High-performance layers are more efficient, leading to tighter zones, better resolution, and more sensitive detection. Flow resistance is higher (migration time per centimeter is slower), but overall development time is shorter because smaller migration distances are used for HPTLC than for TLC (typically 3–8 cm versus 10–16 cm). The low flow rate through fine-particle HPTLC plates led to the development of forced-flow methods. Sample sizes are generally 0.2–1 μL for HPTLC and 1–3 μL for TLC, although the upper levels of these ranges can be exceeded when spotting with the Linomat instrument or using preadsorbent layers.

Silica gel is the most widely used type of HP plate, but other HP layers, including bonded phases, are also commercially available. Among the newest layers are Merck's TLC and HPTLC silica gel 60 plates (60 Å pore size) with imprinted identification codes for use in documentation when analyses are performed according to good manufacturing practice (GMP) and good laboratory practice (GLP) standards (52). Merck also sells two new HPTLC layers with spherical silica gel: HPTLC plates with LiChrospher $Si60F_{254s}$ (0.2 mm layer thickness, 7–8 μm mean particle size), and HPTLC aluminum sheets with $Si60F_{254s}$ Raman (0.1 mm layer thickness and 3–4 μm particle size). Layers with spherical particles offer better efficiency, spot capacity, and detection limits than those with nonspherical particles. The silica gel matrix on the sheets is designed to have the least possible spectral interference for direct coupling of TLC with Raman spectrometry (see Sec. VIII.B).

TLC and HPTLC are compared in Chapter 2 of Ref. 1.

D. Bonded Layers

Reversed-phase TLC, in which the stationary phase is less polar than the mobile phase, was originally carried out on silica gel or kieselguhr layers impregnated with a solution of paraffin, squalane, silicone oil, octanol, or oleyl alcohol. Analtech sells RP plates with hydrocarbon liquid phase physically adsorbed onto the surface of a silica gel layer. Impregnated plates of this kind require the use of aqueous and polar organic mobile phases saturated with the stationary liquid, and they cannot tolerate the use of nonpolar organic solvents, which will strip the coating from the support.

Bonded phases with functional groups chemically bonded to silica gel eliminate stripping of the stationary liquid from the support by incompatible mobile phases. Alkylsiloxane-bonded silica gel with CH_3, C_2H_5, C_8H_{17}, and $C_{18}H_{37}$ (111) functional groups are most widely used for RP-TLC of organic compounds (polar and nonpolar homologous compounds and aromatics), weak acids and bases after ion suppression with buffered mobile phases, and strong acids and bases using ion-pair reagents. Layers from different companies but with the same bonded group can have different percentages of carbon loading and give different results. The hydrophobic nature of the layer increases with both the chain length and the degree of loading of the groups. Alkylsiloxane-bonded layers with a high level of surface modification are incompatible with highly aqueous mobile phases and are used mainly for normal-phase separations of low-polarity compounds (25). Problems of wettability and lack of migration of mobile phases with high proportions of water have been solved by adding 3% NaCl to the mobile phase (Whatman layers) or preparing "water-wettable" layers with a slightly larger particle size, less exhaustive surface bonding, and a modified binder. The latter layers with a low degree of surface coverage and more residual silanol groups exhibit partially hydrophilic as well as hydrophobic character and can be used for RP-TLC and NP-TLC. Chemically bonded phenyl layers are also classified as reversed-phase, but their use has only seldom been reported in the literature.

Hydrophilic bonded silica gel containing cyano (112), amino (113), or diol (114) groups bonded to silica gel through a trimethylene chain [—$(CH_2)_3$—] are compatible with aqueous mobile phases and exhibit multimodal mechanisms. Polarity varies as follows: unbonded silica > diol-silica > amino-silica > cyano-silica > reversed-phase materials (89). Cyano layers can act as a normal or reversed phase, depending on the characteristics of the mobile phase, with properties similar to a low-capacity silica gel and a short-chain alkylsiloxane bonded layer, respectively (25). Amino layers are used in NP and weak anion-exchange modes. In NP-TLC, compounds are retained on amino layers by hydrogen bonding as with silica gel, but the selectivity is different. Charged substances such as nucleotides or sulfonic acids can be separated by ion exchange using