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POLYTETRAFLUOROETHYLENE LAYERS FOR THIN-LAYER CHROMATOGRAPHY*

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SUMMARY

Polytetrafluoroethylene layers have been evolved whose properties are satisfactory for thin-layer chromatography (TLC). These properties include versatility of composition, rate of drying, uniformity, adherence to a support without binder, wettability, rate of development, and resolution of test-mixture components. The layers have been used to separate both inorganic and organic mixtures. Polytetrafluoroethylene is compatible in thin layers with numerous TLC adsorbents and thus can be a component of mixed-adsorbent or gradient-adsorbent layers or an inert diluent for other TLC adsorbents. The inertness of polytetrafluoroethylene layers is an advantage in their deposition from, development by, or visualization with highly corrosive liquids. Polytetrafluoroethylene layers are especially suitable for extraction chromatography; the extractant may be included in either the layer or the developer. A thin layer of polytetrafluoroethylene is a suitable solid support for liquid ion exchangers. Therefore, by TLC on polytetrafluoroethylene it should be possible to study the mechanisms of liquid ion exchange without the need to consider the reactivity of the liquid phases with the solid support.

INTRODUCTION

Polytetrafluoroethylene is often a solid support in gas chromatography[1] and less often in column chromatography of both inorganic[2] and organic compounds[3]. Many of the materials that are solid supports in gas and column chromatography are also used as solid phases for thin-layer chromatography (TLC), but polytetrafluoroethylene is not among them. Possibly, its lack of use in TLC is attributable to its nonwettability by some liquids.

The work described here demonstrates that polytetrafluoroethylene is a satisfactory and versatile solid phase for TLC. Three factors make its use in TLC possible: (1) it is lipophilic and thus is wettable by and swells in numerous organic liquids, (2) fluorochemical surfactants cause it to be wet by aqueous media, and (3) it is now

available in suitable particulate form. In this work, several potentially useful types of particulate polytetrafluoroethylenes and of surfactants were evaluated. Procedures were developed for preparing thin layers of polytetrafluoroethylene, and the layers were used for the TLC separation of inorganic and organic mixtures.

Compared with other TLC media, polytetrafluoroethylene layers have several advantages; the layers are: chemically inert; compatible with corrosive liquids that may be used as slurry media, developers, or reagents for visualization; and essentially noninterfering in the identification and quantitative measurement of resolved components.

PARTICULATE POLYTETRAFLUOROETHYLENE FOR USE IN TLC

Properties desired

To be a suitable solid phase for TLC, a material must have a particle size in the range about 1 to 25 μ^4. The polytetrafluoroethylenes used for gas and column chromatography (e.g., the Tee 6's) have particles that are too large (~ 105 to 120 μ). Those offered as lubricants meet the particle-size requirement and are the types that were evaluated.

Also, the material must be wettable by all the liquids used in the TLC system. The nonwettability of polytetrafluoroethylene by certain liquids is overcome by the use of fluorochemical surfactants.

Sources

Sources of particulate polytetrafluoroethylenes are limited. Table I lists sources of polytetrafluoroethylene and related types of lubricants potentially useful in TLC. Of these, the following were evaluated: TL-120 FEP, TL-126, Fluoroglide 200 lubricant (lots 1 and 2), and Fluoroglide 200 chromatography grade TWO218. The Fluoroglides were the most satisfactory; the supplier has indicated that the Fluoroglide 200

TABLE I

SOURCES OF POLYTETRAFLUOROETHYLENE AND RELATED TYPES OF PARTICULATE LUBRICANTS

Designation	Approximate average particle size (μ)	Source
Fluoroglide 200[a]	10	Chemplast, Inc., 150 Dey Rd., Wayne, N.J.
Fluoroglide 200, chromatography grade TWO218[b]	1	07470, U.S.A. (Distributor: Norrell, Inc., 721 Scott St., Memphis, Tenn., U.S.A.)
TL-115	8 to 10	Liquid Nitrogen Processing Corp.,
TL-120 FEP[c]	0.7	412 King St., Malvern, Pa., U.S.A.
TL-126	8 to 10	
Whitcon 5, 6, 7, and 8	<1	Whitford Chemical Corp., P.O. Box 515, Westchester, Pa. 19380, U.S.A.

[a] Two lots of this were obtained from Norrell, Inc.; their properties differed slightly.
[b] This material was obtained directly from Chemplast, Inc.
[c] Described by the vendor as 'fluorinated ethylene propylene', a material closely related to polytetrafluoroethylene.

chromatography grade TWO218 most likely is the form that will continue to be available[5].

Evaluation of properties

Particle size and shape of each of the materials evaluated were determined by electron microscopy. Figs. 1 and 3 show electron micrographs of the materials as received; the differences among them are readily evident. Figs. 2 and 3 give electron micrographs of the dry residues after the materials were layered from organic liquids.
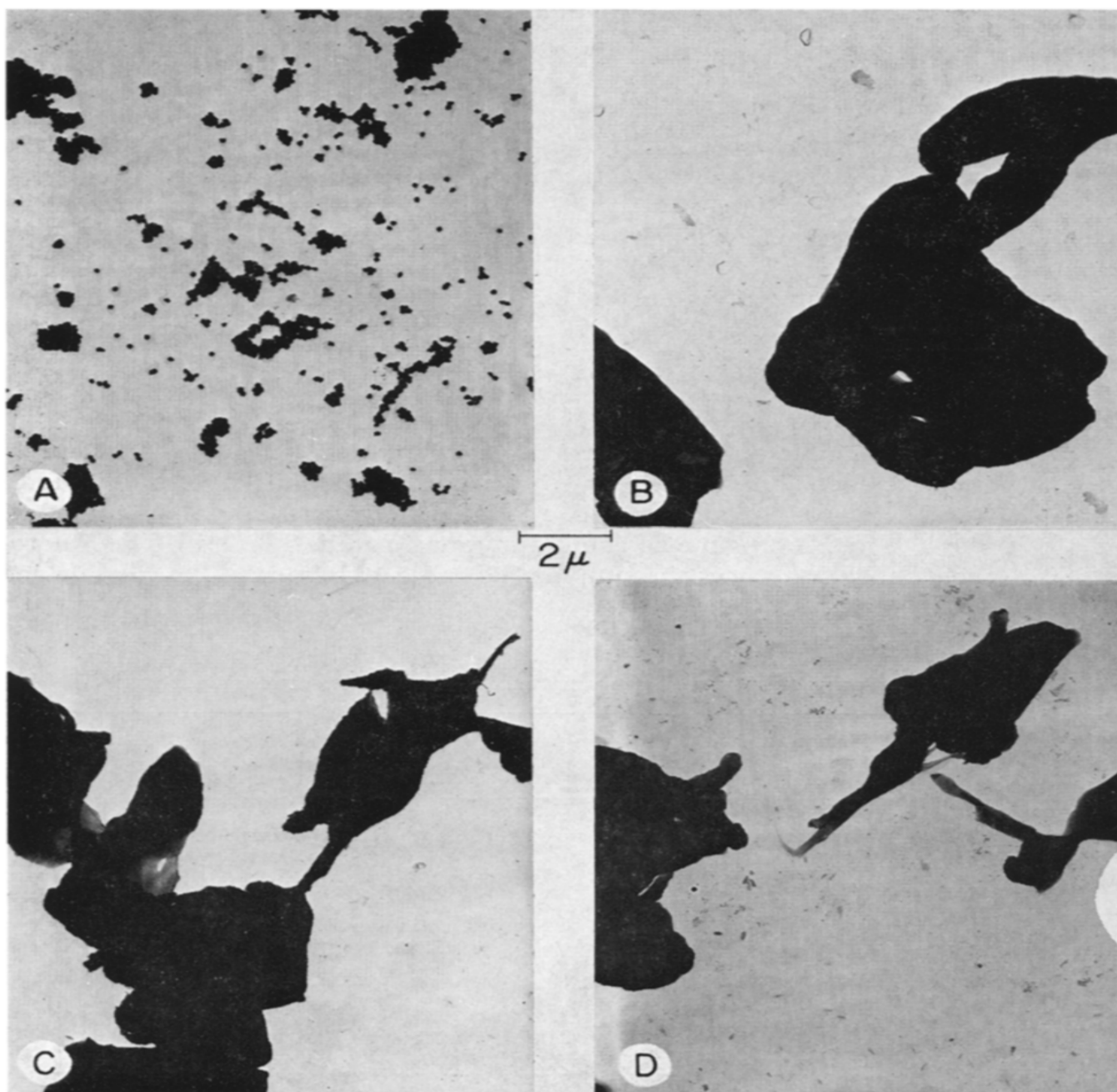

Fig. 1. Electron micrographs of particulate lubricants as received. A = 'fluorinated ethylene propylene' TL-120 FEP; B = polytetrafluoroethylene TL-126; C = polytetrafluoroethylene Fluoroglide 200, lot 1; D = polytetrafluoroethylene Fluoroglide 200, lot 2.
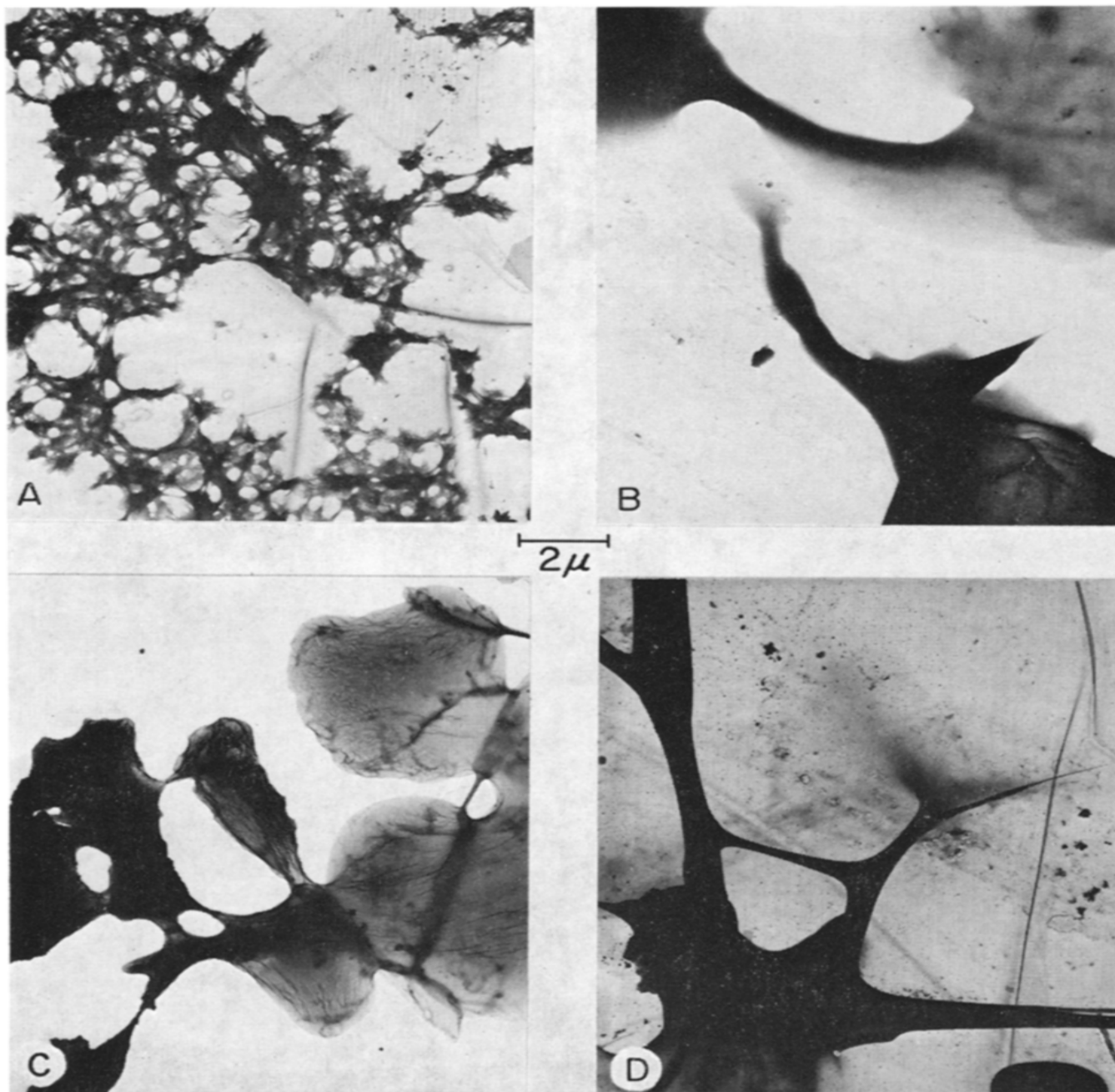
Fig. 2. Electron micrographs of dry residues from slurries of particulate lubricants in methyl isobutyl ketone. A = 'fluorinated ethylene propylene' TL-120 FEP; B = polytetrafluoroethylene TL-126; C = polytetrafluoroethylene Fluoroglide 200 lubricant, lot 1; D = polytetrafluoroethylene Fluoroglide 200 lubricant, lot 2.

These electron micrographs strikingly indicate that the forms of the particles are changed somewhat when the particles are deposited from a slurry in an organic liquid. The degree of change appears to be related to the degree of their swelling in the liquid and to the original size and shape of the particles.

The electron micrographs give clues as to the suitability of the materials for forming thin layers from slurries. The TL-120 FEP forms slurries of excellent quality, but the dry layers 'craze' excessively. Slurries of the TL-126 are difficult to pour or

to spread evenly because of lumping of the solid; the dried layers have a rough dis-
continuous surface. The inclusion of a fluorochemical surfactant with the TL-126
does not improve its performance. Each of the Fluoroglides gives both slurries and
layers of good properties. The Fluoroglides differ among themselves in the amount of
liquid required as a slurrying medium (TWO218 requires about one-third more than
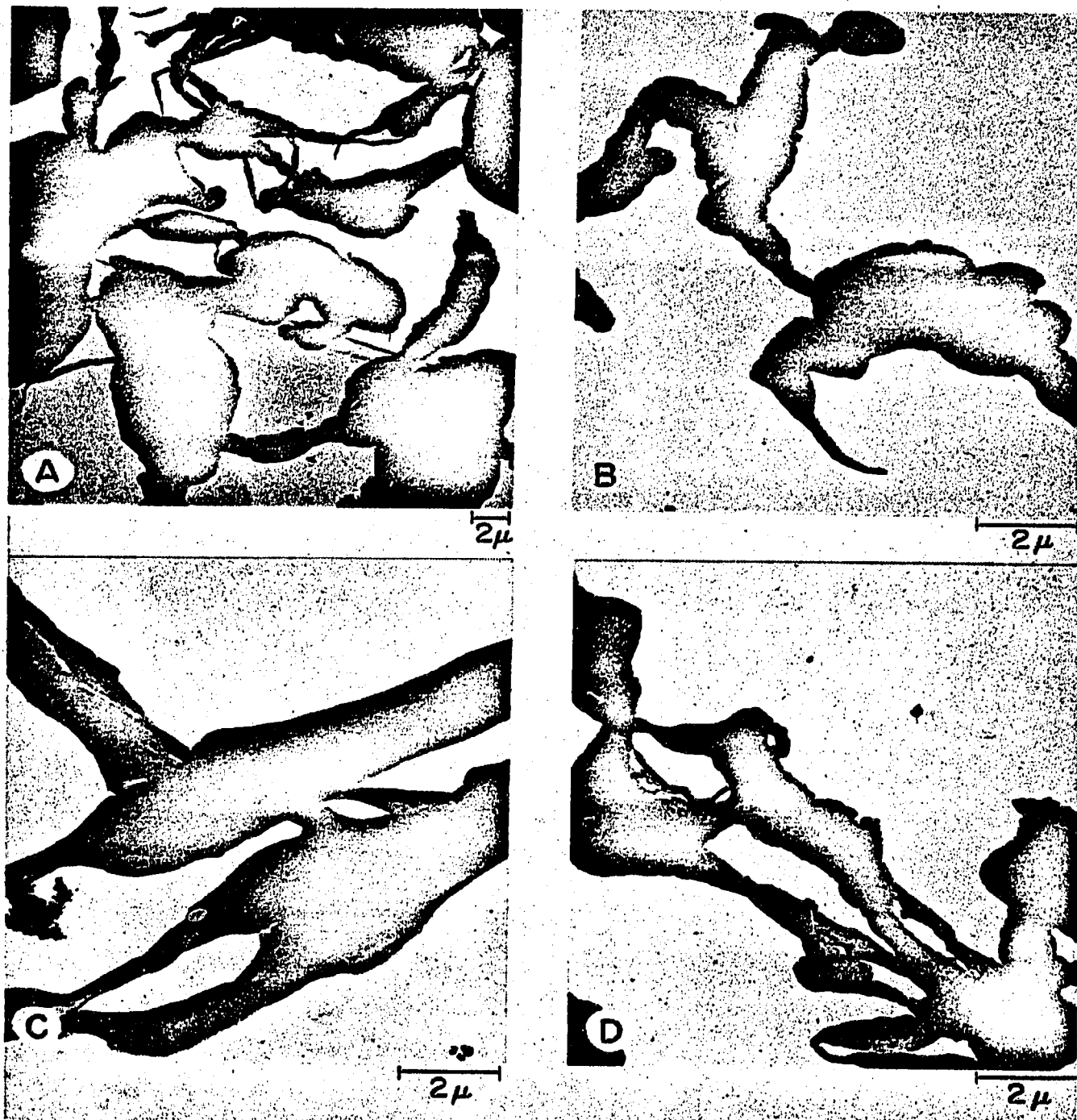the others) and in the color of the layer formed (TWO218 gives the whitest).

Fig. 3. Electron micrographs of Fluoroglide 200 chromatography grade TWO218. A and B = as
received; C = dry residue from slurry in methyl isobutyl ketone; D = dry residue from slurry in
perfluoro-2-butyltetrahydrofuran.

It appears that the great irregularity of shape and the strand-like tails of the particles of the Fluoroglides (especially TWO218) cause interlocking of the particles. Thus, the layers formed from them adhere to supports, do not craze, and provide interstices. Very likely, the interstices entrap some of the liquid phase of the slurry and also serve as capillary channels along which a developer can migrate.

The surface area of the 'fluorinated ethylene propylene' and of each of the polytetrafluoroethylenes was measured by nitrogen adsorption[6]. The results are:

Material	Surface area, m^2/g
TL-120 FEP	13.7
TL-126	1.0
Fluoroglide 200 (lot 1)	1.1
Fluoroglide 200 (lot 2)	0.9
Fluoroglide 200 (TWO218)	3.0

These values indicate the relative adsorptive capacities of the materials.

Swelling in organic liquids is a property of polytetrafluoroethylene that has received only limited attention[7,8]. This property is advantageous in the preparation of TLC layers, because it makes possible slurries that settle relatively slowly and therefore are easy to handle. Also, it facilitates the incorporation into the layers of certain added components such as liquid ion exchangers. The relative degree of swelling of TL-126 in 20 organic liquids and of Fluoroglide 200 (lot 2) in 42 organic liquids was measured. The liquids were representative of those that might be used as slurrying media or as developers. Among the liquids were alkanes, alkenes, arenes, alcohols, ketones, amines, fluorinated organic compounds, chlorinated hydrocarbons, dimethyl sulfoxide, and dimethylformamide. The amines, cyclic ketones, dimethyl sulfoxide, and dimethylformamide give curdy suspensions; secondary and tertiary alcohols and certain fluorinated organic compounds give chalky suspensions. The majority of the other liquids tested give gelatinous suspensions. The degree of swelling is least in the alkanes and greatest in the amines, dimethyl sulfoxide, and dimethylformamide. All the organic liquids tested readily wet polytetrafluoroethylene. The fluorinated organic compounds wet it very quickly and give slurries and layers of excellent qualities. Also, they perform well as developers and possibly should be studied further for this purpose. These results indicate that polytetrafluoroethylene can be layered from organic liquids and that the dry layers can be spotted, developed and visualized with organic liquids.

Solubility of polytetrafluoroethylene in organic liquids is of interest, because resolved components that are to be identified and measured quantitatively are often removed from a TLC layer by dissolution in an organic solvent. If the polytetrafluoroethylene also dissolves, it may interfere. The electron micrographs (Figs. 1–3) indicate that dry residues from slurries of the polytetrafluoroethylenes no longer consist of discrete particles but appear to be networks of interconnected amorphous structures with membranous 'feet' that seem to have been formed from a gel of the polytetrafluoroethylene. Therefore, the solubility of polytetrafluoroethylene in the four selected liquids n-nonane, benzene, methyl isobutyl ketone, and monofluoro-trichloromethane (Genosolv A) was studied. Each liquid was brought into intimate contact with polytetrafluoroethylene long enough to cause dissolution if it occurred. Then the liquid phase was separated carefully from the polytetrafluoroethylene by multiple centrifugations, checked for the Tyndall effect, and analyzed by IR spectro-

metry. Only for the Genosolv A did the IR spectrum (Fig. 4) indicate solubility.

The IR and mass spectra of polytetrafluoroethylene are of particular interest in determining the extent of its interference in the quantitative measurement of resolved components directly on the polytetrafluoroethylene. The spectra are given in Figs. 4 and 5, respectively. Polytetrafluoroethylene has no IR absorption bands at wavenumbers greater than about 1500 cm^{-1}; therefore, that section of the spectrum is not shown in Fig. 4. The mass spectrum at the lower temperatures (150° and lower) is a low background; at the high temperatures ($\sim$ 310°) the bands are chiefly in the high-mass region. These IR and mass spectra indicate that it should be possible to obtain spectra of organic substances isolated on polytetrafluoroethylene layers, provided the ratio of the substance to the polytetrafluoroethylene is sufficiently high.

Its behavior in strong solutions of sodium hydroxide and of hydrofluoric acid was studied with Fluoroglide 200 (lot 2). When a fluorocarbon surfactant and a small amount of an organic solvent are incorporated in the aqueous slurrying medium,
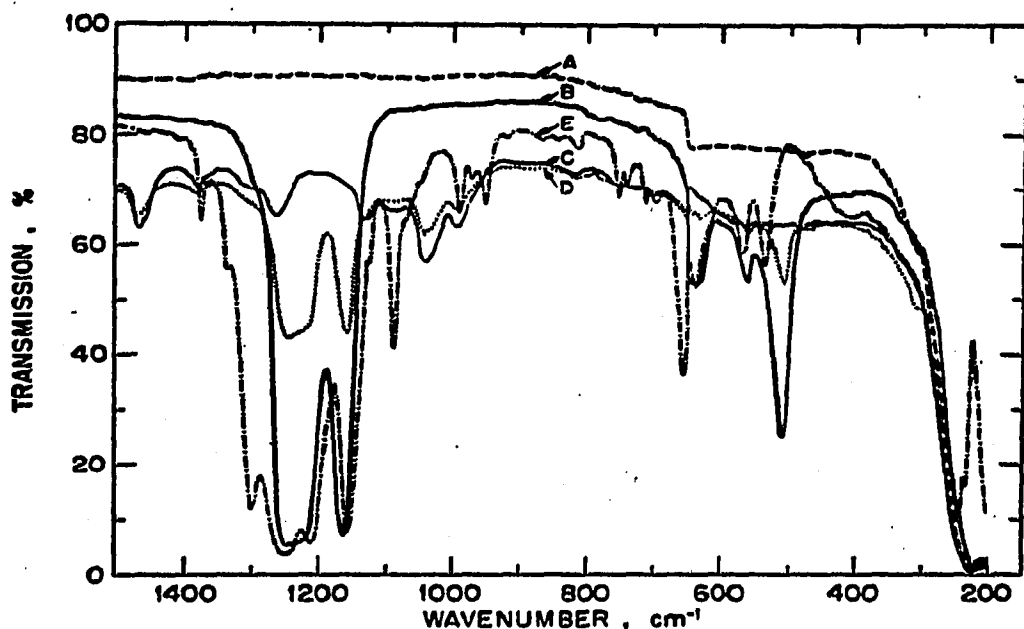

Fig. 4. Infrared spectra. A = potassium bromide blank; B = Fluoroglide 200 chromatography grade TWO218; C = monofluorotrichloromethane, Genosolv A; D = TWO218 in Genosolv A; E = fluorochemical surfactant FX-173.
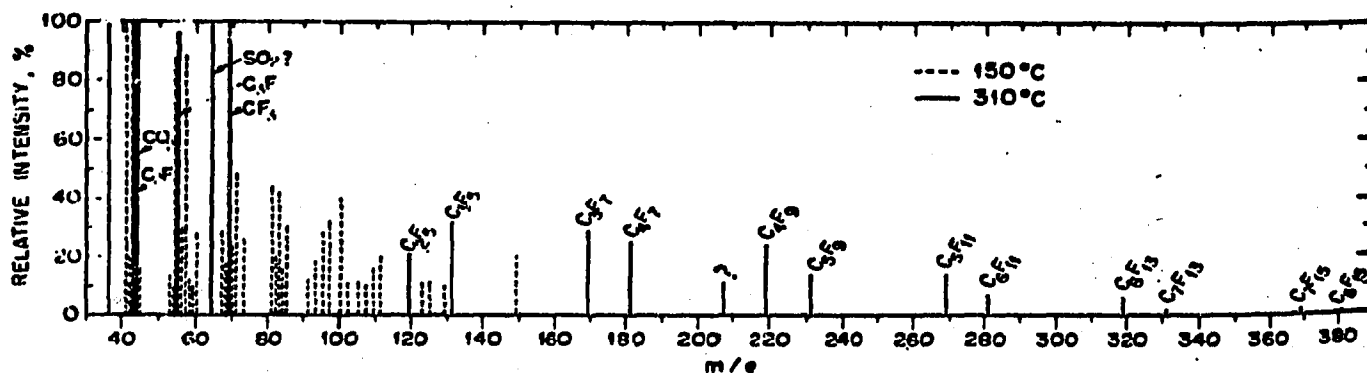

Fig. 5. Mass spectra of polytetrafluoroethylene Fluoroglide 200 chromatography grade TWO218 at 70 eV.

homogeneous suspensions of polytetrafluoroethylene are formed in strong solutions of sodium hydroxide (10 M) and of hydrofluoric acid (28 M). Layers can be made from the slurries. Because the layer from strong sodium hydroxide solution is hygroscopic, it has a gel-like appearance.

The purity of the three Fluoroglide 200 polytetrafluoroethylenes is indicated by IR and mass spectrometry to be high; the three samples, which were obtained over a period of two years, give essentially the same IR and mass spectra. Purification of the material is not required for its use as a TLC solid phase.

FLUOROCHEMICAL SURFACTANTS FOR USE WITH POLYTETRAFLUOROETHYLENE IN TLC

Properties desired

A surfactant suitable for use with polytetrafluoroethylene in TLC should be inert, nonvolatile, and soluble in the slurrying liquid, developer, and test solution. Compared with hydrocarbon type surfactants, fluorochemical surfactants are reported[9] to have the advantages of: chemical stability; effectiveness at smaller concentrations; greater effectiveness for aqueous systems; the same effectiveness in both organic and aqueous systems; stability to heat, acids, electrolysis, and strong oxidizers; depressing effect on the vapor pressure of solvents; and complexation in some cases.

A number of fluorochemical surfactants are available from the 3M Company[9]. These are stated to be anionic fluorochemicals that contain a completely fluorinated tail and a solubilizing group. Nonionic fluorochemical surfactants[10] may also be suitable; they were not studied.

Evaluation

Of the 3M Company's solid fluorochemical surfactants, the following were evaluated: FC-95, FC-98, FC-126, and FX-173. Of these, FX-173 was selected for use, because it is soluble in several organic solvents commonly used for slurrying TLC media and is slightly soluble in water. Also, on layers that contain FX-173 water migrates fastest and with a straight front; with the other three surfactants the front was not straight.

The IR spectrum of FX-173 is given in Fig. 4, where it can be compared with that of Fluoroglide 200 (TWO218). The FX-173 also has no bands at wavenumbers greater than 1500 cm^{-1}. Its spectrum is very similar to that of the Fluoroglides; its interference in the qualitative and quantitative measurement of resolved components should be minimal. The manufacturer has not revealed the chemical formula of FX-173. The IR spectrum indicates that it may be the sulfonate of a perfluorohydrocarbon, probably of the form $C_nF_{(2n+1)}SO_3^-X^+$, where X^+ is not H^+. Its IR spectrum is similar to, but not identical with, those of perfluoronated surface-active agents ('tensides') reported by HUMMEL[11].

The FX-173 can be used satisfactorily in any of a number of ways. It can be included in the slurry and thus become evenly distributed in the dry TLC layer. A solution of it in an organic liquid can be deposited on the layer only in the area to be spotted; in this way the amount and location in the layer are restricted to that just required to cause the layer to accept a test spot. It can be included in a test solution that otherwise might not wet the layer. Also, it can be included in the developer.

It was observed experimentally that FX-173 has some effectiveness as a binder. Polytetrafluoroethylene layers that contain it appear to adhere slightly better to Mylar film than do those without it.

PREPARATION AND PROPERTIES OF POLYTETRAFLUOROETHYLENE LAYERS

Slurries of polytetrafluoroethylene

Slurries of polytetrafluoroethylene are characterized by versatility. By the use of a surfactant, they may be prepared in aqueous as well as in organic vehicles. They may include any of a great variety of other TLC adsorbents. The miscibility of poly-tetrafluoroethylene in slurries with each of some 20 other adsorbents (both inorganic and organic) was demonstrated experimentally. The slurries may include other special solid or liquid agents such as binders, silver nitrate, fluorescing agents, acids, bases, liquid ion exchangers, and complexers.

The preparation of a slurry is simple. The polytetrafluoroethylene is added to a liquid phase that contains the other components of the slurry. An orbital sander is a useful tool for mixing a slurry in a volatile flammable liquid; a closed container that holds the slurry can be attached to the plate of the sander and, with the plate in a vertical position, agitated a few seconds to effect mixing.

The viscosity of polytetrafluoroethylene slurries can be regulated by varying the ratio of polytetrafluoroethylene to liquid. For Fluoroglide 200 (TWO218), a 1:3 w/v ratio of polytetrafluoroethylene to organic liquid usually gives a slurry of satisfactory consistency.

The rate of settling of polytetrafluoroethylene slurries is of interest relative to the possibility of segregation of components of the slurry after it is layered. Fig. 6
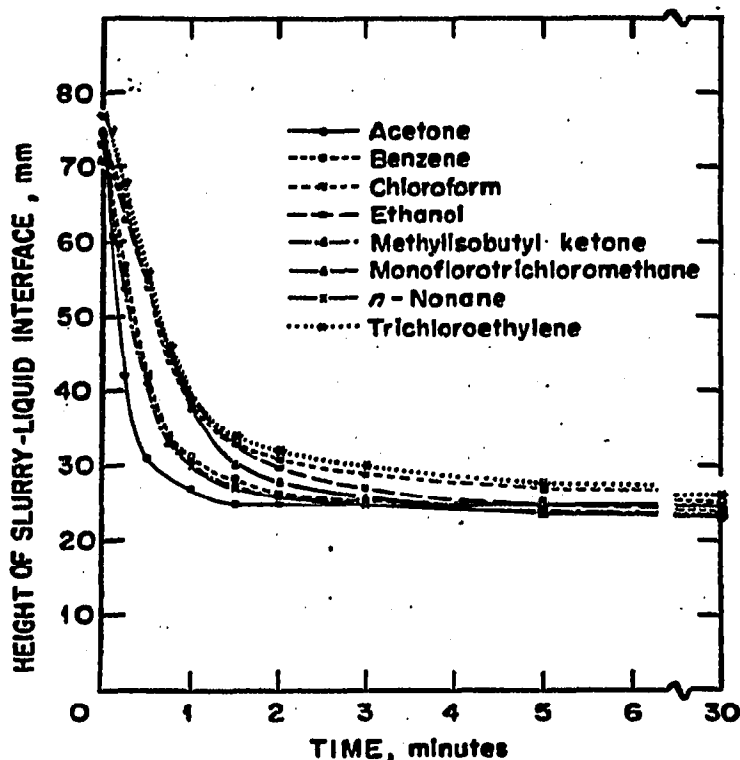

Fig. 6. Curves for the settling rate of Fluoroglide 200 lubricant (lot 2) from eight organic liquids.

gives rate-of-settling curves for Fluoroglide 200 (lot 2) in eight organic liquids. The TWO218 type settles less rapidly.

Application to the support is no problem with polytetrafluoroethylene slurries. By any of the usual means, they can be layered onto glass, vinyl and Mylar films, and metal supports and presumably also onto other types of TLC supports. No difficulty was encountered in preparing an 8 in. by 48 in. chromatofilm of polytetrafluoroethylene on Mylar film by means of a Desaga/Brinkmann applicator.

The rate of drying of the layer is a function of the volatility of the slurrying liquid and of the layer thickness. Apparently, some of the liquid phase of the slurry is permanently retained in the interstices of the polytetrafluoroethylene particles.

Marking of the layers to show the desired origin, development distance, and the like is done conveniently with a stylus or dissecting needle before the layers are thoroughly dry. Dots can be made that are readily evident when the layer is backlighted with a flashlight during the development.

Properties of layers

Adherence to the support is achieved with polytetrafluoroethylene layers without the use of binders. If care is used in wetting the layer with the liquid nitrogen, it is even possible to examine a binder-free polytetrafluoroethylene layer on a Mylar film support under liquid nitrogen without having the layer flake off the support.

The appearance of the layers under UV light depends partly on the other components present in the layer. It has been possible to easily observe resolved components that absorb, fluoresce, and phosphoresce after being excited with 254 or 366 nm UV light.

The rate of developer migration on polytetrafluoroethylene layers is a function of the usual variables such as layer thickness, type of developer, and nature of other components of the layer.

Solvent fronts move in a straight line both in the absence of wetting agent and when FX-173 is present.

Spotting of polytetrafluoroethylene layers is not a problem. The layers readily accept organic test solutions in the absence of a surfactant. With a surfactant present either in the layer or in the test solution, they accept aqueous test solutions.

The precision of R_F values of components isolated on polytetrafluoroethylene layers is comparable with that on other layers.

Mixed-adsorbent layers

The suitability of polytetrafluoroethylene as a component of mixed-adsorbent layers was mentioned above. It can be used not only as an active adsorbent, either alone or together with numerous other TLC adsorbents, but also as an inert diluent for other adsorbents or particulate solids that may be under study, for example, soils.

Gradient-adsorbent layers

Polytetrafluoroethylene was used satisfactorily to prepare gradient-adsorbent layers with polyamides. The layers were slurried from *n*-propanol and were used to separate aromatic and heterocyclic hydrocarbons by development with *n*-propanol. The layers were used with the gradient in each of the three possible directions. Be-

TABLE II

EXAMPLES OF MIGRATIONS AND SEPARATIONS ON THIN LAYERS THAT CONTAINED POLYTETRAFLUOROETHYLENE

Substance chromatographed	Layer		A:B (w/v)	Developer	Substances	
	Solid phase (A)	Slurry vehicle (B)			Migrating	Resolved
Inorganic substances						
Pr^{3+}, Nd^{3+}, Ho^{3+}	FG200(1)-FX-173 (30:1)	Acetone	1:2	0.2 to 1 M HF–0.5 M HDEHPᵃ in acetone	All	Possibly
	FG200(1)-FX-173–HF (conc.) (30:1:0.25)	MIBKᵇ	1:2	Acetone	All	None
Ni^{2+}, Fe^{2+}, Pr^{2+}, Nd^{3+}, Ho^{3+}	FG200(1)-FX-173–HF(conc.) (30:1:0.25)	MIBK	1:2	0.5 M HDEHP in MIBK	Fe^{3+}, Nd^{3+}, Ho^{3+}	Fe^{3+}, (Ni^{2+}, Pr^{3+}), Nd^{3+}, Ho^{3+}
	FG200(1)-FX-173 (30:1)	0.1 M HDEHP in cyclohexane	1:2	0.4 M HCl in H_2O	Ni^{2+}, Pr^{3+}, Nd^{3+}, Ho^{3+}	Fe^{2+}, Ni^{2+}, (Pr^{3+}, Nd^{3+}, Ho^{3+})
	FG200(1) or (2)	0.4 M HCl in cyclohexane	1:2	0.1 M HDEHP in cyclohexane	Fe^{3+}	Fe^{3+}, (Ni^{2+}, Pr^{3+}, Nd^{3+}, Ho^{3+})
Ni^{2+}, UO_2^{2+}, Fe^{3+}	TWO218	n-Butanol	1:3	n-Butanol–H_2SO_4 (conc.)–HF(conc.)–H_2O (100:9.5:5:85.5)	All	Ni^{2+}, UO_2^{2+}, Fe^{3+}
	TWO218	Acetone	1:3	Acetone–HCl (conc.)–HF (conc.)–H_2O (90:5:1:4)	UO_2^{2+}, Fe^{3+}	Ni^{2+}, UO_2^{2+}, Fe^{3+}
29 radioisotopes of metal ions	TWO218-FX-173 (3:0.025)	MIBK–HNO₃ (conc.) (9:0.1)	1:3	0.5 M HDEHP in MIBK	27	Manyᶜ
Organic substances						
Fluoranthene, benzo-[g,h,i] perylene	TWO218	FC-75ᵈ	1:2	FC-75	Fluoranthene	Fluoranthene, benzo[g,h,i]-perylene
	TWO218–Woelm polyamide (2:1, 1:1 and 1:2)	n-Propanol	1:2	n-Propanol	Fluoranthene	Fluoranthene, benzo[g,h,i]-perylene

Substance	Stationary phase	Solvent		Solvent			
Ten aromatic and heterocyclic hydrocarbons	TWO218–Aviamide-6 (1:4)	n-Propanol	1:3	n-Propanol	All		Eight (ten distinguishable by luminescence properties[c])
Old solution of corticosterone in methylene chloride	TWO218–Aviamide-6 (1:4)	n-Propanol	1:3	Methanol	Four		Five
6-Chloro-9-(3'-diethyl-amino-2'-hydroxy-propylamino)-methoxyacridine dihydrochloride	TWO218	Carbon tetra-chloride–ethanol (19.8:0.2)	1:3	Carbon tetra-chloride–ethanol (19.8:0.2)	Two		Three
17β-Estradiol, estrone	TWO218	Chloroform–methanol (97:3)	1:3	Chloroform–methanol (97:3)	17β-Estradiol, estrone		Neither
Androsterone, 11-dehydrocorti-costerone	TWO218	Methanol	1:3	Methanol	Androsterone, 11-dehydrocor-ticosterone		Neither (both moved with solvent front)
Sodium cacodylate	TWO218–FX-173 (30:1)	Acetone	1:3	Perfluorodiethylpropyl amine	A contaminant		Contaminant from sodium cacodylate
Cacodylic acid, sodium cacodylate	TWO218	n-Hexane–acetone (5:1)	1:3	n-Hexane–acetone (5:1)	Cacodylic acid, sodium caco-dylate		Neither (both moved with solvent front)

a HDEHP = di-(2-ethylhexyl)orthophosphoric acid.
b MIBK = methyl isobutyl ketone.
c Data to be reported in detail in a separate article.
d FC-75 = perfluoro-2-butyltetrahydrofuran.

cause of the different rates of migration of n-propanol along layers of polytetrafluoroethylene and polyamide, the solvent front was curved rather than straight when the gradient was in the horizontal direction.

Potential of polytetrafluoroethylene layers for extraction TLC

Polytetrafluoroethylene layers have considerable potential for use in extraction TLC. Because polytetrafluoroethylene swells in and is wet by most organic liquids, a homogeneous immobile phase of an extractant can be obtained on a thin layer of polytetrafluoroethylene. Also, the extractant may be included in the developer rather than in the layer. By changing the location of the extractant, the order of migration of the resolved components can be reversed, and versatility can thus be introduced in the manner of use of the layer in extraction chromatography. This reversal was demonstrated experimentally by the resolution of metal ions with the liquid ion exchanger di-(2-ethylhexyl)orthophosphoric acid (HDEHP). By means of polytetrafluoroethylene layers, it should be possible to use TLC as a means to study liquid ion exchange without the need to consider the reactivity of the liquid phases with the solid support. No doubt many column chromatographic separations made on polytetrafluoroethylene supports[2] can be scaled down by means of thin layers of polytetrafluoroethylene.

Comparison with other chromatographic media

No detailed study has been made to compare polytetrafluoroethylene layers with other chromatographic media. However, in several separations polytetrafluoroethylene layers were observed to be superior. The discreteness of resolution of metal ions with a developer that contained HDEHP was very much greater with polytetrafluoroethylene layers than with polyethylene layers or with Gelman ITLC-SA medium when all the experimental conditions except the type of layer were identical. The resolution of metal ions with the developer n-butanol–H_2SO_4 (conc.)–HF (conc.)–H_2O (100 : 9.5 : 5 : 85.5) was greater on a polytetrafluoroethylene layer than on a paper strip[13].
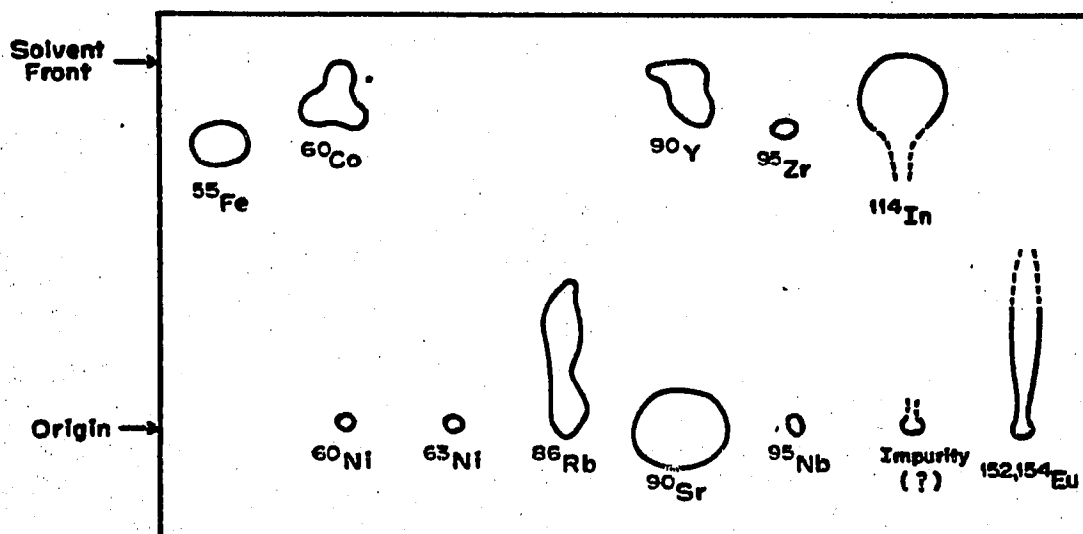

Fig. 7. Map of autoradiograms of thin-layer chromatograms of some inorganic ions on a polytetrafluoroethylene TWO218 layer developed with ~ 0.5 M HDEHP in methyl isobutyl ketone.

SEPARATIONS ON THIN LAYERS OF POLYTETRAFLUOROETHYLENE

Table II gives examples of numerous migrations and separations that have been achieved on thin layers that contained polytetrafluoroethylene. In a separate paper, the separations of the radioisotopes and of the hydrocarbons will be discussed; maps of chromatograms that illustrate these latter separations are given in Figs. 7 and 8, respectively. These examples indicate the versatility of polytetrafluoroethylene as a solid phase for TLC.
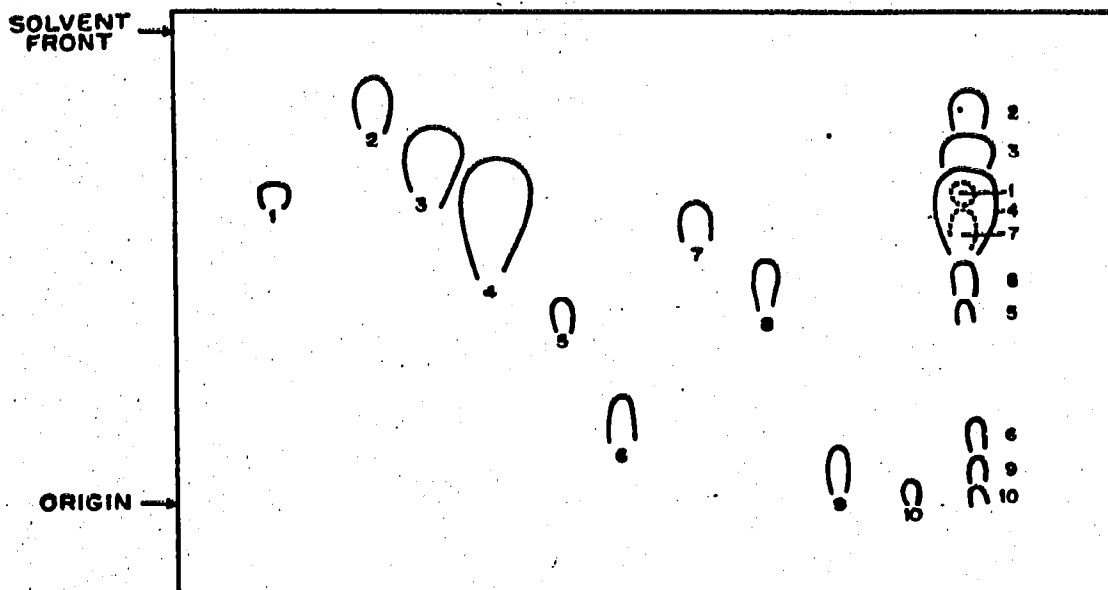

Fig. 8. Map of a thin-layer chromatogram of aromatic and heterocyclic hydrocarbons on TWO218–Aviamide-6 (1:4) developed with *n*-propanol. 1 = *o*-hydroxydiphenyl; 2 = naphthalene; 3 = fluorene; 4 = phenanthrene; 5 = pyrene; 6 = chrysene; 7 = anthracene; 8 = fluoranthene; 9 = benzo[*e*]pyrene; 10 = benzo[*g,h,i*]perylene.

The applicability of polytetrafluoroethylene layers in separation systems that contain hydrofluoric acid[13–14] is of special interest. Table II includes two examples of this application. Also, with aqueous hydrofluoric acid solutions (0.9 to 28 M) as developers, the resolution of amino acids on polytetrafluoroethylene layers was attempted. Some evidence existed for the migration of the amino acids, but their detection was difficult because of the hydrofluoric acid content of the layer. Further work is planned to investigate the TLC behavior of biochemicals in systems that contain hydrofluoric acid.

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