is superior to porous glass in chromatographing spots compactly. The two adsorbents are not equivalent.

Porous glass adsorbent may be useful for TLC when a more acidic adsorbent is preferable, when better detection contrast is required, when speed of development is a consideration, or, in certain instances, when resolution with Silica Gel G is unsatisfactory. Further investigation is warranted.

Food and Drug Administration, VICTOR S. MARINO
1560 E. Jefferson Ave., Detroit, Mich. 48207 (U.S.A.)

1 H. L. MACDONNELL AND J. P. WILLIAMS, *Anal. Chem.*, 33 (1961) 1552.
2 W. S. BRUD, *J. Chromatog.*, 18 (1965) 591.
3 J. K. G. KRAMER, E. O. SCHILLER, H. D. GESSER AND A. D. ROBINSON, *Anal. Chem.*, 36 (1964) 2379.
4 E. STAHL, in E. STAHL (Editor), *Thin-Layer Chromatography*, Academic Press, New York, 1965, p. 7.
5 G. ROUSER, C. GALLI, E. LIEBER, M. L. BLANK AND O. S. PRIVETT, *J. Am. Oil Chemists' Soc.*, 41 (1964) 836.
6 *Corning® Porous Glass Adsorbent for Thin-Layer Chromatography*, TLC-1 (Review), Corning Glass Works, Laboratory Products Department, Corning, N.Y. 14830, October 1967 pp. 10–67.
7 RAJ JHAVERI (Corning Glass Works, Corning, N.Y. 14830), private communication, March 1968.
8 C. BRUNNER (FDA, Division of Pharmaceutical Sciences, Washington, D.C.), private communication, March 1968.

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Enhanced photoemulsion sensitivity at low temperatures used in radiochromatography

Recently a method of detecting tritium and radiocarbon in thin-layer radiochromatography has been developed. By adding scintillators to the thin-layer media, the small β particle energies are converted into light (β-radioluminescence)[1,2]. The detection sensitivity is greatly increased by lowering the temperature when detecting the light by photographic methods[3,4] but not by photomultiplier detection[2,5]. Upon lowering the temperature from 20° to -78° in the applied scintillators, anthracene and 2,5-diphenyloxazole, an increase in detection sensitivity less than 5% is found by photomultiplier detection, while for photographic detection a factor of *ca.* 25 is quoted for the sensitivity increase.

Thus we conclude that the film material, which in fact has been cooled down together with the radiochromatograms, is responsible for the main temperature variation in the overall detection sensitivity. In the film emulsions, back reactions might be prominent, either reducing the extent of latent image formation or producing

a fading of the latent images. The last process could be shown to be negligible[6]. A temperature-sensitive induction of the latent image was then hypothesized.

The mechanisms involved in latent image formation have been thoroughly investigated[7,8], and the low-temperature sensitivity enhancement can be explained according to a suggested model. Electrons released in the silver halide microcrystals by the impinging photons may fall into very shallow traps. New traps are formed at the same sites by successive neutralization of the electrons by Ag^+ from the lattice. These formed silver traps are unstable, and stabilization is reached only if this cycle is rerun, thus giving a site with two silver atoms in its close vicinity. This trap now is considered to be stable and acts as a nucleation center for silver atoms. The lifetime of the first unstable silver trap is temperature dependent, which at low photon intensities determines the rate of formation of stable nucleation centers.

In the following we shall very briefly report on some experiments and results so far as they are relevant to radiochromatography. A broader presentation is given elsewhere[6]. In order to make sure that the greatly increased detection sensitivity by photographic detection cannot be ascribed to temperature variations in scintillator efficiency, pure light exposures were done. Two temperatures, 20° and —78°, were chosen for convenience, and an electroluminescent light source (peak intensity at 470 nm) was used. To obtain the same optical density (O.D. = 0.5) in the film emulsion after a 5-h exposure at 20°, the light intensity had to be about eighty times larger than at —78° (PR X-Omat Estar Medical X-ray film). When the intensity of the electroluminescent light was increased by a factor 1000, no differences in the optical densities could be observed for exposures (5 sec) at the two different temperatures.

Lastly, a radionuclide scintillator system was used as a light source. [³H] or [¹⁴C]glucose solutions were pipetted onto Eastman K301R2 layers and dried. Anthracene was added by spraying a saturated benzene solution onto the layers until no further increase in β-radioluminescence output (peak intensities at 450 and 470 nm) could be measured using a photomultiplier detector.

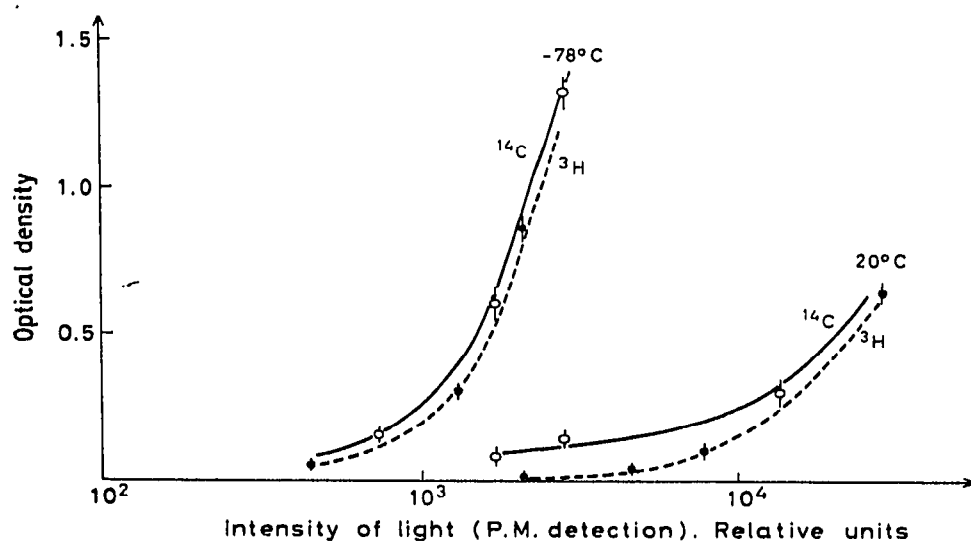For our [³H]anthracene system, the largest part of the exposure results from

Fig. 1. Optical density *versus* intensity of light at two different emulsion temperatures. Further details are given in the text.

scintillations and only very little from direct electron exposure of the film. Yet the induction of latent images seems to be less temperature dependent than for electroluminescent exposure (twelve times increase as compared to eighty times, same exposure time). According to the model, however, a pulsed light source (lifetime of excited states in anthracene $\simeq 2 \cdot 10^{-8}$ sec) would give a less temperature-sensitive induction of latent images.

For the [^{14}C]anthracene exposures, β-particles as well as photons reach the emulsion. In Fig. 1 the [^{3}H]- and [^{14}C]anthracene systems are compared for the two temperatures, 20° and —78°. The abscissa indicates the proper photon intensity (I) measured with a photomultiplier. We notice that [^{14}C]- and [^{3}H]anthracene systems give slightly different O.D.–log I curves. On the one hand we have an additional direct β-electron exposure from the [^{14}C]anthracene system while, on the other hand, we have fewer but more intense scintillations. Both factors would give a less temperature-sensitive induction of the latent images, which is also seen in the figure, at least for low intensities.

To sum up, two main findings seem important to radiochromatography. Firstly by exposure at —78° rather than at 20°, the emulsion sensitivity is increased eighty times if the photons are randomly distributed in space and time (PR X-Omat Estar Medical X-ray film and Kodirex X-ray film at 470 nm and very low intensities). Secondly, the more uneven the distribution of the photons in space and time (depending on the speed of the scintillator) the less temperature-dependent the emulsion sensitivity will be.

Institute of Physics, University of Oslo,   J. F. KOREN
Blindern, Oslo 3 (Norway)   T. B. MELÖ
                                                                                S. PRYDZ

1 H. H. SELIGER AND B. W. AGRANOFF, *Anal. Chem.*, 31 (1959) 1607.
2 S. PRYDZ AND K. S. SKAMMELSRUD, *J. Chromatog.*, 32 (1968) 732.
3 U. LÜTHI AND P. WASER, *Nature*, 204 (1965) 1190.
4 K. RANDERATH, *Anal. Chem.*, 41 (1969) 991.
5 S. PRYDZ, T. B. MELÖ, E. L. ERIKSEN AND J. F. KOREN, *Anal. Chem.*, in press.
6 J. F. KOREN, T. B. MELÖ AND S. PRYDZ, unpublished results, Oslo, 1969.
7 F. TRAUTWEILLER, *Phot. Sci. Eng.*, 9 (1965) 20.
8 B. E. BAYER AND J. F. HAMILTON, *J. Opt. Soc. Am.*, 55 (1965) 429.