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Glass-to-Sapphire End Window Seals*

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SAPPHIRE windows have been used in laboratory devices where radiation from the ultraviolet through the infrared must be transmitted. Sapphire windows have been valuable in chambers which contain the alkali metals, for the alkali metals are known to react with Pyrex 7740 glass and quartz leaving them pitted and darkened. This paper is a report on an improved glass-to-sapphire end window seal.

Previous methods[1] of sealing glass to sapphire consisted of making the seal with 1826 powdered glass. The glass powder seals had limited use because of the obstruction of the window area, the low softening point, and the attack by sodium vapor. Due to these problems it was necessary to seal Corning 7280 glass tubing directly to the sapphire windows.

The sapphire end windows were cut perpendicular to the c axis with a coefficient of expansion of $67\times10^{-7}/°C$. Corning 7280 glass is alkali resistant and has a coefficient of expansion of $64\times10^{-7}/°C$. These coefficients of expansion are close enough so that a durable seal can be made. The 7280 glass can be sealed to Pyrex 7740 glass in small diameter tubing by using 3320 glass as the intermediate. The end window seals which were made had a 29 mm o.d.

The oven for constructing the seals was a $1\frac{1}{2}$-in. diam Alundum core 8 in. long. The core was wrapped with Nichrome V wire and insulated with Hiloset[2] refractory and asbestos. The oven could reach temperatures in excess of 850°C. The sapphire window rested on top of an alumina or CaSiMg disk. This disk contained a small groove on the bottom side where a heating element was placed. The heating element was held in place by Hiloset refractory on the underside of the alumina disk. The sapphire window, alumina disk, and heating element rested on the top of a quartz tube. The 7280 tubing was polished flat on one end and this end was inserted through the top of the oven until it made contact with the sapphire window at the center of the oven. The oven contained a thermocouple which measured the temperature near its center. Another thermocouple was placed upon the alumina disk, and gave a measure of the temperature at the instant the seal was made. The oven was lagged with ceramic wool.

The oven was slowly raised in temperature, for a rapid thermal shock would crack either the 7280 glass or the sapphire window. When the oven reached approximately 850°C, the current on the main oven was slightly reduced. The heater under the disk was started and raised in temperature until the seal area reached approximately 1000°C. This was done by passing 10 amp through the winding for one minute. This temperature was above the melting point of the 7280 glass and the tube became fused to the sapphire. The system was allowed to reach room temperature over a period of 12 hr.

The seal was tested on a vacuum system and a vacuum of approximately 2×10^{-6} mm Hg was obtained. The seal was then exposed to sodium vapor at 400°C for four hours with no noticeable effects on the seal. Additional seals and tests will be performed when new cells are constructed for research.

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[1] G. P. Spindler, *Proceedings of the Fourth Symposium on the Art of Glassblowing* (The American Scientific Glassblowers Society, Wilmington, Delaware, 1959), p. 28.
[2] Trademark of Kaiser Refractories and Chemicals.