Shop Notes: Jewelry

Expansion

Richard Austin (1936-1990) was a metalsmith and author, with several hundred articles to his credit.

After his death I was given custody of an extensive collection of manuscript material-mostly on the technical issues of metalworking.

This text represents the first effort to organize the material-an attempt merely to group the files by topic. None of this is finished, and the text makes reference to illustrations that were never done-illustrations which were stored separately in any case, making it extremely difficult to bring the parts together.

It is unlikely that I will ever be able to spend the time to sort this all out. But it seemed a shame to let these articles languish unread by those who might benefit from them in some small way. So I have decided to release them in their roughly sorted form in the hopes that someone may find them useful.

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EXPANSION

The expansion or contraction of solids is generally expressed as a Coefficient of Thermal Expansion. Typically, this is measured in units per unit per degree centigrade. The unit of measurement is immaterial, since the coefficient is a proportional measurement. It is important to note that the rate of expansion varies with temperature. The coefficient at room temperature will be different than the rate at 800°C. However, for purposes of this discussion, the change in the coefficient is insignificant. An understanding of the approximate amount of expansion or contraction is what is important. Three of the common jewelry metals have the following coefficients of expansion:

Gold	13.20×10^{-6}
Copper	14.09×10^{-6}
Silver	17.04×10^{-6}

These materials are in the mid-range of most of the common metals and alloys. Some metals such as platinum will display less expansion, while some of the bronze alloys will have considerably more. However, almost all of the common alloys will be somewhere in the range of 8 and 22×10^{-6}.

What this means is that a one inch bar of silver (17.04×10^{-6}) will expand 0.00001704 inches for each degree centigrade its temperature rises. The expansion effect is obviously rather small. However, it occurs over a wide range of temperature during the solidification process. If we assume that the average craft metal has a coefficient of thermal expansion of approximately 15×10^{-6}, and a melting point of about 900°C, the consequences are interesting. This means that our hypothetical metal will contract by a total of $875 \times 15 \times 10^{-6}$ inches per inch going from its solidification point to room temperature. This equals about 0.013 inches per inch, or a contraction of about 1.3%. You will note on the attached graph that cristobalite investment contract about 1.25% in the range of temperatures being considered. In essence, this means that the cristobalite investments will almost exactly offset the contraction of most of the common jewelry metals and alloys.

Most stainless steel (flask material) has a coefficient of thermal expansion in the range of $10\text{-}12 \times 10^{-6}$. This means that during heating, the flask will expand about 0.96%, while the investment is trying to expand 1.25%. The difference of 0.29% represents a compressive load or restraint on the system. This is consistent with literature references suggesting differences in casting dimensional tolerances related to orientation in the flask.