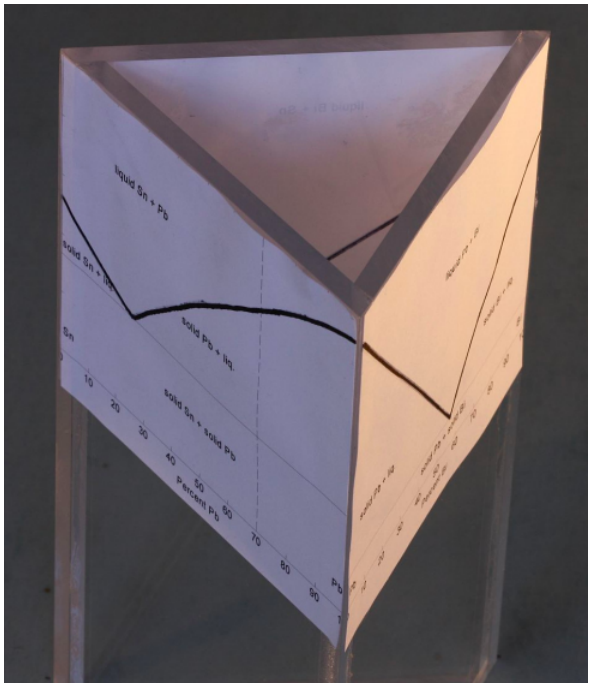
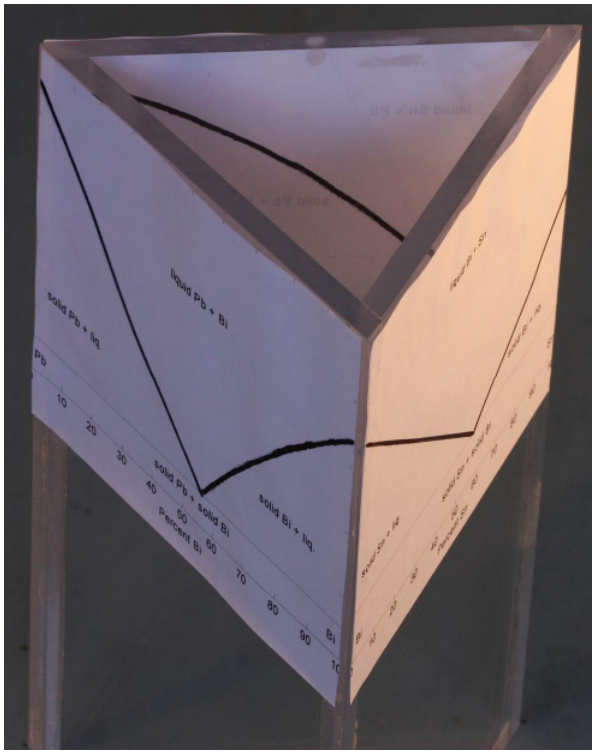
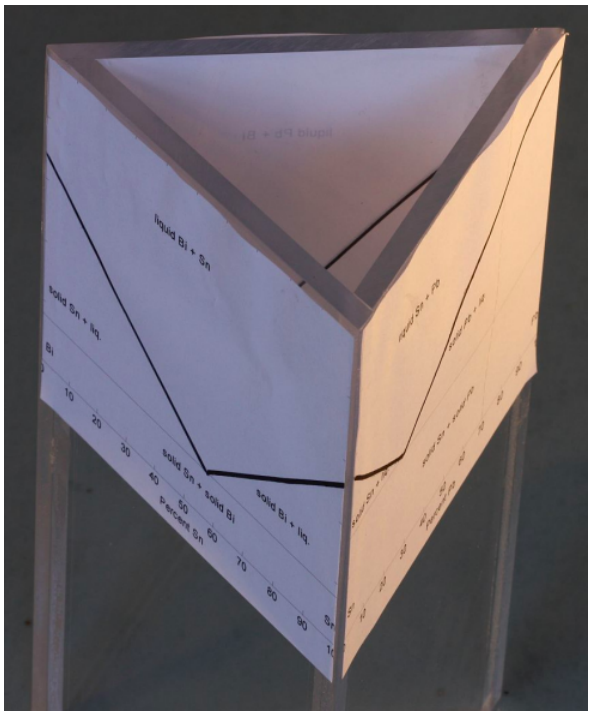
17.10: Ternary Alloys

In this section we look at what happens with an alloy of three metals, and we shall use as an example Pb-Bi-Sn. Our description is merely illustrative of the principles; for more exact details, see the specialized literature.

To illustrate the phase equilibria of an alloy of these three metals, I have pasted the eutectic diagrams of the previous section to the faces of a triangular prism, as shown below. The vertical ordinate is the temperature.

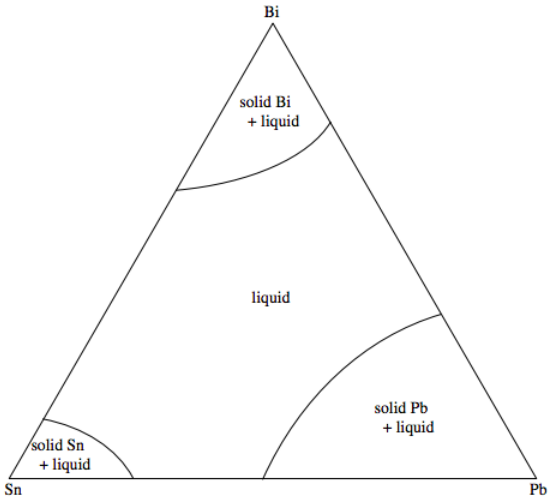






On each of the three faces only two of the metals are present. The situation where all three metals are present on comparable quantities would be illustrated by a surface inside the prism, but creating this inner surface is unfortunately beyond my skills. Anywhere above the surface outlined by the curves on each face is completely liquid. Below it one or other of the constituent metals solidifies. The surface goes down to a deep well, terminating in a eutectic temperature well below the 125 ºC of the Pb-Bi eutectic.

In lieu of building a nice three-dimensional model, the next best thing might be to take a horizontal slice through the prism at constant temperature. If I do that at, say, 200ºC, the ternary phase diagram might look something like this:



You can imagine what happens as you gradually lower the temperature. First a bit of Pb solidifies out. Then a bit of Bi. Lastly a bit of Sn. You have to try and imagine what this ternary diagram would look like as you lower the temperature. Eventually the solidification parts spread out from the corners of the triangle, and meet at a single eutectic point where there are no degrees of freedom. Below that temperature, all is solid, whatever the composition.