SNS-STR-90-98

PERMEATION OF HELIUM THROUGH SCHOTT 8246 GLASS

R. G. H. Robertson,
August 31, 1990

Permeation of He from the atmosphere through the glass or quartz envelopes of photomultipliers is a threat to their longevity. Helium occurs naturally at the level of 5 ppm in the atmosphere, and can be much higher in laboratories that handle liquid He, or where natural gas is used as a fuel.

Helium causes afterpulsing in photomultipliers. There are (at least) two papers that discuss it[1,2].

Because the permeation characteristics of Schott 8246 were not known, Los Alamos contracted with Jeff Kohli at the New York State College of Ceramics to measure it. The method used is mentioned in his letter, and described in more detail in Ref. 3. It is fairly straightforward, and the same method we are using at Los Alamos to study permeabilities of other materials.

Kohli's data shows that 8246 is actually quite good from the standpoint of resisting permeation by He. As it appears to be better than any other glass commonly used for photomultipliers (see attached Figure), we have not attempted to make a detailed interpretation in terms of afterpulsing. If other glasses are acceptable, Schott 8246 should be more so. The physical reason for this good performance is understood in terms of the presence of relatively heavy cations in the 8246 glass matrix (proprietary ingredient). These tend to block otherwise open channels.

We conclude that Schott 8246 should be entirely satisfactory from the He permeation standpoint and that no special precautions (other than protection from high He concentrations) will be required.

References

1. "He^+ Afterpulses in Photomultipliers: Their effect on atomic and molecular lifetime determinations", W. C. Paske, Rev. Sci. Instrum. 45, 1001 (1974).

2. "The Performance of Photomultipliers Exposed to Helium", J. R. Incandela, S. P. Ahlen, J. Beatty, A. Ciocio, M. Felcini, D. Ficenec, E. Hazen, D. Levin, A. Marin, J. L. Stone, L. R. Sulak, and W. Worstell, Nucl. Instrum. Methods in Phys. Res. A269, 237 (1988).

3. "Molecular Solubility and Diffusion", J. E. Shelby, in Treatise on Materials Science and Technology (Academic, 1979), V. 17, p. 1.

Jeff Kohli
5 Greene St.
Alfred, NY 14802
(607) 871-2120

8/3/90

Dr. Hamish Robertson
Los Alamos National ab
Los Alamos, NM 87545

Dr. Robertson:

I am sorry that this letter is a bit late. I have just returned from Brookhaven National Lab where I was using the synchrotron light source.

Enclosed is a brief description of the technique we use to measure gas permeability and diffusivity in glass. Figure 4. shows the sample holder for these measurements. The sentences high-lighted in the text desribe the method. The permeation coefficient is measured when a steady-state flow is achieved (after the sample is saturated). The flow rate is compared to that of a standard whose flow rate is known. This gives us the permeation coefficient. The gas is then removed from the sample and the exponential decay of the gas from the sample is monitored as a function of time. From this decay we calculate the diffusion coefficient. If you have further questions, please feel free to contact me.

I have enclosed a copy of my resume and a list of publications/patents/presentations. I expect to be finished with my doctorate at the end of this year, so I have begun to look for positions at research facilities such as Los Alamos. Please let me know if you, or someone else at Los Alamos is looking for a glass/ceramics scientist.

Sincerely,

Jeffrey T. Kohli

(3)

Jeff Kohli
5 Green St.
Alfred, NY 14802
(607) 871-2120

5/29/90

University of California
Los Alamos National Lab
Accounting Dept.
P.O. Box 1663
Los Alamos, NM 87545

Dr. Robertson:

The enclosed data is for helium gas migration in Schott 8246. The piece of glass which Schott sent me was designated 8246/4; the /4 indicating their melting sequence or code. I have provided results on the diffusivity of helium through this glass, as well as the permeability. This particular glass has relatively moderate helium permeation and diffusion coefficients.

We would gladly accept further gas migration measurement requests if you find that it is necessary. Additionally, we would be happy to suggest other glass compositions which may be suitable for any of your applications.

Please let me know if you would like the remainder of the 8246 glass slab which was sent from Schott to our facility.

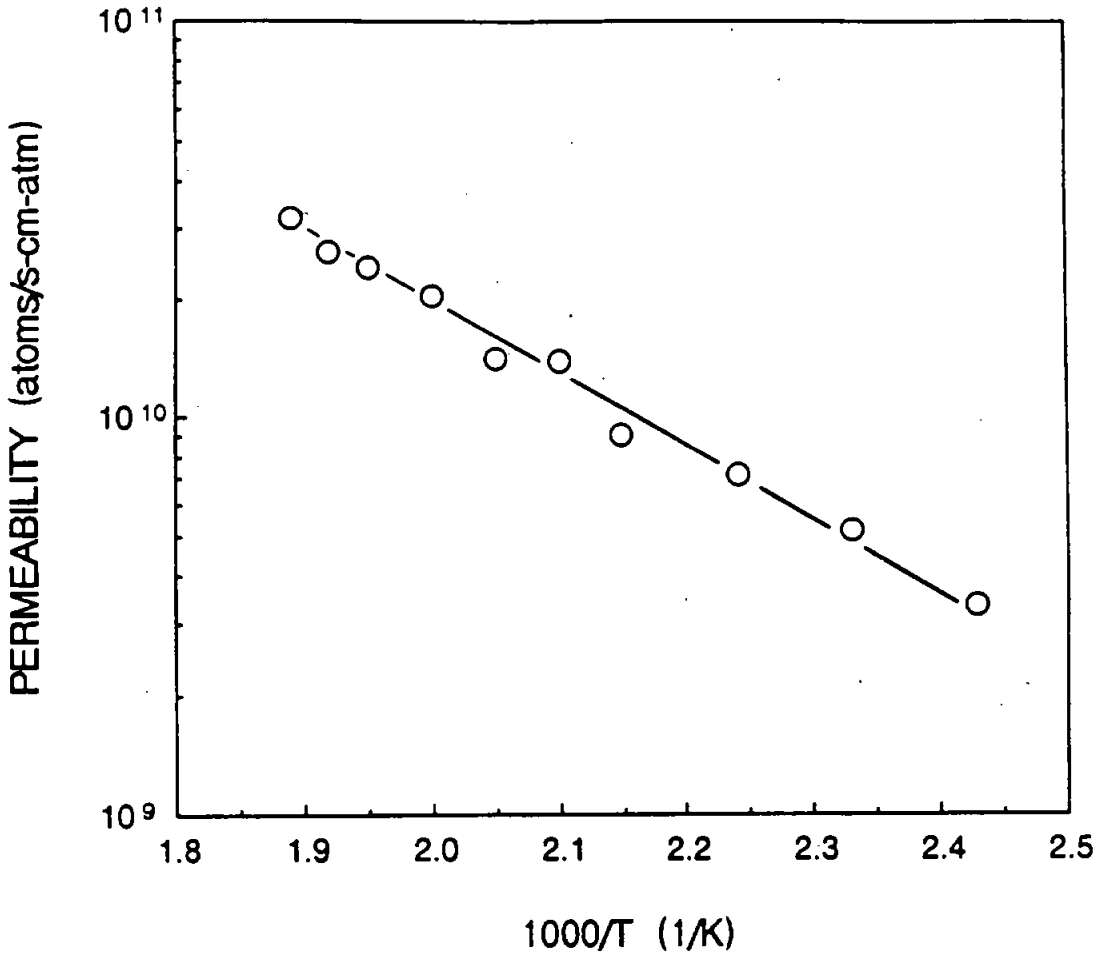
Sincerely,

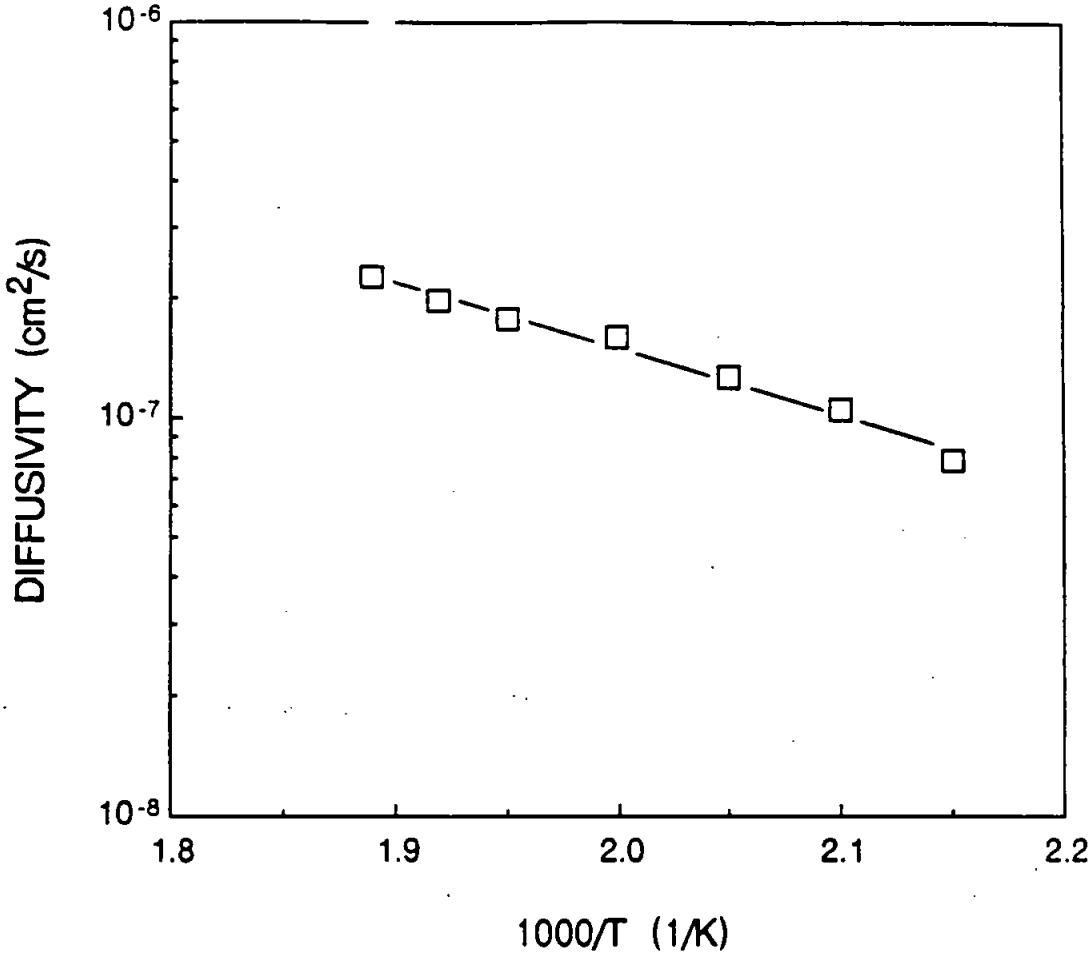
Jeffrey T. Kohli

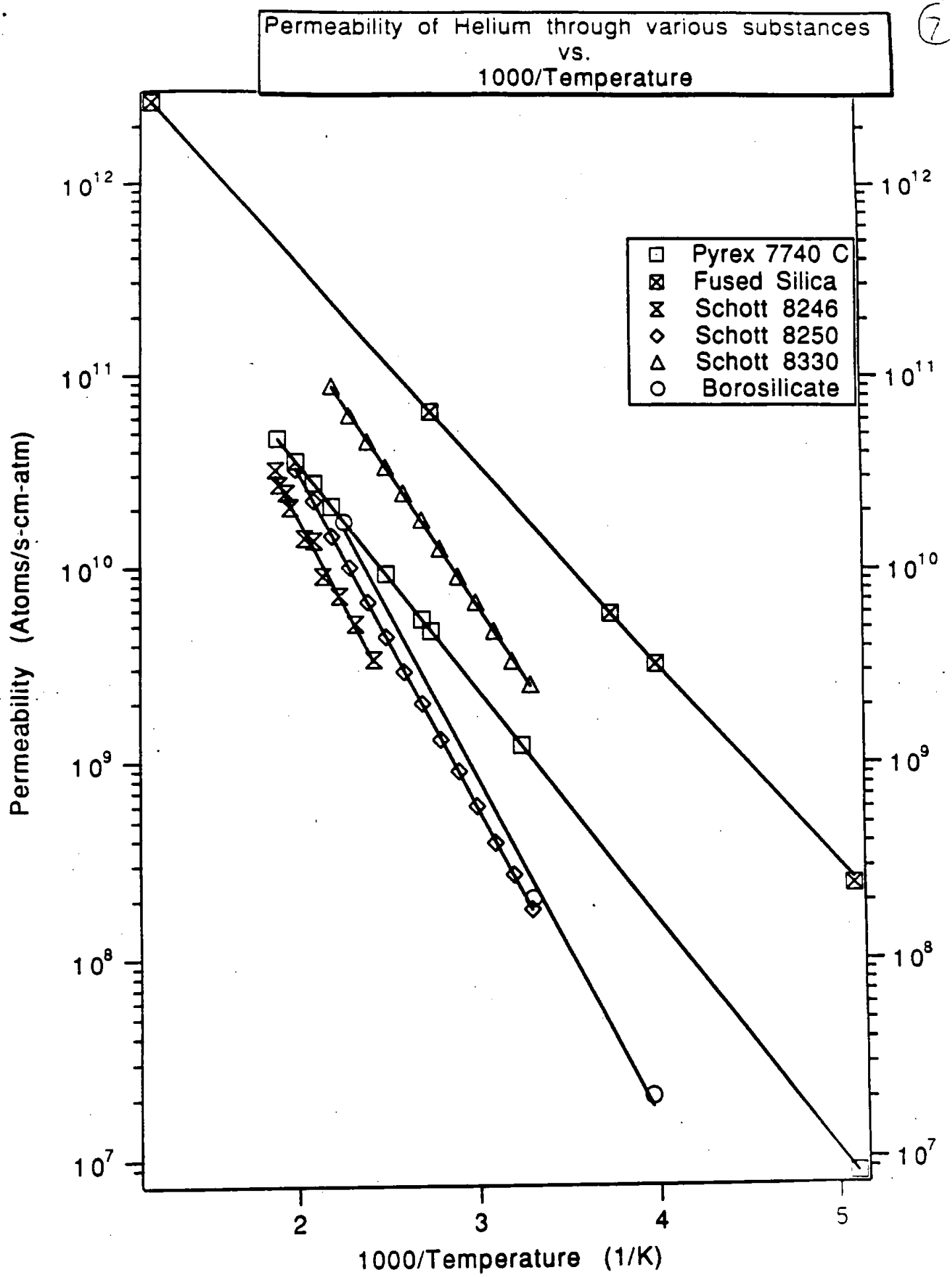
PERSONNEL FILE JUN 05 1990

HELIUM PERMEABILITY AND DIFFUSIVITY
IN SCHOTT 8246/4

TEMPERATURE (K)	PERMEABILITY (atoms/s-cm-atm) $X10^9$	DIFFUSIVITY (cm^2/s) $X10^{-7}$
412	3.35	
430	5.13	
446	7.12	
465	9.01	0.78
476	13.7	1.04
487	14.1	1.25
501	20.3	1.58
512	24.1	1.77
521	26.5	1.97
528	31.9	2.25


PERMEABILITY (atoms/s-cm-atm)
10 11
10 10
10 9
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
1000/T (1/K)


10-6
10-7
10-8
DIFFUSIVITY (cm2/s)
1.8
1.9
2.0
2.1
2.2
1000/T (1/K)


Permeability of Helium through various substances
vs.
1000/Temperature
Pyrex 7740 C
Fused Silica
Schott 8246
Schott 8250
Schott 8330
Borosilicate
Permeability (Atoms/s-cm-atm)
10^12
10^11
10^10
10^9
10^8
10^7
2
3
4
5
1000/Temperature (1/K)