Basic principles of TLC

Thin layer chromatography (TLC) and high performance thin layer chromatography (HPTLC), also called planar chromatography, are, like all chromatographic techniques, based on a multistage distribution process involving

- a suitable adsorbent (the stationary phase) coated as a thin layer onto a suitable support (e.g. glass plate, polyester or aluminium sheet)
- solvents or solvent mixtures (the mobile phase or eluent)
- the sample molecules

The principle of TLC is known for more than 100 years [M. W. Beyerinck, Z. Phys. Chem. **3** (1889) 110]. The real break-through as an analytical method, however, came about 50 years ago as a consequence of the pioneering work of Egon Stahl [Thin layer chromatography, 2nd edition, Springer-Verlag Berlin, Reprint 1988].

Today TLC has gained increasing importance as an analytical separation technique, which is probably due to effects of instrumentalisation and automatisation [H. Jork, Laborpraxis 2 (1992) 110]. At the same time the applicability of thin layer chromatography was enhanced by the development of new adsorbents and supports.

Today MACHEREY-NAGEL offers a versatile range of ready-to-use layers, which are the result of 45 years of continuous research and development.

Features of modern TLC/HPTLC

The success of thin layer chromatography as a highly efficient microanalytical separation method is based on a large number of advantageous properties:

- high sample throughput in a short time
- suitable for screening tests
- pilot procedure for HPLC and flash chromatography
- after separation the analytical information can be stored for a longer period of time (the TLC ready-to-use layer acts as storage medium for data)
- separated substances can be subjected to subsequent analytical procedures (e.g. IR, MS) at a later date
- rapid and cost-efficient optimisation of the separation due to easy change of mobile and stationary phase

For a better understanding of a thin layer chromatographic separation we describe here the basic steps:

- sample preparation
- sample application
- development of a chromatogram, separation techniques
- evaluation in TLC – visualisation of separated substances, qualitative and quantitative determinations

Principle steps of a thin layer chromatographic separation

Sample preparation

For separation the sample must meet several requirements to obtain good results. Since the TLC plate is a disposable product, sample preparation in general is not as demanding as for the other chromatographic methods. However, eventually several steps for sample pretreatment may be necessary. These include sampling, mechanical crushing of a sample, extraction steps, filtration and sometimes enrichment of interesting components or clean-up, i.e. removal of undesired impurities.

Our TLC micro-sets introduce some simple methods of sample pretreatment. The dyes or dye mixtures of the beginner's set do not require complicated procedures. The advanced sets require the user to carry out some additional steps for preparing a sample, thus introducing the user to techniques often performed in industrial laboratories.

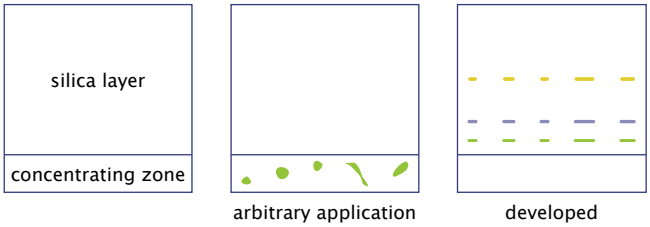
Thorough preparation of samples is an important prerequisite for the success of a TLC separation. For our range of products for more demanding sample pretreatment please see the chapter "SPE" from page 2.

Sample application

The aim of a chromatographic separation determines how the sample should be applied to the TLC plate or sheet. The most frequent technique is application with a glass capillary as spot or short streak.

Application as streak will yield better results especially for instrumental quantification. For both types of application some manual skill is required to obtain reproducible results. Substance zones which are too large from the beginning will cause poor separation since during chromatography they will become even larger and more diffuse.

A valuable aid for manual application especially of large volumes of very dilute samples is the concentrating zone (e.g. SILGUR-25 UV_{254}), which consists of a chromatographically inactive adsorbent (kieselguhr). The substances to be separated are concentrated to a small band in the concentrating zone and the separation starts at the beginning of the chromatographically active adsorbent silica.



Another method for sample concentration is a short pre-elution (few mm) with a solvent, in which all substances have a high R_f value.

If a quantitative evaluation with a TLC scanner is to follow the separation we recommend to use commercially available sample applicators for spotting. These range from simple spotting guides via nanoapplicators to completely automated spotting devices. Application as streak can be performed automatically by spraying of the sample without touching the layer of the TLC plate. Application as band over the whole width of the TLC plate is especially important for preparative TLC.

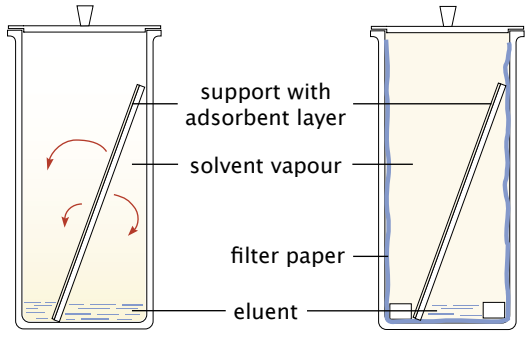
After application allow the solvent of the samples to evaporate completely (about 10 minutes) or blow with cold or hot air. Development of a chromatogram should never start before the solvent of the applied samples is evaporated completely.

Developing a chromatogram – separation techniques

The most frequently used separation technique is ascending TLC in a trough chamber (standard method, linear development). Usually it is applied as single development. However, multiple development, with or without change of eluent (step technique) can improve separation results. For 2-dimensional development only 1 spot of the sample is applied in one edge of a plate. After chromatography in the first direction the plate is dried, turned by 90° and developed in the 2nd dimension with another eluent. Thus complicated mixtures give 2-dimensional chromatograms taking advantage of the different separating properties of two eluents.

For selection and optimisation of the eluent numerous publications are available. A generally applicable standardised optimisation method is described by H. Keuker et al. [in "Proceedings of the International Symposium on Instrumental TLC", Brighton, Sussex, UK 1989, 105 – 114]

It is important to pay attention to the atmosphere in the developing chamber. If reproducible migration distances are required, saturation of the chamber atmosphere with eluent vapour is necessary. For this purpose the developing chamber is lined with well absorbing chromatography paper (e.g. MN 260) and charged with a correspondingly larger volume of eluent.



A) normal saturation, arrows show evaporation of eluent from the layer

B) chamber lined with filter paper, saturated with eluent vapour

Another interesting technique is the PMD technique (Programmed Multiple Development) [K. Burger, Fresenius Z. Anal. Chem. **318** (1984) 228 – 233], which is a true gradient development on silica for TLC. Contrary to the common multiple development every single run is slightly longer than the previous one. Thus broadening of substance zones during chromatography is easily compensated for. Usually, about 10 to 25 development cycles are run, generally with a universal gradient. Since this technique can be automated, you can also find the name AMD (Automated Multiple Development) [K. Burger, Pflanzenschutz-Nachrichten Bayer 41,2 (1988) 173] (also see our nano plates with extremely thin silica layer, page 179).

It should be noted, that the considerable increase in performance with these techniques also requires a considerable increase in instrumental expense.

Evaluation of a thin layer chromatogram

Evaluation depends on the purpose of the chromatographic analysis. For qualitative determination often localisation of substances is sufficient. This can be easily achieved by parallel runs with reference substances.

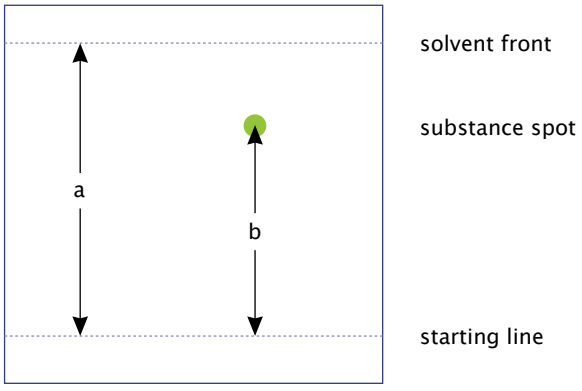
A parameter often used for qualitative evaluation is the R_f value (retention factor) or the 100fold value hR_f. The R_f value is defined as follows:

$$R_f = \frac{\text{distance starting line – middle of spot}}{\text{distance starting line – solvent front}} = \frac{b}{a}$$

i.e. the R_f values are between 0 and 1, best between 0.1 and 0.8 (i.e. 10 – 80 for hR_f). If reproducible R_f values are to be obtained, it is essential that several parameters such as chamber saturation, composition of solvent mixtures, temperature etc. are strictly controlled.

Quantitative evaluation is possible by suitable calibration measurements. For this purpose either the area of a substance spot is measured or a photometric evaluation is performed directly on the layer. The latter procedure, however, requires a higher instrumental expense.

The following paragraphs describe the most frequently used methods for evaluation in TLC.



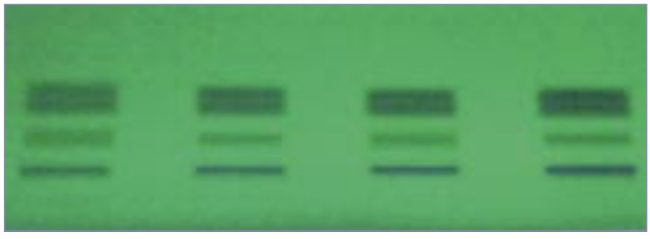
Basic principles of TLC

Qualitative detection

Qualitative evaluation is generally made directly on the TLC plate via the characteristic R_f values of substances, i.e. the ratio of distance start – substance zone to distance start – solvent front and specific chemical reactions.

Visualisation of separated substances

First of all it is necessary to recognise the position of a substance spot. Only in very few cases the sample is a dye which can be seen with the naked eye. Much more often for unspecific visualisation substances can be viewed under UV light, since many substances show a UV absorption. If a fluorescent indicator is added to the layer, all substances absorbing in the respective region of wave length cause a quenching of the fluorescence, i.e. they appear as dark spots on the fluorescent layer. Customary fluorescent indicators are excited at 254 nm or (less frequently) at 366 nm with a mercury lamp. For our programme of fluorescent indicators for TLC please see page 196.



Identification of separated substances is possible via the R_f value compared to the pure compound, which is often applied simultaneously on the same plate.

For a number of compounds their native fluorescence can be used for visualisation, which is excited by UV light (mostly long-wave UV) (e.g. aflatoxins). This allows not only determination of the R_f value, but often enables a further qualitative assignment.

If these methods do not allow localisation or characterisation of a substance, post-chromatographic detection methods can be applied, chemical reactions on the TLC plate [H. Jork et al., Dünnschicht-Chromatographie, VCH Verlagsgesellschaft, 1989]. Quite unspecific reactions are iodine adsorption and the charring technique (spraying with sulphuric acid and heat treatment).

More reliable results are possible with specific reagents for spraying or dipping, which form coloured or fluorescent compounds with the substances to be detected. Depending on the sensitivity of these reactions they are not only used for group or substance specific characterisation (in addition to the R_f value) but also for quantification down to trace levels. As example take the ninhydrin reaction. Formation of a (usually red) zone with this detection method yields the information, that a certain group of substances, e.g. α-amino acids, are present. The R_f value allows further assignment to one or several single compounds.

For identification of a substance a combination of different detection methods can be useful. Thus almost all lipids can be converted to products with light green fluorescence by reaction with 2',7'-dichlorofluorescein. Adsorption of iodine vapour enables a differentiation between saturated and unsaturated lipids or lipids containing nitrogen. And finally the R_f value is a third means of identification.

Here are some general remarks concerning spraying: use all spray reagents under a fume hood. The developed, dried TLC plate or sheet is placed on a sheet of filter paper for spraying. Usually it is sufficient to fill the sprayer with about 5 – 10 ml solution. Spray from a distance of about 15 cm with the aid of a rubber ball or – if available – with pressurised air. It is always better to spray a layer twice very thinly and evenly (with intermediate drying), than to saturate the layer with excessive spray reagent. In the latter case spots tend to become diffuse. After visualisation mark outlines of zones with a lead pencil, because some spots tend to fade after a while.

Especially for quantitative evaluation short dipping of the layer in the respective reagent solution is recommended. For this purpose automatic instruments are commercially available, which allow reproducible dipping.

When a substance is localised on the TLC plate (e.g. in the UV), but not yet identified, TLC scanners allow recording of UV spectra of individual substance zones directly on the layer, or the zone is removed by scratching or cutting (for sheets), eluted and further analysed, e.g. by FT-IR, RAMAN, NMR or mass spectroscopy.

Quantitative evaluation

Often TLC is considered to be only a semiquantitative analytical procedure. This is true for visual evaluation of spots, since the eye can only compare but not measure absolute values. If, however, a direct optical evaluation („in situ" measurement) is performed on the TLC plate with a thin layer scanner, after measurement of calibration functions exact quantitative results are possible. Commercial scanners offer many features such as evaluation in absorption and fluorescence, unattended programmed scanning of lanes, multi-wave length measurement, background correction, selectable base line for integration, recording of spectra, evaluation of circular or anti-circular chromatograms with very high ease of operation. In addition to manual operation control by a computer is possible with respective data collection and storage. Usually wavelengths from 200 to 700 nm are available (visible and UV), e.g. all post-chromatographic (and of course all pre-chromatographic) visualisation procedures are evaluated with the proper wavelength, which is determined with the instrument. Time requirements for all these possibilities are extremely low. Interlaboratory experiments with standard deviations of 2 % show how excellent results are obtainable [Planar Chromatography, Vol. 1, ed. R. E. Kaiser, Dr. Alfred Hüthig Verlag, Heidelberg, 1986].

Overview of MN ready-to-use layers for TLC

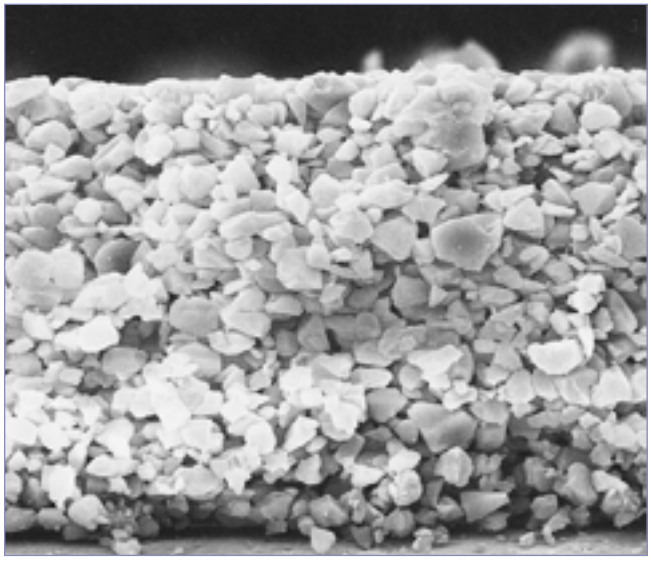
Advantages of MN plates and sheets for TLC

- **continuous high quality**
  guaranteed by stringent production control including standardised lot tests, surface checks for roughness or cracks as well as hardness and adherence checks
- **comprehensive range of phases for TLC / HPTLC**
  there is no universal TLC plate which meets all possible types of analyses. Our versatile range of TLC ready-to-use layers covers many different types of applications.
- **immediately ready for chromatographic separation**
  coatings or impregnations are not necessary
- **homogeneous, smooth, well adhering layers**
  an important criterion especially for reproducible quantitative evaluation

Adsorbents for MN plates and sheets for TLC

- **classical adsorbents**
  for ~ 80 % of all TLC separations silica 60 (mean pore diameter 60 Å = 6 nm) is used. Other classical adsorbents are aluminium oxide, cellulose, kieselguhr, ion exchangers and polyamide.
- **special phases**
  reversed phases, mainly C18 (octadecyl) modified silica, but also cyano-, amino-, diol and RP-2 modified silica are available. Special layers for specific separations, like our CHIRALPLATE for enantiomer separation complete the versatile range of TLC plates.
- **particle size distribution** and **thickness of layer** are chosen to fit the given type of application (e.g. HPTLC, standard or preparative separations)
- most MN ready-to-use layers are available with or without fluorescent indicator

Electron microscope photograph of a cross section through a glass plate with silica layer (magnification x 500)



Electron microscope photograph of a cross section through an aluminium sheet with silica layer (magnification x 500)

Supports for ready to use layers for TLC

	glass plates	POLYGRAM®	ALUGRAM®
Physical properties of support materials			
Material	glass	polyester	aluminium
Thickness (approx.)	1.3 mm	0.2 mm	0.15 mm
Weight, packaging and storage requirements	high	low	low
Torsional strength	ideal	low	relatively high
Temperature stability	high	max. 185 °C	high
Susceptible to breakage	yes	no	no
Can be cut with scissors	no	yes	yes
Chemical resistance of support materials			
against solvents	high	high	high
against mineral acids and conc. ammonia	high	high	low
Stability of the binder system of NP plates in water			
suitability for aqueous detection reagents	depends on the phase	very suitable	limited suitability

Summary of MN ready-to-use layers for TLC

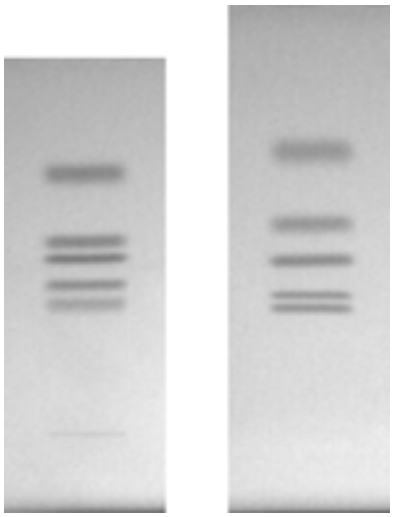
ADAMANT

unmodified standard silica layers

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
- **outstanding hardness** and **abrasion resistance** due to an optimized binder system
- **increased separation efficiency** due to an optimized particle size distribution
- **high suitability for trace analyses** resulting from a UV indicator with increased brilliance and a low-noise background of the layer

Separation of steroids

Layers: ADAMANT UV_{254}, SIL G/UV_{254}
Eluent: chloroform – methanol (97:3)
Developing time: 10 minutes
0.1 % solution in CCl_3



ADAMANT UV $_{254}$ SIL G/UV_{254}

R_f	ADAMANT	SIL G
Cortisone	0.37	0.27
Corticosterone	0.43	0.30
Testosterone	0.50	0.39
Deoxycorticosterone	0.55	0.46
Progesterone	0.73	0.62
Migration distance	5.0 cm	5.7 cm

MN Appl. No. 402930

Separation of barbiturates

Layer: ADAMANT UV254
Eluent: chloroform – acetone (95:5, v/v)
Migration distance: 73 mm in 20 minutes
Sample volume: 1 µl

Substance	R_f
Thiamylal (0.5 %)	0.69
Thiopental (1.0 %)	0.65
Hexobarbital (5.0 %)	0.41
Pentobarbital (1.0 %)	0.26
Phenobarbital (1.0 %)	0.18

MN Appl. No. 402950

For more applications of ADAMANT ready-to-use layers, check our application database at *www.mn-net.com*

Ordering information

Plate size [cm]	2.5 x 7.5	5 x 10		5 x 20	10 x 10	10 x 20	20 x 20	Fluorescent indicator	Thickness of layer
Pack of [plates]	100	50	200	100	25	50	25		
Glass plates									
ADAMANT		**821040**	**821040.200**		**821050**		**821060**	-	0.25 mm
ADAMANT UV_{254}	**821005**	**821010**	**821010.200**	**821015**	**821020**	**821025**	**821030**	UV_{254}	0.25 mm

Standard silica layers for TLC

SIL G — unmodified standard silica layers

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm; standard grade
- thickness of layer for analytical plates 0.25 mm, for preparative plates 0.5 and 1 mm; for 2 mm preparative layers a slightly coarser material is used
- indicators: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm); special inorganic fluorescent pigment with blue fluorescence for long-wave UV (366 nm)
- binders: highly polymeric products, which are stable in almost all organic solvents and resistant towards aggressive visualisation reagents; binder system for POLYGRAM® sheets is also completely stable in purely aqueous eluents

Ordering information

Glass plates

Plate size [cm]	2.5 x 7.5	5 x 10		5 x 20	10 x 10	10 x 20	20 x 20	40 x 20	Thickness of layer
Pack of [plates]	100	50	200	100	25	50	25		
SIL G-25		**809017**	**809017.200**	**809011**		**809012**	**809013**		0.25 mm
SIL G-25 UV_{254}	**809028.100**	**809027**	**809027.200**	**809021**	**809020**	**809022**	**809023**		0.25 mm
SIL G-25 $UV_{254+366}$				**809121**		**809122**	**809123**		0.25 mm
Pack of [plates]							20		
SIL G-50							**809051**		0.50 mm
SIL G-50 UV_{254}							**809053**		0.50 mm
Pack of [plates]							15		
SIL G-100							**809061**		1.00 mm
SIL G-100 UV_{254}							**809063**		1.00 mm
Pack of [plates]							12		
SIL G-200							**809073**		2.00 mm
SIL G-200 UV_{254}							**809083**		2.00 mm

POLYGRAM® polyester sheets

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 20	20 x 20	40 x 20	
Pack of [plates]	200	50	50	25	25	
SIL G	**805902**	**805032**	**805012**	**805013**	**805014**	0.20 mm
SIL G/UV_{254}	**805901**	**805021**	**805022**	**805023**	**805024**	0.20 mm
SIL G/UV_{254}			Roll 500 x 20 cm		**805017**	0.20 mm

ALUGRAM® aluminium sheets

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 7.5	5 x 10	5 x 20	10 x 20	20 x 20		
Pack of [plates]	200	50	20	50	50	20	25		
SIL G			**818030.20**	**818161**	**818032**	**818163**	**818033**		0.20 mm
SIL G/UV_{254}	**818129**	**818131**	**818130.20**	**818160**	**818132**	**818162**	**818133**		0.20 mm

DURASIL — unmodified standard silica layers

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
- hard, water-resistant and wettable layers due to a special binder system

Ordering information

Plate size [cm]	5 x 10		5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	200	100	50	25		
Glass plates							
DURASIL-25				**812003**	**812004**	0.25 mm	-
DURASIL-25 UV_{254}	**812005**	**812005.200**	**812006**	**812007**	**812008**	0.25 mm	UV_{254}

SIL N-HR — unmodified standard silica layers

- **high purity** silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
  different binder system compared to SIL G results in different separation characteristics
- a special feature of the POLYGRAM® SIL N-HR is a **higher gypsum content**

Ordering information

Plate size [cm]	5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
POLYGRAM® polyester sheets				
SIL N-HR	**804012**	**804013**	0.20 mm	–
SIL N-HR/UV_{254}	**804022**	**804023**	0.20 mm	UV_{254}

For plates SIL G-HR for aflatoxin separation please see page 189.

SILGUR — unmodified standard silica layers with concentrating zone

- silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm
- **kieselguhr zone for rapid sample application:** because kieselguhr is completely inert towards a large number of compounds, the samples always form a narrow band at the interface of the two adsorbents, irrespective of shape, size or position of the spots in the concentrating zone (see page 170). Separation then takes place in the silica layer.

Ordering information

Plate size [cm]	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
Glass plates				
SILGUR-25	**810012**	**810013**	0.25 mm	–
SILGUR-25 UV_{254}	**810022**	**810023**	0.25 mm	UV_{254}

Nano-SILGUR — unmodified nano silica layers with concentrating zone

- **nano** silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm**
- narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, lower amount of samples and an increased detection sensitivity compared to standard silica
- with kieselguhr zone for rapid sample application (see SILGUR above)

Ordering information

Plate size [cm]	10 x 10	Thickness of layer	Fluorescent indicator
Pack of [plates]	25		
Glass plates			
Nano-SILGUR-20	**811032**	0.20 mm	–
Nano-SILGUR-20 UV_{254}	**811042**	0.20 mm	UV_{254}

Nano silica layers for HPTLC

Nano-ADAMANT

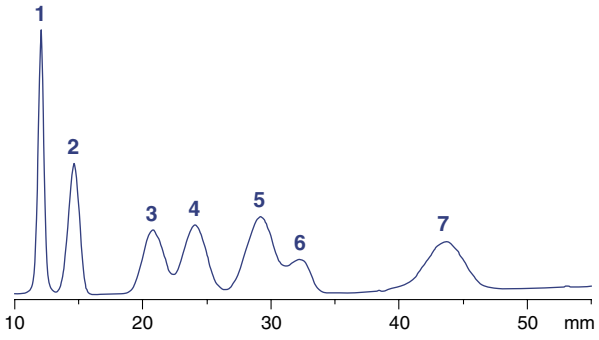
unmodified nano silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- **outstanding hardness** and **abrasion resistance** due to an optimized binder system
- **increased separation efficiency** due to an optimized particle size distribution
- **high suitability for trace analyses** resulting from a UV indicator with increased brilliance and a low-noise background of the layer
- narrow fractionation of the silica particles allows theoretical plate heights, which are one order of magnitude smaller than on standard silica layers with the advantage of sharper separations, shorter developing times, shorter migration distances, lower amount of samples, and increased detection sensitivity with equal selectivity

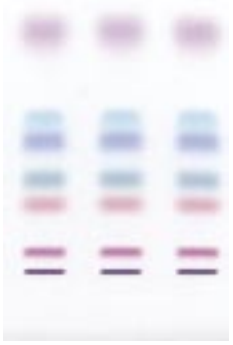
Comparison of ADAMANT and Nano-ADAMANT plates for separation of anthraquinone dyes

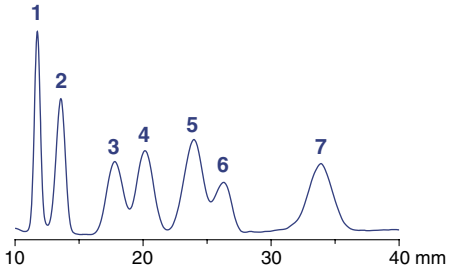
Layers: A) ADAMANT
B) Nano-ADAMANT
Sample: 1 µl, about 0.1 %
Eluent: toluene – cyclohexane (4:3, v/v)
Migration time: A) 30 min, B) 15 min

Peaks:
1. Blue 3
2. Violet 2
3. Red
4. Green
5. Blue 1
6. Greenish blue
7. Violet 1



A





B

Ordering information

Plate size [cm] Pack of [plates[	5 x 5 100	10 x 10 25	10 x 20 50	Thickness of layer	Fluorescent indicator
Glass plates					
Nano-ADAMANT-20	**821130**	**821140**	**821150**	0.20 mm	-
Nano-ADAMANT-20 UV_{254}	**821100**	**821110**	**821120**	0.20 mm	UV_{254}

Nano-SIL — unmodified nano silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
- binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualisation reagents
- narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, smaller samples and an increased detection sensitivity compared to SIL G plates

Ordering information

Plate size [cm] / Pack of [plates]	5 x 5 / 100	5 x 20 / 50	10 x 10 / 25	10 x 20 / 50	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates							
Nano-SIL-20	**811011**		**811012**	**811013**		0.20 mm	–
Nano-SIL-20 UV_{254}	**811021**		**811022**	**811023**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets							
Nano-SIL G		**818140**			**818141**	0.20 mm	–
Nano-SIL G/UV_{254}		**818142**			**818143**	0.20 mm	UV_{254}

Nano-DURASIL — unmodified nano silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
- hard, water-resistant and wettable layers due to a special binder system
- narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, smaller samples and an increased detection sensitivity compared to DURASIL plates
- different selectivity compard to ADAMANT and SIL-G plates
- no reversed phase tendency, more polar than SIL-G

Ordering information

Plate size [cm] / Pack of [plates]	5 x 5 / 100	10 x 10 / 25	10 x 20 / 50	Thickness of layer	Fluorescent indicator
Glass plates					
Nano-DURASIL-20		**812010**	**812011**	0.20 mm	–
Nano-DURASIL-20 UV_{254}	**812012**	**812013**	**812014**	0.20 mm	UV_{254}

AMD SIL — thin unmodified nano silica layers

- nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0,75 ml/g, **particle size 2 – 10 µm**
- very thin nano silica layer for the AMD procedure (automated multiple development), which allows rapid and efficient simultaneous analyses of several active ingredients at ultra trace levels (see page 171)

Ordering information

Plate size [cm]	10 x 20	Pack of [plates]	Thickness of layer	Fluorescent indicator
Glass plates				
AMD SIL G-05 UV_{254}	**811101**	5	0.05 mm	UV_{254}
AMD SIL G-10 UV_{254}	**811103**	25	0.10 mm	UV_{254}

Modified RP silica layers for HPTLC

Nano-SIL C 18 — octadecyl-modified nano silica layers

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 10
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- partial (50 %) or complete (100 %) octadecyl modification, carbon content 7.5 and 14 %, respectively
- order of polarity: silica > DIOL > NH_2 > CN > RP-2 > **C 18-50** > RP-18 W > **C 18-100**
- reversed phase separation mode with eluents from anhydrous solvents to mixtures with high concentrations of water (see table below)
- recommended application: alkaloids, amino acids, preservatives, optical brighteners, barbiturates, polycyclic aromatic hydrocarbons (PAH), drugs, peptides, flavonoids, phenols, indole derivatives, steroids

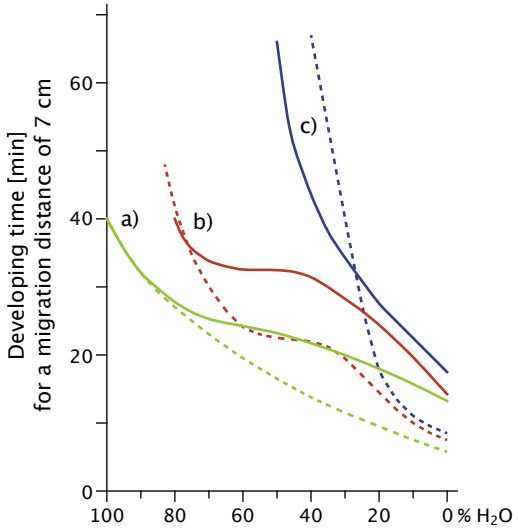
Ordering information

Plate size [cm] / Pack of [plates]		10 x 10 / 25	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-SIL C 18-50	} 50 % silanised	**811054**	0.20 mm	–
Nano-SIL C 18-50 UV_{254}		**811064**	0.20 mm	UV_{254}
Nano-SIL C 18-100	} 100 % silanised	**811052**	0.20 mm	–
Nano-SIL C 18-100 UV_{254}		**811062**	0.20 mm	UV_{254}

Migration of C 18-50 and C 18-100 silica layers as compared to RP-18 W plates

Eluent	v/v	Migration distances [mm/15 min] C 18-50	C 18-100	RP-18 W
methanol/H_2O	2:1	57	45	44
	1:1	52	21	40
	1:2	50	0	43
	1:3	40	0	45
	1:4	30	0	46
	0:1	0	0	54
acetonitrile/H_2O	2:1	62	46	66
	1:1	52	30	54
	1:2	51	27	46
	1:3	48	15	44
	1:9	20	0	42
chloroform		68	64	71

Elution properties of MN RP plates in mixtures of methanol/water and acetonitrile/water



a) RP-18 W, b) Nano-SIL C 18-50, c) Nano-SIL C 18-100
all plates with UV indicator
methanol/water; **acetonitrile/water**

For numerous separations with MN RP plates please visit our application database at *www.mn-net.com*

RP-18 W/UV_{254} — octadecyl-modified nano silica layers

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, mean particle size 9 µm, pH stability 2 – 10
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- partial octadecyl (C_{18}) modification, wettable with water, carbon content 14 %
- order of polarity: silica > DIOL > NH_2 > CN > RP-2 > C 18-50 > **RP-18 W** > C 18-100
- normal phase or reversed phase separation modes with eluents from anhydrous solvents to mixtures with high concentrations of water (see table on previous page); the relative polarity of the eluent determines the polarity of the layer
- recommended application: aminophenols, barbiturates, preservatives, nucleobases, polycyclic aromatic hydrocarbons, steroids, tetracyclines, plasticizers (phthalates)

Ordering information

Glass plates							
Plate size [cm]			5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]			50	25	50	25		
RP-18 W/UV_{254}			**811073**	**811075**	**811072**	**811071**	0.25 mm	UV_{254}
Pack of [plates]						15		
RP-18 W/UV_{254}						**811074**	1.00 mm	UV_{254}
ALUGRAM® aluminium sheets								
Plate size [cm]	4 x 8	5 x 10	5 x 20	10 x 10		20 x 20		
Pack of [plates]	50	50	50	25		25		
RP-18 W/UV_{254}	**818144**	**818152**	**818145**	**818147**		**818146**	0.15 mm	UV_{254}

RP-2/UV_{254} — "silanised silica" = dimethyl-modified standard silica layers

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, particle size 5 – 17 µm, pH stability 2 – 10
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- silanised silica with dimethyl modification, carbon content 4 %
- order of polarity: silica > DIOL > NH_2 > CN > **RP-2** > C 18-50 > RP-18 W > C 18-100
- normal phase or reversed phase separation modes with purely organic, organic – aqueous or purely aqueous eluents
- recommended application: active plant constituents, steroids

Ordering information

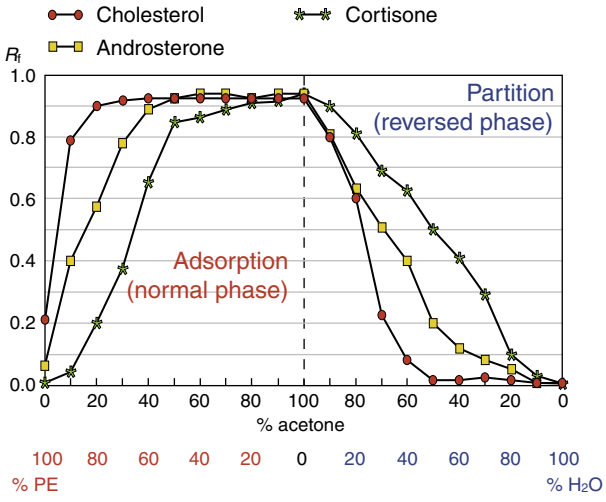
Plate size [cm]	4 x 8	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25	50	25		
Glass plates						
RP-2/UV_{254}		**811080**	**811081**	**811082**	0.25 mm	UV_{254}
ALUGRAM® aluminium sheets						
RP-2/UV_{254}	**818170**			**818171**	0.15 mm	UV_{254}

Modified silica layers for HPTLC

Nano-SIL CN — cyano-modified nano silica layers

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 8
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- cyanopropyl modification, carbon content 5.5 %
- order of polarity: silica > DIOL > NH_2 > **CN** > RP-2 > C 18-50 > RP-18 W > C 18-100
- available as glass plates or ALUGRAM® aluminium sheets
- normal phase or reversed phase separation modes depending on the polarity of the developing solvent (see figure below)
- recommended application: steroid hormones, phenols, preservatives

R_f values of different steroids as a function of eluent composition



Layer: Nano-SIL CN/UV

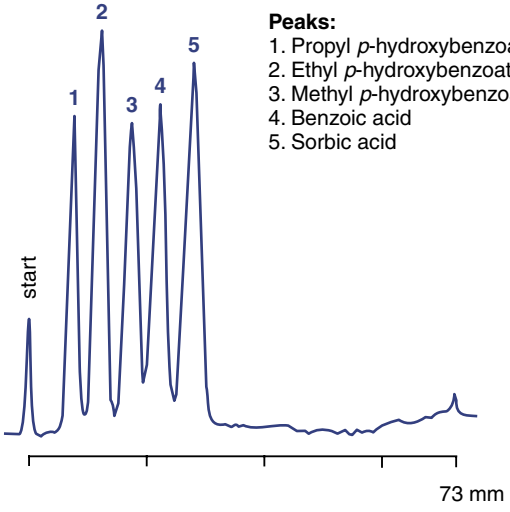
Polarity of the eluent governs the type of separation mechanism:

eluent system petroleum ether (PE) – acetone (NP mode)
the higher the concentration of PE, the stronger are the adsorptive interactions of the steroids with the stationary phase

eluent system acetone – water (RP mode)
the sequence of elution of the steroids is reversed, the most nonpolar compounds are most strongly retained

Separation of preservatives

Layer: Nano-SIL CN/UV
Sample volume: 400 nl
Eluent: ethanol – water – glacial acetic acid 20:80:0.2 with 0.1 mol/l tetraethylammonium chloride
Migration distance: 7.3 cm in 30 min
Detection: TLC scanner, UV 254 nm



Peaks:
1. Propyl *p*-hydroxybenzoate
2. Ethyl *p*-hydroxybenzoate
3. Methyl *p*-hydroxybenzoate
4. Benzoic acid
5. Sorbic acid

MN Appl. No. 401440

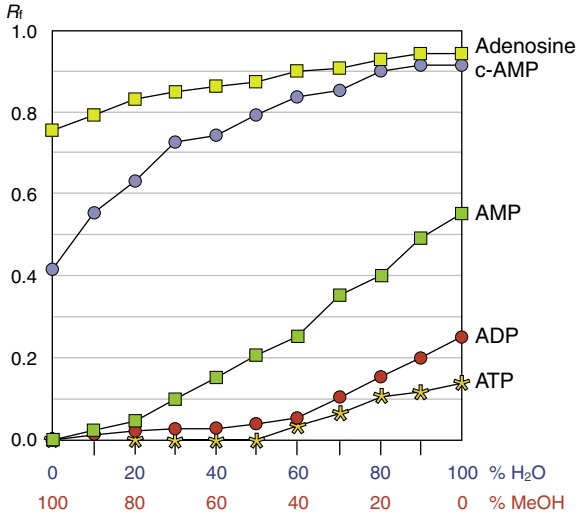
Ordering information

Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates						
Nano-SIL CN/UV		**811115**	**811116**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets						
Nano-SIL CN/UV	**818184**			**818185**	0.15 mm	UV_{254}

Nano-SIL NH_2 — amino-modified nano silica layers

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 8
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- aminopropyl modification, carbon content 3.5 %
- order of polarity: silica > DIOL > **NH_2** > CN > RP-2 > C 18-50 > RP-18 W > C 18-100
- available with or without fluorescent indicator, as glass plates or ALUGRAM® aluminium sheets
- layer can be wetted equally well by pure water as by organic solvents
- recommended application: vitamins, sugars, steroids, purine derivatives, xanthines, phenols, nucleotides and pesticides

Influence of eluent composition on the separation of nucleotides

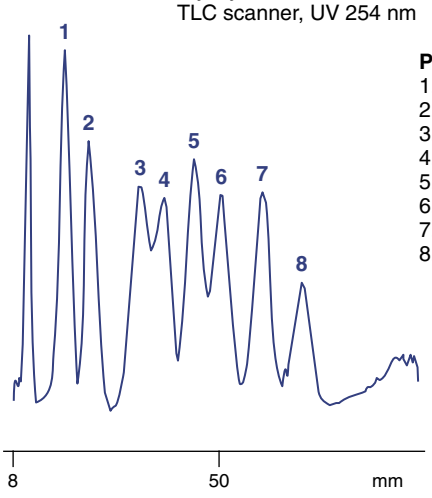


Layer: Nano-SIL NH_2/UV
Eluent: MeOH – H_2O according to fig. + 0.18 M NaCl
Migration distance: 7 cm

c-AMP, AMP: adenosine monophosphate
ADP: adenosine diphosphate
ATP: adenosine triphosphate

Separation of sugars

Layer: Nano-SIL NH_2/UV
Eluent: ethyl acetate – pyridine – water – glacial acetic acid (60:30:10:5, v/v/v/v)
Migration distance: 8 cm in 45 min, double development
Sample volume: 500 nl
Detection: dry layer at 160 °C for 5 min, TLC scanner, UV 254 nm



Peaks (0.1 % each):
1. Lactose
2. Saccharose
3. Galactose
4. Glucose
5. Fructose
6. Arabinose
7. Xylose
8. Ribose

MN Appl. No. 401590

Ordering information

Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates						
Nano-SIL NH_2		**811109**			0.20 mm	–
Nano-SIL NH_2/UV		**811111**	**811112**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets						
Nano-SIL NH_2/UV	**818182**			**818183**	0.15 mm	UV_{254}

Modified silica layers for HPTLC

Nano-SIL DIOL

diol-modified nano silica layers

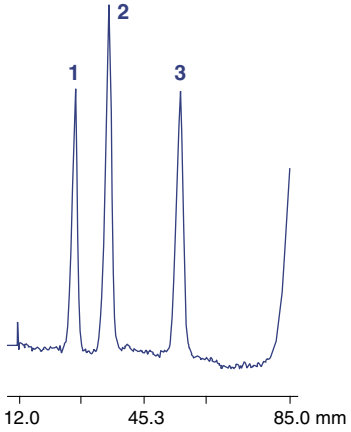
- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm,** pH stability 2 – 8
  indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances apppear as dark-blue to black spots on a light-blue background
- diol modification, carbon content 5.5 %
- order of polarity: silica > **DIOL** > NH_2 > CN > RP-2 > C 18-50 > RP-18 W > C 18-100
- available as glass plates or ALUGRAM® aluminium sheets
- layer can be wetted equally well by pure water as by organic solvents
- recommended application: steroids, pesticides and plant constituents; for critical separations an alternative to silica, since it is less sensitive to the water content of the environment; leads to more reproducible results compared to silica

Separation of pesticides

Layer: Nano-SIL DIOL/UV
Sampe volume: 2 µl
Eluent: petroleum ether (40-60 °C) – acetone (80 + 20, v/v)
Migration distance: 7 cm
Detection: TLC scanner, 238 nm

Peaks:
(0.07 % each in MeOH)
1. Metoxuron
2. Monuron
3. Metobromuron

MN Appl. No. 402340



Ordering information

Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates						
Nano-SIL DIOL/UV		**811120**	**811121**		0.20 mm	UV_{254}
ALUGRAM® aluminium sheets						
Nano-SIL DIOL/UV	**818180**			**818181**	0.15 mm	UV_{254}

HPTLC method development kits

for selection of the optimum HPTLC plate for a given separation

- **glass plates:** 3 plates 10 x 10 cm (scored to 5 x 10 cm) each of Nano-SIL C18-100/UV_{254}, RP-18 W/UV_{254}, RP-2/UV_{254}, Nano-SIL CN/UV, Nano-SIL NH_2/UV, Nano-SIL DIOL/UV **(Cat. No. 811001)**
- **ALUGRAM® aluminium sheets:** 5 sheets 4 x 8 cm each of RP-18 W/UV_{254}, RP-2/UV_{254}, Nano-SIL CN/UV, Nano-SIL NH_2/UV, Nano-SIL DIOL/UV **(Cat. No. 818001)**

ALOX

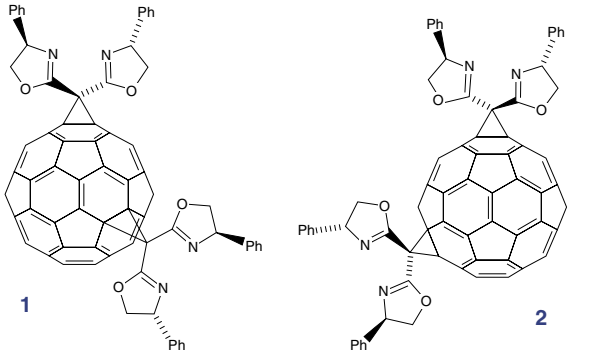
aluminium oxide layers for TLC

- aluminium oxide, specific surface (BET) ~ 200 m^2/g, mean pore size 60 Å; inert organic binder
  indicator manganese-activated zinc silicate
  recommended application: terpenes, alkaloids, steroids, aliphatic and aromatic compounds
  We recommend to activate aluminium oxide layers before use by heating 10 minutes at 120 °C.

Separation of bisadducts of fullerenes

F. Djojo, A. Hirsch, Chem. Eur. J. **4** (1998), 344 – 356
Layer: ALUGRAM® ALOX N/UV_{254}
Eluent: toluene – ethyl acetate (95:5, v/v)
Detection: UV, 254 nm

Compound	R_f values:
Bis[bis(4-phenyloxazolin)methan]fullerene 1:	0.14
Bis[bis(4-phenyloxazolin)methan]fullerene 2:	0.26

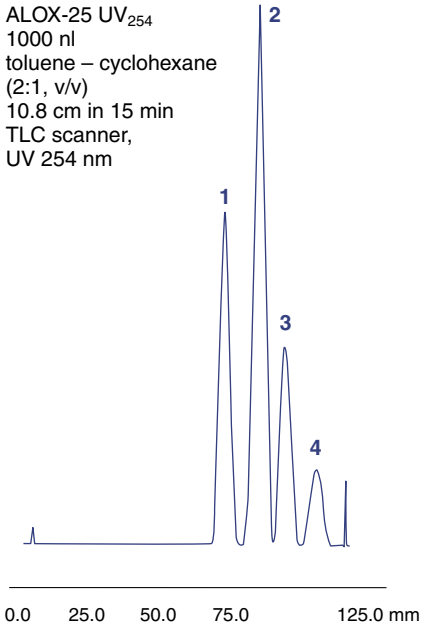


MN Appl. No. 401930

Separation of lipophilic dyes

Layer: ALOX-25 UV_{254}
Sample volume: 1000 nl
Eluent: toluene – cyclohexane (2:1, v/v)
Migration distance: 10.8 cm in 15 min
Detection: TLC scanner, UV 254 nm

Peaks:
1. Indophenol
2. Sudan red G
3. Sudan blue II
4. Butter yellow



MN Appl. No. 403010

Ordering information

Glass plates					
Plate size [cm]		5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]		100	25		
ALOX-25		**807011**	**807013**	0.25 mm	–
ALOX-25 UV_{254}		**807021**	**807023**	0.25 mm	UV_{254}
Pack of [plates]			15		
ALOX-100 UV_{254}			**807033**	1.00 mm	UV_{254}
POLYGRAM® polyester sheets					
Plate size [cm]	4 x 8	5 x 20	20 x 20		
Pack of [plates]	50	50	25		
ALOX N		**802012**	**802013**	0.20 mm	–
ALOX N/UV_{254}	**802021**	**802022**	**802023**	0.20 mm	UV_{254}
ALUGRAM® aluminium sheets					
Plate size [cm]		5 x 20	20 x 20		
Pack of [plates]		50	25		
ALOX N			**818013**	0.20 mm	–
ALOX N/UV_{254}		**818024**	**818023**	0.20 mm	UV_{254}

Cellulose layers for TLC

Cellulose MN 300 — native fibrous cellulose layers for TLC

- fibre length (95 %) 2 – 20 µm, average degree of polymerisation 400 – 500, specific surface acc. to Blaine 15000 cm^2/g
  ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P; CH_2Cl_2 extract ≤ 0.25 %; residue on ignition at 850 °C ≤ 1500 ppm
  recommended application: partition chromatography of polar substances such as amino acids, carboxylic acids or carbohydrates

Ordering information

Plate size [cm] / Pack of [plates]	4 x 8	5 x 20 / 100	10 x 20 / 50	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates						
CEL 300-10		**808011**	**808012**	**808013**	0.10 mm	–
CEL 300-10 UV_{254}		**808021**	**808022**	**808023**	0.10 mm	UV_{254}
CEL 300-25			**808032**	**808033**	0.25 mm	–
CEL 300-25 UV_{254}			**808042**	**808043**	0.25 mm	UV_{254}
Pack of [plates]				20		
CEL 300-50				**808053**	0.50 mm	–
CEL 300-50 UV_{254}				**808063**	0.50 mm	UV_{254}
POLYGRAM® polyester sheets						
Plate size [cm]	4 x 8	5 x 20		20 x 20		
Pack of [plates]	50	50		25		
CEL 300	**801011**	**801012**		**801013**	0.10 mm	–
CEL 300 UV_{254}		**801022**		**801023**	0.10 mm	UV_{254}
ALUGRAM® aluminium sheets						
Plate size [cm]	4 x 8	5 x 20		20 x 20		
Pack of [plates]	50	50		25		
CEL 300	**818155**	**818154**		**818153**	0.10 mm	–
CEL 300 UV_{254}		**818157**		**818156**	0.10 mm	UV_{254}

Cellulose MN 400 (AVICEL®) — microcrystalline cellulose layers for TLC

- prepared by hydrolysis of high purity cellulose with HCl; mean degree of polymerisation 40 – 200
  recommended application: carboxylic acids, lower alcohols, urea and purine derivatives

Ordering information

Plate size [cm] / Pack of [plates]	5 x 20 / 50	10 x 20 / 50	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates					
CEL 400-10		**808072**	**808073**	0.10 mm	–
CEL 400-10 UV_{254}		**808082**	**808083**	0.10 mm	UV_{254}
POLYGRAM® polyester sheets					
CEL 400	**801112**		**801113**	0.10 mm	–
CEL 400 UV_{254}	**801122**		**801123**	0.10 mm	UV_{254}

Cellulose MN 300 DEAE

DEAE-modified cellulose ion exchange layers

- fibrous cellulose modified with diethylamino groups: R – O – C_2H_4 – $N(C_2H_5)_2$

  mixed layers of cellulose MN 300 DEAE and high purity cellulose MN 300 HR are recommended for separation of mono- and oligonucleotides in nucleic acid hydrolysates

Separation of mono- and oligonucleotides in nucleic acid hydrolysates on layers of MN 300 DEAE/HR

The Medical Research Council Laboratory of Molecular Biology in Cambridge (UK) has developed a special procedure for the separation of radioactively labelled mono- and oligonucleotides in hydrolysates of ribonucleic acid. It is a 2-dimensional procedure, in which mononucleotides and oligonucleotides are separated up to n = 50. The separation process consists of 2 stages, first a high voltage electrophoretic group fractionation on acetate sheets in the 1st dimension and then a TLC separation in the 2nd dimension after blotting of the preseparated substances onto a mixed layer of DEAE cellulose and HR cellulose in the ratio 2:15.

As eluent concentrated urea solutions with addition of homomix solutions are used, which consist of ribonucleic acid hydrolysates and dialysates. Mononucleotides move up to the front, and depending on chain length the oligonucleotides appear between the R_f values 1 and 0. The evaluation of chromatograms is by autoradiography after treatment with red ink, which contains radioactive sulphur ^{35}S.

References

G. G. Brownlee et al., European J. Biochem. **11** (1969) 395
B. E. Griffin, FEBS Letters **15** (1971) 165
F. Sanger et al., J. Mol. Biol. **13** (1965) 373 – 398.

Ordering information

Plate size [cm] / Pack of [plates]	5 x 20 / 50	20 x 20 / 25	40 x 20 / 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets					
CEL 300 DEAE	**801072**	**801073**	**801074**	0.10 mm	–
CEL 300 DEAE/HR-2/15			**801084**	0.10 mm	–

Cellulose MN 300 PEI

PEI-impregnated cellulose ion exchange layers

- fibrous cellulose **impregnated** with polyethyleneimine

  recommended application: analysis of nucleic acids, and of mutagenic substances with the ^{32}P postlabelling procedure (see application 402260 at *www.mn-net.com*)

Ordering information

Plate size [cm] / Pack of [plates]	5 x 20 / 50	20 x 20 / 25	40 x 20 / 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets					
CEL 300 PEI	**801052**	**801053**	**801054**	0.10 mm	–
CEL 300 PEI/UV_{254}	**801062**	**801063**	**801064**	0.10 mm	UV_{254}

Acetylated cellulose MN 300

- fibrous cellulose with 10 or 20 % content of acetylated cellulose

  recommended application: reversed phase chromatography

Ordering information

Plate size [cm] / Pack of [plates]	Acetyl content	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates				
CEL 300-10/AC-10 %	10 %	**808113**	0.10 mm	–
CEL 300-10/AC-20 %	20 %	**808123**	0.10 mm	–
POLYGRAM® polyester sheets				
CEL 300 AC-10 %	10 %	**801033**	0.10 mm	–

Layers for special TLC separations

Polyamide-6

ϵ-aminopolycaprolactame layers for TLC

- polyamide 6 = Nylon 6 = perlon = ϵ-aminopolycaprolactame

  separation mechanism based on hydrogen bonds to amide groups of the polymer matrix as well as on ionic, dipol and electron donor/acceptor interactions

  recommended application: natural compounds, phenols, carboxylic acids, aromatic nitro compounds and especially amino acids

Ordering information

Plate size [cm]	5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
POLYGRAM® polyester sheets				
POLYAMIDE-6	**803012**	**803013**	0.10 mm	-
POLYAMIDE-6 UV_{254}	**803022**	**803023**	0.10 mm	UV_{254}

CHIRALPLATE

special layer for TLC enantiomer separation

- reversed phase nano silica impregnated with Cu^{2+} ions and a chiral selector (a proline derivative, DP 31 43 726 and EP 0 143 147)

  separation based on ligand exchange, i.e. formation of ternary mixed-ligand complexes with the Cu(II) ions; differences in the stability of the diastereomeric complexes cause chromatographic separation

  recommended application: enantiomer separation of amino acids, *N*-methylamino acids, *N*-formylamino acids, α-alkylamino acids, thiazolidine derivatives, dipeptides, lactones, α-hydroxycarboxylic acids

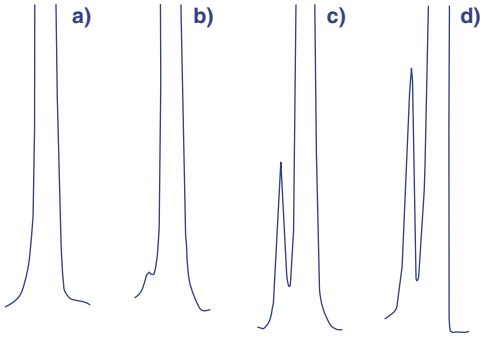
  A review on the application of CHIRALPLATE has been given by K. Günther [J. Chromatogr. 448 (1988) 11 – 30].

Enantiomer separation of amino acids

Quantitative determination (remission location curves) of TLC-separated enantiomers of tert.-leucine:

Layer: CHIRALPLATE
Eluent: methanol – water (10:80, v/v)
Detection: dip in 0.3% ninhydrin solution
quantification with scanner, 520 nm

a) L-tert.-leucine
b) L-tert.-leucine + 0.1 % D-tert.-leucine
c) L-tert.-leucine + 1 % D-tert.-leucine
d) external reference sample



Ordering information

Plate size [cm]	5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates						
Pack of [plates]			4			
CHIRALPLATE			**811056**		0.25 mm	UV_{254}
Pack of [plates]	50	25	25	25		
CHIRALPLATE	**811057**	**811059**	**811055**	**811058**	0.25 mm	UV_{254}

SIL G-25 HR

special layer for aflatoxin separation

- high purity silica 60 **with gypsum** and a very small quantity of a polymeric organic binder
  softer than the standard silica layer, i.e. spots can be scratched and the layer absorbs faster
  recommended for the separation of aflatoxins

Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
SIL G-25 HR	**809033**	0.25 mm	-
SIL G-25 HR/UV_{254}	**809043**	0.25 mm	UV_{254}

SIL G-25 Tenside

special layer for separation of surfactants

- silica G impregnated with ammonium sulphate
  recommended for the separation of detergents, alkanesulphonates, polyglycols etc.
  also suited for the assessment of fetal lung maturity by determination of the ration lecithin/sphingomyelin and the presence of phosphatidylglycerol in amniotic fluid (see application 4000730 at *www.mn-net.com*)

Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
SIL G-25 Tenside	**810063**	0.25 mm	-

GUR N

TLC layers with kieselguhr

- kieselguhr is completely inactive and mostly used for special separations after suitable impregnation

Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
GUR N-25	**810074**	0.25 mm	-
GUR N-25 UV_{254}	**810073**	0.25 mm	UV_{254}

Layers for special TLC separations

Nano-SIL PAH

special nano silica layer for PAH analysis

- base material: silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 ml/g, **particle size 2 – 10 µm;** impregnated with caffeine, an electron acceptor for PAH analysis based on charge-transfer complexes

  recommended for determination of the six PAH according to German drinking water specifications (TVO) in accordance with German standard DIN 38407 part 7 (see application 402400 at *www.mn-net.com*)

Ordering information

Plate size [cm] Pack of [plates]	10 x 10 25	10 x 20 50	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-SIL-PAH	**811050**	**811051**	0.20 mm	-

IONEX

special mixed layers of silica with ion exchange resins

- IONEX-25 SA-Na: mixture of silica and a strongly acidic cation exchanger coated to polyester sheets
- IONEX-25 SB-AC: mixture of silica and a strongly basic anion exchanger coated to polyester sheets

  both layers contain an inert organic binder

  recommended application: amino acids, e.g. in protein and peptide hydrolysates, in seeds and fodder, in biological fluids; for racemate separation in peptide syntheses, for the separation of nucleic acid hydrolysates, aminosugars, aminocarboxylic acids, antibiotics, inorganic phosphates, cations and other compounds with ionic groups

Ordering information

		Plate size [cm] Pack of	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets					
IONEX-25 SA-Na	strongly acidic cation exchanger		**806013**	0.20 mm	-
IONEX-25 SB-AC	strongly basic anion exchanger		**806023**	0.20 mm	-

Mixed layers for TLC

- **ALOX/CEL-AC-Mix-25:** mixed layer of aluminium oxide G and acetylated cellulose
  recommended for separation of PAH (see application 401040 at *www.mn-net.com*)
- **SILCEL-Mix-25:** mixed layer of cellulose and silica
  recommended for separation of preservatives and other antimicrobial compounds (see application 401420 at *www.mn-net.com*)
- **GURSIL-Mix-25:** mixed layer of kieselguhr and silica
  recommended for separation of carbohydrates, antioxidants, steroids and photographic developer solutions

Ordering information

Plate size [cm] Pack of [plates]	10 x 20 50 / pack	20 x 20 25 / pack	Thickness of layer	Fluorescent indicator
Glass plates				
ALOX/CEL-AC-Mix-25	**810054**	**810053**	0.25 mm	-
SILCEL-Mix-25 UV_{254}		**810043**	0.25 mm	UV_{254}
GURSIL-Mix-25 UV_{254}	**810076**		0.25 mm	UV_{254}

Chromatography papers

- paper chromatography is the oldest chromatographic technique
  separation due to partition of the analytes between special paper grades and the mobile phase, which penetrates the paper by capillary action
  ascending, descending and circular techniques are possible
- *please note:* always treat chromatography papers with care:
  never touch them with fingers, because this will contaminate the surface
  do not bend them sharply, because this will decrease the capillary action (preferably store them flat)

  Chromatography papers possess a preferred direction of the fibres with higher absorption properties (with our sheets 58 x 60 cm, the longer edge). We recommend to use them in the direction of higher absorption.

Ordering information

Code	Weight [g/m²]	Thickness [mm]	Description	Flow rate	Size [cm]	Pack of	Cat. No.
MN 214	140	0.28	smooth	90 – 100 mm/30 min	58 x 60	100 sheets	**817001**
MN 218	180	0.36	smooth	90 – 100 mm/30 min	58 x 60	100 sheets	**817002**
MN 260	90	0.20	smooth	120 – 130 mm/30 min	58 x 60	100 sheets	**817003**
MN 261	90	0.18	smooth	90 – 100 mm/30 min	58 x 60	100 sheets	**817004**
MN 827	270	0.70	soft carton	130 – 140 mm/10 min	58 x 60	100 sheets	**817005**
MN 866	650	1.70	soft carton	100 – 120 mm/10 min	38 x 38	100 sheets	**817006**
MN 866	650	1.70	soft carton	100 – 120 mm/10 min	80 x 80	100 sheets	**817007**
MN 214 ff	140	0.28	MN 214 defatted *	90 – 100 mm/30 min	56 x 58	100 sheets	**817008**

*) This paper is extracted with organic solvents

For further papers, filters and membranes, feel free to ask for our catalogue "Filtration"

Introductory kits for TLC

TLC micro-sets — introductory kits for science education

- **Beginner's set**
  features separations with simple developing solvents; samples are coloured thus eliminating the need for visualisation. All equipment needed is contained in the set.
- **Advanced sets**
  require some experience and skill from the user: some of the samples have to be pretreated before separation, and for identification of substances spray reagents have to be used
- **TLC wine set**
  chromatographic rapid test for evaluating the conversion of malic acid to lactic acid in wine (2nd fermentation), i.e. the optimum time for bottling of a wine

TLC micro-set A for beginners

This kit contains all chemicals and accessories for the following separations:

- ✓ separation of the fat-soluble (lipophilic) dye mixture 1: butter yellow, indophenol, sudan blue II, sudan red G
- ✓ separation of a mixture of anthraquinone dyes (test dye mixture 2): blue 1, blue 3, green, green blue, red, violet 1, violet 3
- ✓ separation of a mixture of food dyes (test dye mixture 3): brilliant black BN (E151), fast red E, erythrosine (E127), yellow orange S (sunset yellow CFC, E110), naphthol red S, ponceau 4 R (E124), tartrazine (E102)
- ✓ separation of dyes from felt tip pens

Contents of TLC micro-set A for beginners

1	manual
3	developing chambers
50	glass capillaries 1 µl
1	spotting guide
1	measuring cylinder10 ml
50	polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$, ALOX N/UV$_{254}$ and CEL 300
8 ml	each of test dye mixture 1 (4 lipophilic dyes), test dyes sudan red G, and sudan blue II
8 ml	each of test dye mixture 2 (7 anthraquinone dyes), test dyes blue 1 and violet 2
8 ml	each of test dye mixture 3 (7 food dyes), test dyes yellow orange S, and brilliant black BN
100 ml	each of toluene, toluene/cyclohexane (2:1, v/v) chloroform/acetone (1:1, v/v) 2.5 % sodium citrate solution 25 % ammonia/2-propanol (5:3, v/v)
2	felt tip pens

TLC micro-set M

This kit is prerequisite for the separations with kits F 1 to F 3. In addition, it serves as basic equipment for the individual study of further thin layer chromatographic experiments.

Contents of TLC micro-set M (materials kit)

2 x 50 glass capillaries 1 µl, 2 spotting guides
1 rubber cap for capillaries, 1 measuring cylinder 10 ml,
1 beaker 25 ml, 2 developing chambers
1 glass laboratory sprayer with rubber bulb
1 plastic syringe 1 ml, 20 sheets filter paper MN 713 (15 x 21 cm)
50 polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$, ALOX N/UV$_{254}$ and CEL 300

Ordering information

Designation	Pack of	Cat. No.
TLC micro-set A for beginners	1 kit	**814000**
Replacement parts for TLC micro-set A		
Test dye mixture 1, solution of 4 lipophilic dyes in toluene (components see above)	8 ml	**814001**
Test dye mixture 2, solution of 7 anthraquinone dyes in chloroform (components see above)	8 ml	**814002**
Test dye mixture 3, aqueous solution of 7 food dyes (components see above)	8 ml	**814003**
Collection of 4 individual components of test dye mixture 1	4 x 8 ml	**814011**
Collection of 7 individual components of test dye mixture 2	7 x 8 ml	**814012**
Collection of 7 individual components of test dye mixture 3	7 x 8 ml	**814013**
Sodium citrate, 2.5 g in 100 ml bottles to fill up with distilled water	2.5 g	**814029**
TLC micro-set M (materials kit)	1 kit	**814100**

Introductory kits for TLC

TLC micro-set F 1

This kit contains all chemicals required for the separation of

- ✓ amino acids (test mixture, consisting of alanine, arginine, tryptophan and valine)
- ✓ amino acids in urine
- ✓ the heavy metal cations cobalt(II), copper(II), manganese(II), and nickel(II)

Contents of TLC micro-set F1

1 manual; 50 glass capillaries 1 µl
50 polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$ and CEL 300
100 ml each of *n*-butanol, ninhydrin spray reagent (0.2 % in ethanol), acetone, 25 % ammonia, rubeanic acid spray reagent
50 ml each of 50 % acetic acid, 18 % hydrochloric acid
8 ml each of the amino acid test mixture (see above), tryptophan and arginine reference solutions
8 ml each of the heavy metal cation test mixture (see above), Co^{2+}, Mn^{2+}, and Ni^{2+} reference solution

TLC micro-set F 2

This kit contains all chemicals required

- ✓ for the analysis of edible fats
- ✓ as well as for analysis of fats and cholesterol in blood

Contents of TLC micro-set F2

1 manual; 50 glass capillaries 1 µl
50 polyester sheets 4 x 8 cm POLYGRAM® SIL G/UV$_{254}$
5 blood lancets, 5 disposable pipettes 25 µl, 5 alcoholic pads,
5 sample vials N 11-1 (2 ml) with PE caps and seals,
3 sample vials 30 ml (for butter, margarine and edible oil)
100 ml each of chloroform, dichloromethane, toluene and molybdatophosphoric acid spray reagent
50 ml acetone with calibrated pipette
8 ml cholesterol reference solution

TLC micro-set F 3

This kit contains all chemicals required

- ✓ for the separation of analgetics (pain relievers)
- ✓ and for drug analysis as shown for cinchona bark

Contents of TLC micro-set F3

1 manual, 50 glass capillaries 1 µl
50 polyester sheets 4 x 8 cm POLYGRAM® SIL G/UV$_{254}$
5 Aspirin® tablets, 5 Thomapyrin® tablets, 20 folded filters MN 615 1/4, 11 cm diameter, 3 sample vials 8 ml (for Aspirin sample, Thomapyrin sample, cinchona bark extract), 5 g cinchona bark,
100 ml each of chloroform, methanol, toluene/diethyl ether (55:35, v/v), spray reagent for caffeine and Dragendorff-Munier spray reagent, 50 ml each of iron(III) chloride solution and potassium hexacyanoferrate solution, 30 ml glacial acetic acid/ethyl acetate (6 : 2,5, v/v), 25 ml each of 12.5% ammonia and diethylamine
8 ml each of caffeine, paracetamol, quinine reference solutions

TLC wine set

This kit contains all chemicals and equipment required for determination of malic, lactic, and tartaric acid in wine (evaluation of the conversion of malic to lactic acid, 2nd fermentation)

Contents of the TLC wine set

detailed instruction leaflet
50 polyester sheets 4 x 8 cm POLYGRAM® CEL 300
cation exchanger, eluent, reference substances
developing chamber, capillaries, spotting guide

Ordering information

Designation	Pack of	Cat. No.
TLC micro-set F1	1 kit	**814200**
Replacement parts for TLC micro-set F1		
Amino acid test mixtures (components see above)	8 ml	**814201**
Collection of 4 individual components of the amino acid test mixture	4 x 8 ml	**814202**
Cation test mixture (components see above)	8 ml	**814204**
Collection of 4 individual components of the cation test mixture	4 x 8 ml	**814205**
TLC micro-set F2	1 kit	**814300**
Replacement parts for TLC micro-set F2		
Cholesterol reference solution	8 ml	**814301**
TLC micro-set F3	1 kit	**814400**
Replacement parts for TLC micro-set F3		
Quinine reference solution	8 ml	**814405**
Paracetamol reference solution	8 ml	**814406**
Caffeine reference solution	8 ml	**814407**
TLC wine set	1 kit	**814500**

Accessories for TLC

Designation	Pack of	Cat. No.
Replacement parts for all TLC micro-sets		
TLC polyester sheets POLYGRAM® SIL G/UV_{254}, 4 x 8 cm	4 x 50	**814025**
TLC polyester sheets POLYGRAM® ALOX N/UV_{254}, 4 x 8 cm	4 x 50	**814026**
TLC polyester sheets POLYGRAM® CEL 300, 4 x 8 cm	4 x 50	**814027**
TLC polyester sheets POLYGRAM® 4 x 8 cm: 100 x SIL G/UV_{254}; 50 x ALOX N/UV_{254}; 50 x CEL 300	1 set	**814028**

TLC accessories

Designation	Pack of	Cat. No.
Simultaneous developing chamber for TLC, 20 x 20 cm, for up to 5 plates	1	**814019**
Developing chambers for TLC micro-sets	4	**814021**
Glass laboratory sprayer with rubber bulb	1	**814101**
Glass capillaries 1 µl	3 x 50	**814022**
Rubber caps for capillaries	2	**814102**
Plastic syringe, 1 ml content with gradation	1	**814104**
Spotting guides	2	**814023**
Measuring cylinders, glass, 10 ml content	2	**814024**
Filter paper MN 713, 15 x 21 cm	100	**814103**
Folded filters MN 615 1/4, 11 cm diameter	100	**531011**
Chromatography paper MN 260, 7.5 x 17 cm (for chamber saturation)	100	**814030**

Visualisation reagents

- a small selection of frequently used spray reagents for postchromatographic detection reactions in TLC suited for spraying or dipping TLC plates

  a detailed description of many more detection procedures for TLC is available on request

Ordering information

Spray reagent	Solvent	Detection of	Pack of	Cat. No.
Aniline phthalate	2-propanol / ethanol (1:1)	reducing sugars, oxohalic acids	100 ml	**814919**
Bromocresol green	2-propanol	organic acids	100 ml	**814920**
Caffeine reagent	water/acetone	caffeine	100 ml	**814401**
2',7'-Dichlorofluorescein	2-propanol	lipids (saturated, unsaturated)	100 ml	**814921**
4-(Dimethylamino)-benzaldehyde	2-propanol	terpenes, sugars, steroids	100 ml	**814922**
Dragendorff-Munier	water	alkaloids and other nitrogen compounds	100 ml	**814402**
Iron(III) chloride	water	acetylsalicylic acid, paracetamol	100 ml	**814403**
Potassium hexacyanoferrate(III)	water		100 ml	**814404**
Molybdatophosphoric acid	ethanol	lipids, sterols, steroids, reducing compounds	100 ml	**814302**
Ninhydrin	ethanol	amino acids, amines and amino sugars	100 ml	**814203**
Rhodamin B	ethanol	lipids	100 ml	**814923**
Rubeanic acid	ethanol	heavy metal cations	100 ml	**814206**

Silica

adsorbents for TLC

pore size 60 Å, pore volume 0.75 ml/g, specific surface (BET) ~ 500 m^2/g, pH of a 10 % aqueous suspension 7.0

- **Silica G**
  standard grade, particle size 2 – 20 µm, Fe < 0.02 %, Cl < 0.02 %, 13 % gypsum as binder, supplied with or without fluorescence indicator UV_{254}
- **Silica N**
  standard grade, particle size 2 – 20 µm, Fe < 0.02 %, Cl < 0.02 %, no binder, supplied with or without fluorescence indicator UV_{254}
- **Silica G-HR**
  high purity grade, particle size 3 – 20 µm, Fe < 0.002 %, Cl < 0.008 %, gypsum as binder, supplied without fluorescence indicator
- **Silica P**
  preparative grade, particle size 5 – 50 µm, Fe < 0.02 %, Cl < 0.02 %, organic binder, supplied with fluorescence indicator UV_{254}
- **Silica P with gypsum**
  preparative grade, particle size 5 – 50 µm, Fe < 0.02 %, Cl < 0.02 %, gypsum as binder, supplied with fluorescence indicator UV_{254}

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Silica G	–	**816310.1**	**816310.5**
Silica G/UV_{254}	UV_{254}	**816320.1**	**816320.5**
Silica N	–	**816330.1**	**816330.5**
Silica N/UV_{254}	UV_{254}	**816340.1**	**816340.5**
Silica G-HR	–	**816410.1**	**816410.5**
Silica P/UV_{254}	UV_{254}	**816380.1**	**816380.5**
Silica P/UV_{254} with gypsum	UV_{254}	**816400.1**	**816400.5**

Aluminium oxide

adsorbents for TLC

pore size 60 Å, specific surface (BET) ~ 200 m^2/g

- **Aluminium oxide G**
  ~ 10 % gypsum as binder, supplied with or without fluorescence indicator
- **Aluminium oxide N**
  no binder, supplied without fluorescence indicator

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Aluminium oxide G	–	**816010.1**	**816010.5**
Aluminium oxide G/UV_{254}	UV_{254}	**816020.1**	**816020.5**
Aluminium oxide N	–	**816030.1**	**816030.5**

Polyamide

adsorbents for TLC

- Polyamide 6 = nylon 6 = perlon = ϵ-aminopolycaprolactame

Ordering information

Designation	Fluorescent indicator	1 kg
Polyamide TLC 6	–	**816610.1**
Polyamide TLC 6 UV_{254}	UV_{254}	**816620.1**

Cellulose MN 301

native fibrous cellulose

- fibre length (95%) 2 – 20 µm, average degree of polymerisation 400 – 500, specific surface acc. to Blaine 15000 cm^2/g
- **Cellulose MN 301:** native fibrous cellulose, standard grade
  ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P, CH_2Cl_2 extract ≤ 0.25%, residue on ignition at 850 °C ≤ 1500 ppm
- **Cellulose MN 301 HR:** fibrous cellulose, high purity grade, acid-washed and defatted
  ≤ 2 ppm Fe, 1 ppm Cu, CH_2Cl_2 extract ≤ 0.025%, residue on ignition at 850 °C ≤ 200 ppm
  recommended for quantitative investigations, e.g. for separation of carbohydrates with subsequent IR spectroscopy or separation of phosphoric acids, phosphates etc.
- **Cellulose MN 301 A:** special grade for the ^{32}P postlabelling procedure
  ≤ 20 ppm Fe, ≤ 6 ppm Cu, ≤ 7 ppm P, CH_2Cl_2 extract ≤ 0.01%, residue on ignition at 850 °C ≤ 500 ppm
  free of lactobacili contaminations; **not** impregnated with PEI, but designed for impregnation and coating by the user

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Cellulose MN 301	–	**816250.1**	**816250.5**
Cellulose MN 301 UV_{254}	UV_{254}	**816260.1**	**816260.5**
Cellulose MN 301 HR	–	**816270.1**	**816270.5**
Cellulose MN 301 A	–	**816300.1**	**816300.5**

Fluorescent indicators

- UV indicators with efficient radiation for short-wave as well as long-wave UV ranges
  UV_{254}: manganese activated zinc silicate with absorption maximum at 254 nm; green fluorescence; relatively susceptible towards acids; thus its fluorescence can be completely quenched by acidic solvents
  UV_{366}: inorganic fluorescent pigment with absorption maximum at 366 nm; blue fluorescence

Ordering information

	Composition	Absorption maximum	Colour of fluorescence	Pack of 100 g
Fluorescent indicator UV_{254}	manganese-activated zinc silicate	254 nm	green	**816710.01**
Fluorescent indicator UV_{366}	inorganic fluorescent pigment	366 nm	blue	**816720.01**