Thermal contraction of Vespel SP-22 and Stycast 1266 from 300K to 4K

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The use of Vespel SP-22 polymide resin[1] and Stycast 1266 epoxy[2] as construction materials is becoming common in low temperature apparatus. Vespel SP-22 has a thermal conductivity nearly as low as graphite,[3] yet is more easily machined and is much stronger; Stycast 1266 bonds well to metals, and its transparency and low viscosity greatly simplify casting procedures. A knowledge of the coefficient of thermal contraction of such construction materials is often necessary for proper design of low temperature devices. We present here data on the total thermal contraction of these two materials, measured relative to OFHC copper, from room temperature to dry ice, liquid nitrogen, and liquid helium temperatures.

The simple pushrom dilatometer used to make the measurements is shown in Fig. 1. The test piece and the copper reference pieces are 0.01 m diameter by 0.27 m long rods, and are immersed in liquid in a dewar flask. Expansion or contraction of the test piece relative to the copper is transmitted to the dial indicator outside the dewar by the stainless steel pushrod and support tubes. These tubes are cut from the same piece of stock to ensure that their thermal contractions will be identical. The dial indicator[4] is an ordinary machinists' gauge with a resolution of 5×10^{-6} m and total range of 2×10^{-2} m.

Since the dilatometer measures the difference in contraction between the reference and test rods, it is necessary to add the contraction of the reference to the observed differential contraction to find the contraction of the test piece. OFHC copper was chosen as the reference material because its contraction is well documented and because there seems to be negligible variation in contraction from sample to sample.[5,6]

The apparatus is checked by cooling to 77 K with test pieces of 304 stainless steel and of OFHC copper. As expected, no differential contraction is observed with the copper sample, within the resolution of the dial indicator. The contraction observed for the stainless steel agrees with previous work[7] to within 1%.

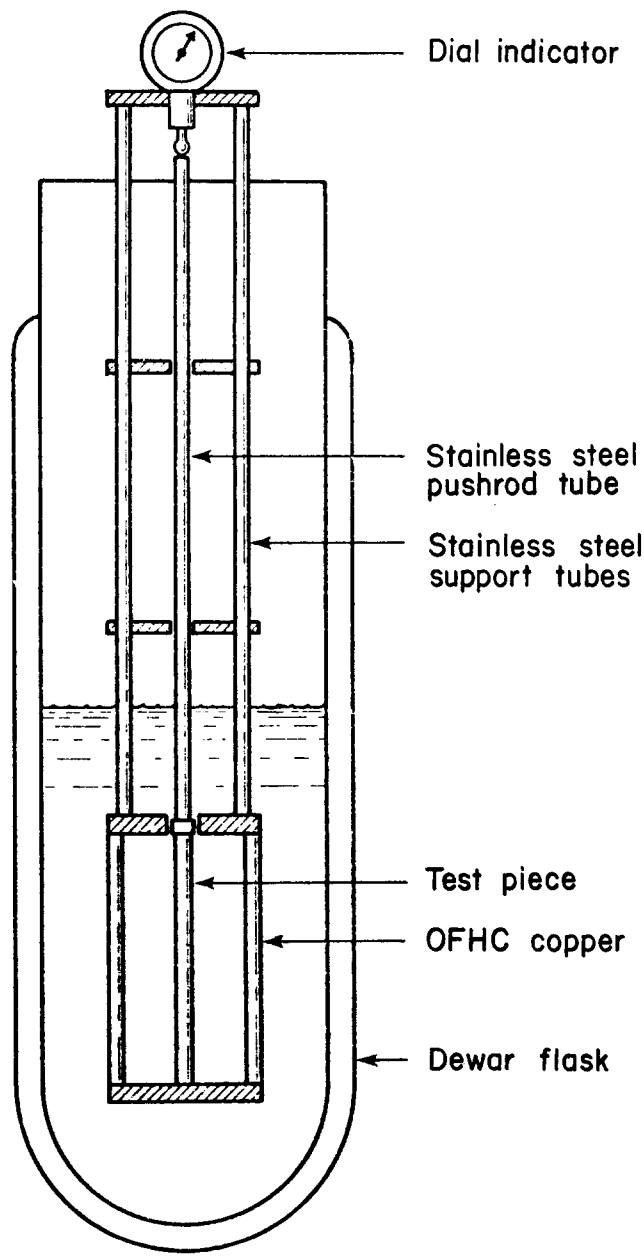

Fig. 1 Sketch of the apparatus

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0011-2275/79/060362-02 $02.00

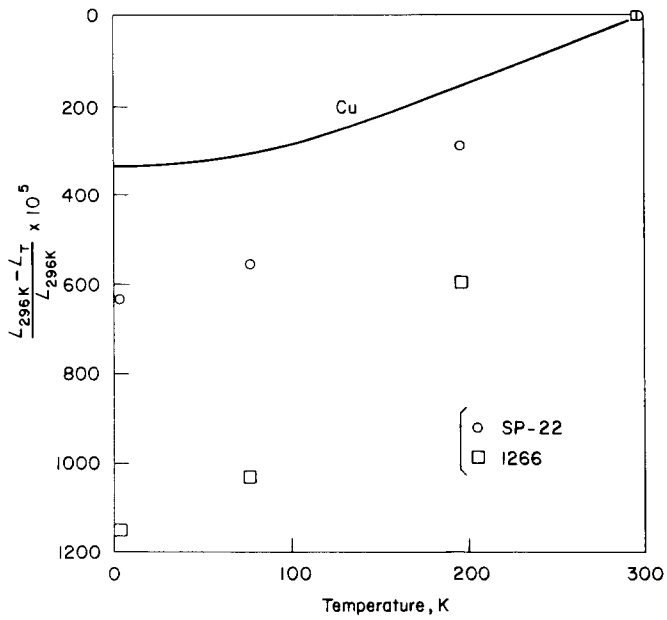

Fig. 2 Thermal contraction of Vespel SP-22 and Stycast 1266. The curve for copper (included for comparison) is from reference 5

The data on isotropic Vesepl SP-22 and Stycast 1266 are shown in Fig. 2 and Table 1. The Stycast 1266 4 K datum agrees with previous work.[8] The dilatometer is very inexpensive and easy to build and to use, and its accuracy of $\Delta L/L \sim 2 \times 10^{-5}$ is adequate for many applications.

Table 1. $(1 - L_T/L_{296}) \times 10^5$

	Vespel SP-22	Stycast 1266
195 K	289 ± 2	596
77 K	558	1035
4 K	633	1150 ± 2

We would like to thank the DuPont Company for making available the Vespel SP-22. This work was supported in part by NSF grant DMR-76-82934.

References

1 Dupont Company, Plastic Products and Resins Department, Wilmington, Delaware 19898
2 Emerson and Cuming, Inc, Dielectric Materials Division, Canton, Mass
3 **Locatelli, M., Arnaud, D., Routin, M.** *Cryogenics* **16** (1976) 374
4 Type 8241-942, Brown and Sharpe Mfg Co, Kingstown, R.I. 02852
5 **Rubin, T., Altman, H.W., Johnston, H.L.** *J Amer Chem Soc* 76 (1954) 5289
6 **White, G.K.** AIP Conference Proceedings 17, Thermal Expansion (1973) 1
7 **Altman, H.W.** Coefficients of Thermal Expansion of Solids at Low Temperatures, Part IV, Tech Rep 264-28, Ohio State Univ Research Foundation
8 **Veuro, M.C.** Thesis, Helsinki University of Technology, Helsinki, Finland