TECHNICAL INFORMATION

ILFOCHROME® MICROGRAPHIC

HIGH RESOLUTION DIRECT- POSITIVE COLOUR FILM BASED ON SILVER-DYE BLEACH TECHNOLOGY

ILFORD

1. Introduction

ILFOCHROME MICROGRAPHICS FILM, previously known as CIBACHROME MICROGRAPHICS FILM, is a direct-positive working colour material based on silver-dye bleach technology.

ILFOCHROME MICROGRAPHICS FILM is balanced for tungsten light. Due to its extremely fine grain it offers very high resolution and acutance. Its contrast and colour saturation are optimised for microfilming or reproducing copies from colour reflection originals such as maps, drawings, schematics, catalogues, prints, etc.

Two versions exist for specific applications: Type M and Type P which differ in contrast. Type M, a high contrast film, suitable especially for the reproduction of reflection originals whereas Type P, with a lower contrast value, is used for reproducing transparent originals or as a duplicating film.

Colour slides can be reproduced at original or reduced scale. For some critical applications and originals with a large tonal range it may be necessary to apply contrast masking.

ILFOCHROME MICROGRAPHICS FILM is available on 4-mil (0.10mm) and 7-mil (0.18mm) polyester base for high flexibility and excellent dimensional stability.

ILFOCHROME MICROGRAPHICS FILM is processed by the user in ILFOCHROME Process P-5. This relatively uncritical 3-bath process equal sequences for development, bleach and fix. Manual tank or dish processing as well as replenishment machine processing are possible.

In addition ILFOCHROME MICROGRAPHICS FILM offers extremely high archival stability resistance to light fading.

2. Applications

ILFOCHROME MICROGRAPHICS FILM finds its main application in microfilming of coloured reflection originals. Contrast and colour saturation have been adjusted to provide optimum results for this application.

The maximum density of approximately 2.2 was adjusted for optical viewing and overhead projection. Reproduced on ILFOCHROME MICROGRAPHICS FILM and viewed in projectors or microfiche readers sustain extremely long projection times due to the excellent resistance to fading. This in turn is due to the use of special image dyes typical for all ILFOCHROME products.

Reproduction of coloured catalogues onto microfiche is another frequent application of this product. The outstanding resolving power allows text and illustrations to be copied in one step. Artwork and colour line drawings are ideal originals to be reproduced in ILFOCHROME MICROGRAPHICS FILM.

Colour slide reproduction may require the use of a low-density contrast mask, depending on the tonal range of the original slide.

Resolution values with ILFOCHROME MICROGRAPHICS FILM surpass those normally obtained by conventional colour films. The limiting factor in many cases is the optical system.

The numerous applications for ILFOCHROME MICROGRAPHICS FILM can be summarised as follows:

- microreproductions of colour documents
- micropublishing
- catalogues
- educational materials
- medical illustrations
- maps
- drawings
- diagrams
- schematics
- advertising
- arial photography duplicates
- satellite images
- colour coded documents
- fashion designs
- annual reports
- lecture slides
- computer slides

3. Sensitivity and exposure

ILFOCHROME MICROGRAPHICS FILM is balanced for a colour temperature of 3200°K, i.e. for exposure with tungsten-halogen lamps. It must be handled in total darkness.

The appropriate effective speed is rated below 1 ASA. This relatively low speed value is due to the fact that ILFOCHROME MICROGRAPHICS FILM is a silver-dye bleach material where all dyes are incorporated in the emulsion layers during manufacture and to not have to be generated during processing. During exposure these dyes absorb part of the light. On the other hand, this layer structure accounts for the high acutance, the excellent archival stability and high resistance to light fading, characteristic of ILFOCHROME material.

In most cases only marginal filtration is required to match the original colours. In addition to colour filtration, a UV filter should always be used. When exposing with other light sources then tungsten-halogen, higher filterations may be required. Pulsed xenon light, for example, can be used with equal good results if the filtration is adjusted accordingly.

When reproducing originals of the size DIN A4 (8¼x11¾ inches) they should be illuminated with about 1500 - 2000 watts of tungsten-halogen light. For larger size originals the wattage should be increased proportionally.

Microfilm or microfiche cameras have to be equipped with a variable-speed shutter to allow for exposure time adjustment. Under the above-mentioned conditions, exposure times between ½ and 1 second are typical for reproducing a DIN A4 format to a 25x reduced microfiche format.

With the recommended exposure and illumination conditions the speed of this film is such that ideal exposure times results for all reproduction and duplication work.

When preparing masters for subsequent contact duplication onto the same film material, under-exposure of the master by ½ stop is recommended.

Reciprocity correction

As a guide, the following corrections for reciprocity failure should be made:

Exposure time (seconds)	c	½	2	8	32	256
Lens stop adjustment	0	0	+¼	+½	+¾	+1

Storage of unexposed material

All photographic materials undergo undesirable changes of their sensitometric characteristic if exposed to high temperature and humidity.

Where ILFOCHROME MICROGRAPHICS FILM is to be kept for short periods of up to two months, it should be stored away from chemicals and processing solutions in a well-ventilated room at a temperature not exceeding 20°C (68°F).

If the films are to be kept for longer periods, they should be stored at or below 10°C (50°F) in a refrigerator, or as low as -18°C (0°F) in a freezer.

Films that have been stored in a freezer or refrigerator must be allowed to equilibrate at room temperature before opening the sealed plastic envelope, in order to avoid condensation on the cold film. This adaptation takes 2 to 4 hours or longer, depending on the storage temperature. It is good practice to let the materials adjust to ambient temperature over night. Never try to accelerate the warming-up process by using a hot air drier or by placing the packs of cold film in a warm drying cabinet.

4. Processing

ILFOCHROME MICROGRAPHICS FILM can only be processed in ILFOCHROME Process P-5. Processing can easily be carried out by the user.

ILFOCHROME Process P-5 is suitable for manual processing in dishes, deep tanks or trays, as well as for machine processing. It is a 3-bath process consisting of developer, beach and fix, with equal treatment times for each of the three steps.

ILFOCHROME P-5 chemicals

KIT 5.5

This processing kit, containing concentrates to make 5 litres of working solution for the developer, bleach and fix is intended for start-ups and test in customer labs where the regular 20-liter size is too large and costly.

Composition of KIT 5.5

	Code	Part A	Part B	Part C
Developer for 5 litres	DE 5.5	1.25 litres	0.5 litre	-
Bleach for 5 litres	BL 5.5	0.5 litre	0.5 litre	0.5 litre
Fix for 5 litres	FX 5.5	2x 1.25 litres of concentrate		

Mixing instructions

Developer:

Prepare 3 litres of water. While stirring, add part A (1.25 L) and part B (0.5 L).
Add water to make 5 litres and stir to get a homogeneous solution.

Bleach:

Prepare 3 litres of water, add parts A, B and C in this order, add water to make 5 litres and stir to get a homogeneous solution.

Fix:

Prepare 2.5 litres of water, add the contents of the two bottles (2x1.25L) and stir to get a homogeneous solution.

Individual solutions:

For routine operations individual chemical concentrates to make 20 litres of each bath are supplied. These can be used for one-shot or total loss processing as well as for machine processing. In addition, replenish in a pack size to make 50 litres are available for economical and high-quality machine processing.

Solution	Code	Part A	Part B	Part C
Developer	DE 5.20	5 litres	2 litres	-
Bleach	BL 5.20	2 litres	2 litres	2 litres
Fix	FX 3.20*	10 litres	-	-
Developer Replenisher	DER 5.50	3x4.17 litres	5 litres	
Bleach Replenisher	BLR 5.50	5 litres	5 litres	5 litres
Fix Replenisher	FXR 3.50*	25 litres		

Mixing instructions

Developer and Developer replenisher:

Prepare 10 litres (replenisher: 25 litres) of water at 30 - 40°C. While stirring, add part A, then part B, complete with water to 20 litres, resp. 50 litres and stir to get homogenous solution.

Bleach and Bleach Replenisher:

Prepare 10 litres (replenisher: 25 litres) of water at 30 - 40°C. Add part A, B and C in this order, fill with water to 20 litres, resp. 50 litres and stir to get a homogenous solution.

Fix and Fix Replenisher:

Prepare exactly 10 litres (replenish: exactly 25 litres) of water, add an equal volume of fix concentrate, resp. replenisher concentrate and stir to get a homogenous solution.

Smaller volumes may be prepared as follows:

	To make 1 litre of solution, mix:			
	water	Part A	Part B	Part C
Developer and Developer Replenisher	650 ml	250 ml	100 ml	-
Bleach and Bleach Replenisher	700 ml	100 ml	100 ml	100 ml
Fix and Fix Replenisher	500 ml	500 ml	-	-

* For Process P-5 the fix and fix replenisher are identical with the corresponding solution of Process P-3: FX 3.20 and FXR 3.50 respectively.

Processing and replenishment

Processing sequence

	24°C/75°F	30°C/86°F
Development	4 minutes	2 minutes
Rinse	-	½ minute
Bleach	4 minutes	2 minutes
Rinse	-	½ minute
Fix	4 minutes	2 minutes
Final wash	4 minutes	2 minutes

The processing temperature of 24°C is primarily used for manual dish, tray or deep tank processing, whereas a temperature of 30°C is ideal for machine processing in terms of results and access time. Temperatures above 30°C/86°F are not recommended.

With processing drums or low throughput machines, one-shot or total loss processing is possible. When working with a high-throughput machine, replenishment is indicated. In this case, intermediate rinses of about 30 seconds are recommended between developer and bleach and between bleach and fix. This avoids excessive solution carry-over and keep the replenishment rates at a minimum.

Processor for the ILFOCHROME Process P-5 must be built according to the specification valid for all ILFOCHROME processes. This implies that all metal parts in the bleach tank must be made of a special grade stainless steel or preferably of titanium. Several manufacturers offer suitable machines which can be used as such for Process P-5 or which can easily be modified.

Replenishment rates for Process P-5

Solution	ml/m^2	per meter of 35 mm film	per meter of 105mm film
Developer Replenisher DER 5.50	400	14 ml	42 ml
Bleach Replenisher BLR 5.50	400	14 ml	42 ml
Fix Replenisher FXR 3.50	500	17.5 ml	52.5 ml

The data of this table should be taken as a guide. Due to differences in machine constructions, which may cause different oxidation rates, the actual necessary replenishment rates may vary slightly.

If the amount of CIBCHROME COPY paper processing (for re-enlargements, see chapter 8) surpasses 10% as compared to the volume of MICROGRAPHIC FILM, the replenishment rates should be readjusted to:

Developer Replenisher DER 5.50:	400 ml/m^2
Bleach Replenisher BLR 5.50:	200 ml/m^2
Fix Replenisher FXR 3.50:	250 ml/m^2

Process control with Control Strips TEST T5

Pre-exposed test strip, TEST T5, to control the process activity and the condition of the solutions, are available on 35 mm film strips of 30 cm length. Colour balance, contrast, D_{min} and D_{max} are measured from a grey step wedge.

To recognise early enough photographic problems due to processing a process control is necessary. This involves:

- daily processing of P-5 test strips TEST T5;
- densitometric evaluation of grey step wedge;
- graphic presentation of data on a control chart.

Charting the measured data permits early recognition of possible deviation and thus to take corrective measures before the quality of the processing begins to suffer. The ILFORD process control chart can be used to display the results of Process P-5.

From each grey step three density readings are obtained, i.e. through the blue, the green and the red filter. These values are then entered in the control chart and the corresponding points are connected by colour lines. The resulting curves demonstrates sensitometric trends as well as sudden changes, and they permit to react accordingly.

5. Handling of the chemicals

The developer and the fixer of the Process P-5 for ILFOCHROME MICROGRAPHIC FILM are very similar to the corresponding solution of black-and-white photographic process. Do not swallow these solutions, keep them out of reach of children. Avoid spilling and keep the processing equipment clean.

The developer is an alkaline solution, the bleach is strong acidic. Both solutions are harmful to the eyes, goggles are recommended, especially when handling the concentrates. If solution gets into eyes, wash immediately with plenty of running water (eyes have to be forced open), then seek medical attention.

If bleach gets onto skin or clothing, wash immediately with soap and water.

The ready-to-use working solution of the bleach solution contains about 3.4% of sulphuric acid, the concentrate part A about 29%. This acid must be neutralised before the exhausted bleach is discarded together with wastewater (provided the local laws allow this procedure). In a correctly replenished processor the overflows are automatically adjusted to provide a neutral effluent at a pH value of about 7.0. In tray processing, or when using total loss processor the solution can be neutralised by mixing equal volumes of exhausted developer and exhausted bleach solution. The resulting pH will be about 6.6 to 6.7. By adding 35 ml of Neutraliser NE-22 per litre of solution, a pH value of 7.0 is obtained.

When neutralising in an open container, a vessel with the double content of volumes of exhausted bleach and developer should be used because the mixture may effervesce. Pour the developer into the neutralising vessel, then add the bleach in small portions under constant agitation with a stirring rod. Harmless carbon dioxide gas is formed under effervescence. The solution should be allowed to react under occasional stirring for about one hour. Do not close the vessel. If the procedure is reversed, i.e. the developer is added to the bleach, less effervescence is produced, but there is a risk that, in addition to the harmless carbon dioxide, poisonous sulphur dioxide may be generated.

If there is no developer available to neutralise the bleach, neutralising chemicals can be added instead. Sodium carbonate (washing soda), sodium bicarbonate (baking soda) or the liquid Neutraliser NE-22 available from ILFORD can be added. These chemicals are added to neutralising vessel in place of the exhausted developer and the bleach is added as described above. When using the chemicals in powder form a reaction time of more then one hour may be required. The pH of the reaction mixture can be checked with commercially available pH paper and adjusted to pH 7.0 if necessary. To neutralise 1 litre of exhausted bleach the following amount of chemicals are necessary:

Sodium carbonate	60 to 70 g
or Sodium bicarbonate	100 to 120 g
or Neutraliser NE-22	300 ml

For reasons of environmental protection it is strongly recommended that the exhausted fix be treated in a silver recovery unit. The de-slivered fix can then be added to the other neutralised solutions. Under no circumstances must be mixed with un-neutralised bleach. This would generate large amounts of poisonous sulphur dioxide gas and precipitate of solid sulphur would form.

Waste solution data for ILFOCHROME Process P-5

Like all ILFOCHROME processes, Process P-5 comprises a developer which contains the ecologically well compatible developing agents hydroquinone and phenidone, and not a paraphenylenediamine derivative like the chromogenic developers.

The substance in the leach bath characteristics for ILFOCHROME processes is sulphuric acid. However, this acid is neutralised by the carbonate and sulphite of the developer, so that the machine effluent has a pH of 6.9 to 7.0 (the pH of the undiluted mixture of the bleach and the developer is 6.6 to 6.7).*

In the tables below, the composition of the individual bath overflows is listed. This may vary slightly, depending on the working conditions. About 10% of each overflow is carried-over directly into the wash water. The total water volume amounts normally to about 100 to 400 litres per square meter (9 to 37 litres per sq. ft.), depending on the machine load** (30 to 40 l/m^2 or 3 to 4 l/sq.ft. at hypothetical machine load of 100%). This large water volume is necessary for high archival stability.

In addition, the chemicals and biological oxygen demand, COD and BOD_5 respectively, are listed. This is a measure of the oxygen consumption, which is necessary to decompose the chemicals contained in the effluents.

The fixing bath can be de-silvered with the usual electrolytical silver recovery methods. On account of its high pH and high iodide content extremely low residual silver values of 2 to 20 mg/l, depending on the installation, are obtained. The electrolytical silver recovery is more efficient with ILFOCHROME fixers then with conventional black-and-white fixing baths.

Volume and composition of the various overflows

Developer:	
Volume per square meter	440 ml
Volume per square foot	41 ml
Carbonate ion	15 g/l
Sulphite ion	20 g/l
Hydroquinone	4 - 5 g/l
Hydroquinone sulphonater	1 - 2 g/l
Phenidone derivative	0.5 g/l
Antifogging agent	0.5 g/l
Water softening agent	4 g/l
Water miscible solvent	50 g/l
pH value	9.5

* For neutralising the bleach separately see preceding chapter: “Handling of the Chemicals”.
**Ration of the actual machine load to the theoretical possible load. In normal operation, the machine load is between about 10 to 25%.

Bleach bath:	
Volume per square meter	440 ml
Volume per square foot	41 ml
Sulphuric acid	35-40 g/l
Bisulphate ion	5-10 g/l
Aromatic nitro compound	2 g/l
Organic bleach catalyst	2 g/l
Organic anti-oxidant	3 - 6 g/l
Oxidised anti-oxidant	1 - 3 g/l
Iodide ion	10 g/l
Dyestuff fragments	< 1 g/l
Water miscible solvent	50 g/l
pH value	below 1

Fixing bath:	
Volume per square meter	540 ml
Volume per square foot	50 ml
Ammonium ion	55 g/l
Thiosulphate ion	190 g/l
Sulphite and bisulphite ion	20 g/l
Silver (in form of a thiosulphate complex)	4 - 5 g/l
Water softening agent	0.3 g/l
pH value	6.5

Wash water:	
Volume per square meter	100 - 400 litres
Volume per square foot	9 - 37 litres

Chemicals:

a) about 40 ml of each bath per square meter, before adding the solution overflows;
b) 440 ml of developer + 440 ml of bleach + 540 ml of fix per square meter after adding the solution overflows.

Chemical and biological oxygen demand:

Bath	COD	BOD_5
Developer DE-5	111 g O/litre	12-17 g O/litre
Bleach	112 g O/litre	about 1 g O/litre
Fix FX-5	112 g O/litre	about 2.5 g O/litre
Total wash water at 20% machine load	0.7-1 g O/litre	0.02-0.03 g O/litre
Total wash water per square meter	159 g O/litre	7-9 g O/litre
Total wash water per square foot	15 g O/sq.ft.	0.7-0.9 g O/sq.ft.

6. Sensitometric and physical data

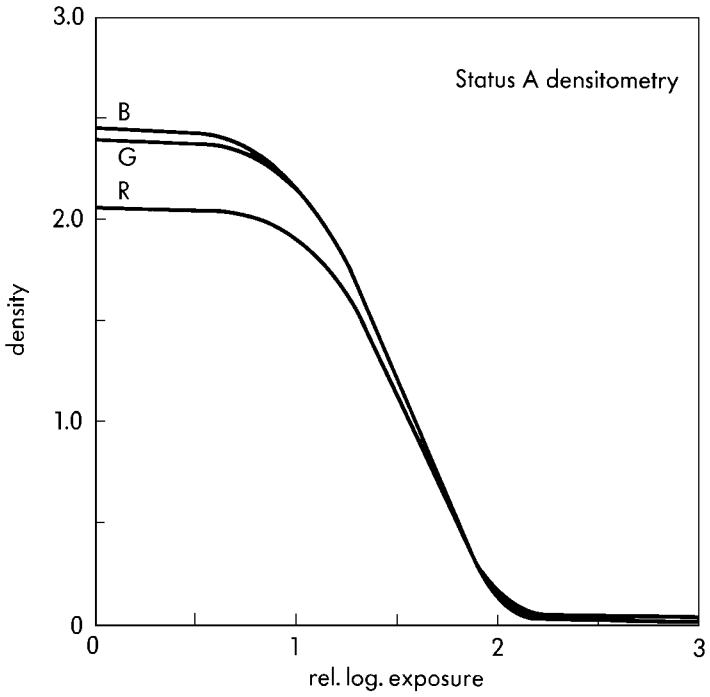
The following data and curves show typical results for ILFOCHROME MICROGRAPHIC FILM Type M and Type P, respectively, obtained by exposure with tungsten-halogen light and processing in Process P-5.

The sensitometric data may vary slightly from batch to batch. The data below can therefore not be interpreted as specification or standard which must be met by ILFORD. Product characteristic may be changed or improved at any time.

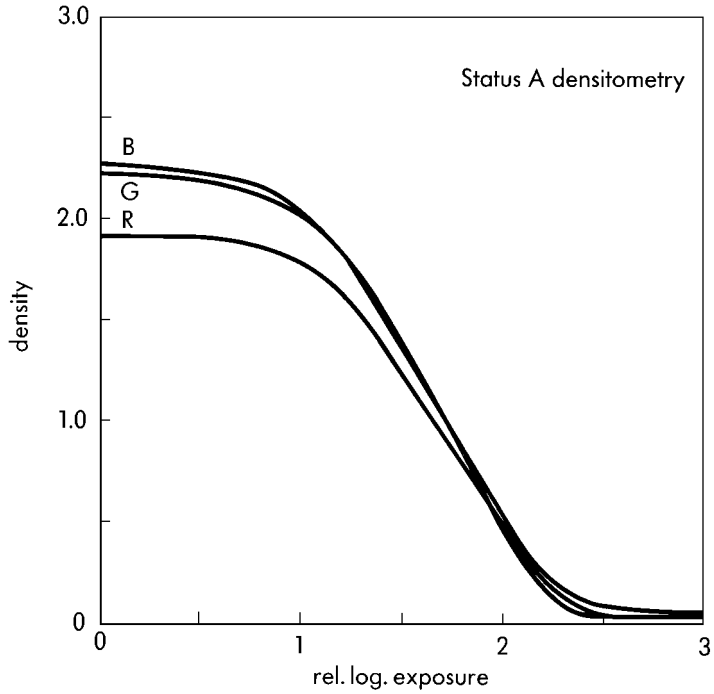
Practical applications under different conditions may also lead to slightly different results.

ILFOCHROME MICROGRAPHIC FILM	Type M	Type P
Effective speed at 3200°K	0.2-0.5 ASA	0.4-0.8 ASA
Resolving power (target contrast 1000:1)	365 lp/mm	325 lp/mm
Diffuse RMS granularity	6	9
Modulation transfer at 100 lp/mm	55%	53%
Maximum density	2.3	2.15
Contrast (midrange tonal reproduction)	2.0	1.4
Projector light fastness	Decrease of integral density at initial density D=1.0 is less then 3% after 10^7 lux-hours of continuous irradiation in a projector.	
Natural light fastness	Decrease of integral density at initial density D=1.0 is less then 0.2% units after exposure to radiant energy of $5x10^4$ joules/cm^2	
High temperature storage	After 300 days at 77°C/40% RH the density loss at initial density D=1.0 amounts to about 0.02 units, and the yellow stain increases by about 0.03 units	
Dimensional stability	The hysteresis of 0.10 mm (=4 mil) material after a humidity cycle of (40-90-40) percent RH amounts to 0.02%	

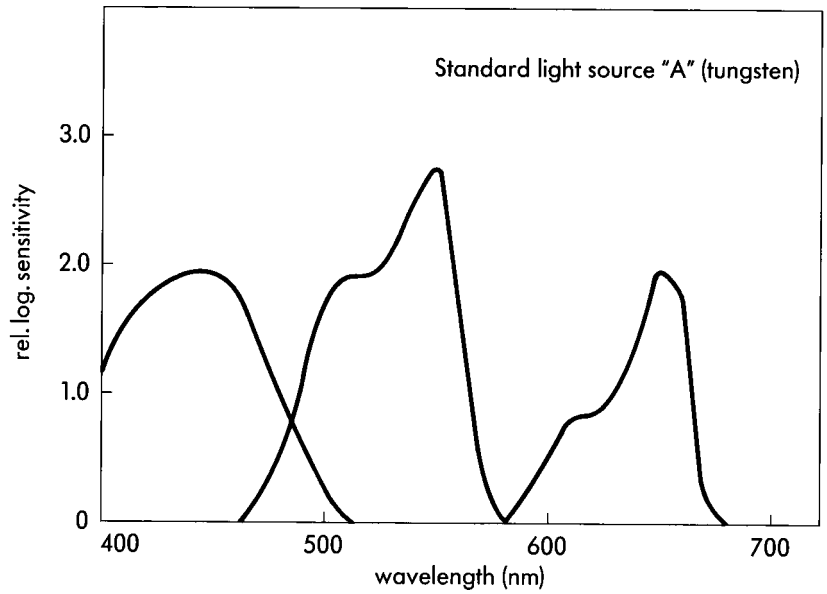
Characterisitc curves, Type M



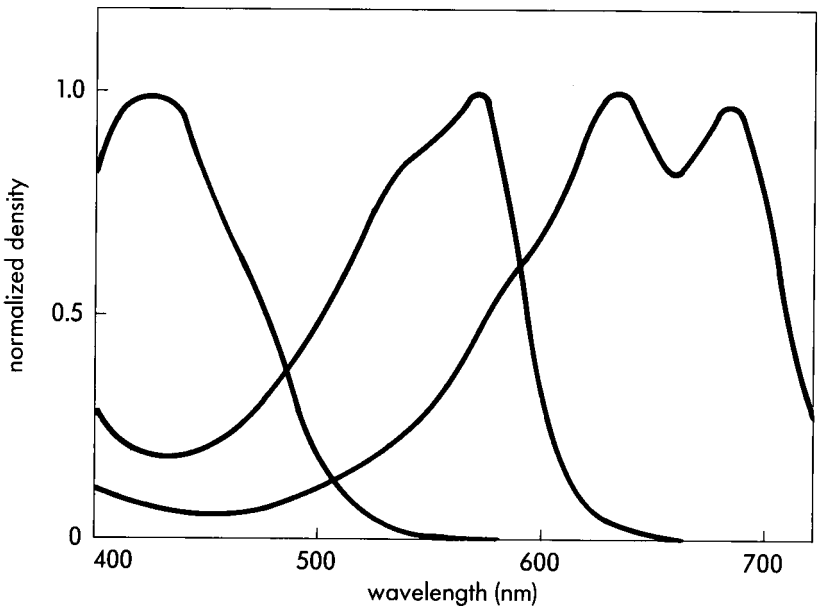
Characteristic curves, Type P



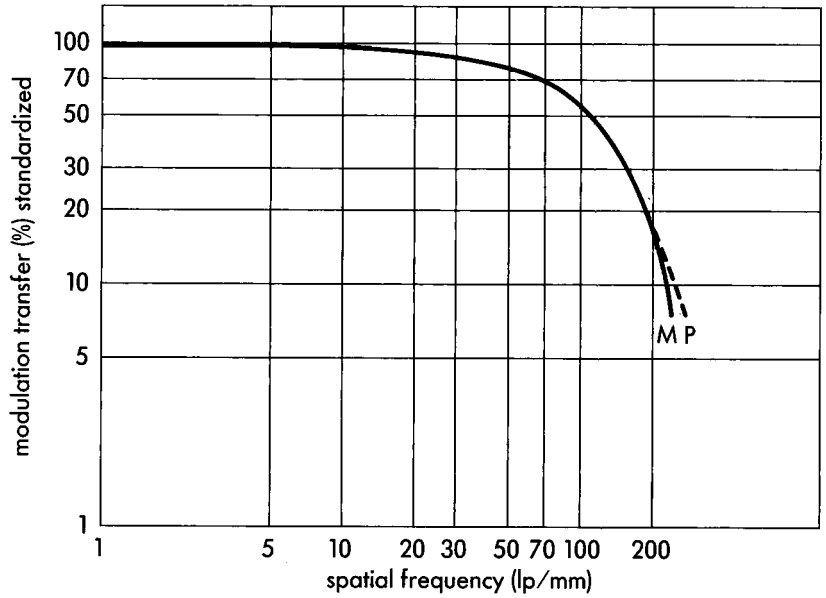
Spectral sensitivity (Type M and Type P)



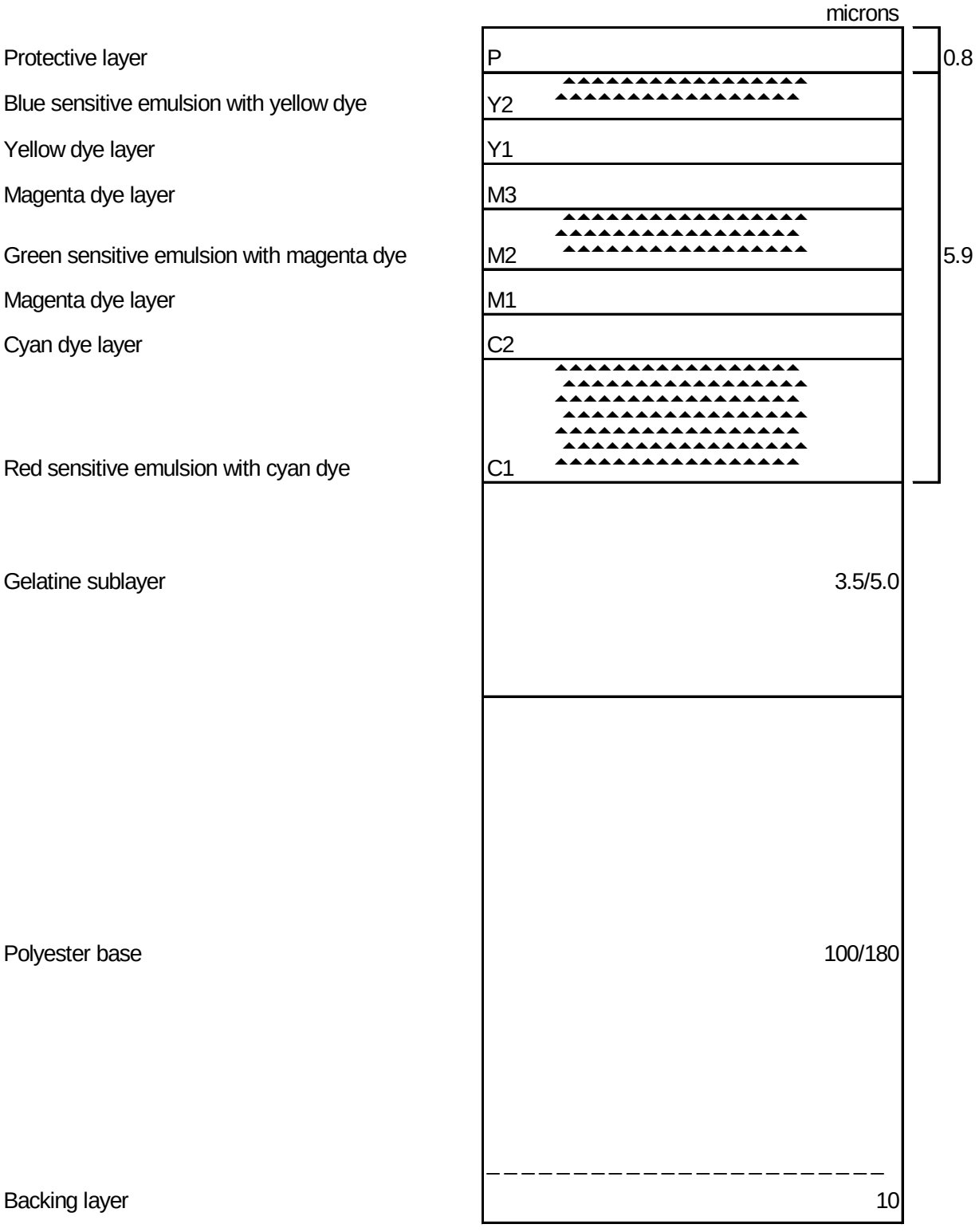
Spectral dye density (Type M and Type P)



Modulation transfer function



Schematic layer structure (Type M and Type P)



7. Availability

Light sensitive materials

Type M - CMM.F4	16 mm x 30 m	SP16 EI UP
	35 mm x 30 m	RKS30 EI UP
	35 mm x 30 m	RKS30 EI DPP
	35 mm x 100 m	CP2P EI DPP
	10.5 cm x 14.8 cm	50 (sheets)
	10.5 cm x 30 m	CC76 EI
Type M - CMM.F7	24 cm x 30 cm	50 (sheets)*
	21.0 cm x 29.7 cm	50 (sheets)*
Type P - CMP.F4	35 mm. x 30 m	RKS30 EI UP
	35 mm. x 30 m	RKS30 EI DPP
	35 mm. x 300 m	CP2P EI DPP*
Type P - CMP.F7	10.5 cm x 14.8 cm	50 (sheets)
	18 cm x 24 cm	50 (sheets)
	21.0 cm x 29.7 cm	50 (sheets)*

Abbreviatons:

RSK30 = 35 mm x 30 m spool
CP2P = 2-inch plastic core
CC76 = 76 mm iner diameter cardboard core
EI- Emulsion-in
EO- Emulsion-out
UP- Unperforated
DPP- Double Perforated
* Special Order only

Processing chemicals

KIT 5.5		
Developer DE 5.5		Parts A and B to make 5 litres
Bleach BL 5.5.		Parts A, B and C to make 5 litres
Fix FX 5.5		2x 1.25 litres to make 5 litres

Individual solutions		
Developer	DE 5.20	1 pack to make 20 litres
Developer replenisher	DER 5.50	1 pack to make 20 litres
Bleach	BL 5.20	1 pack to make 20 litres
Bleach replenisher	BLR 5.20	1 pack to make 20 litres
Fix	FX 3.20	10 litres to make 20 litres
Fix replenisher	FXR 3.50	25 litres to make 50 litres

Process control strips

TEST T5	35 mm x 30 cm	box of 30 strips

8. Re-enlargements

Re-enlarged prints from ILFOCHROME MICROGRAPHIC FILM can be produced on ILFOCHROME COPY paper.

Many applications require blowbacks from either 35 mm roll film or microfiche to the original scale. ILFOCHROME COPY Paper is suitable for this purpose. It is compatible with ILFOCHROME Process P-5, so that microfilm or microfiches as well as subsequent blowbacks can be processed in the same equipment.

The compatibility of these two product groups opens a wide variety of practical applications where storage in microform is required on the one hand and copies in the original scale are desired during subsequent steps.

Important:

ILFOCHROME COPY paper, normally processed in ILFOCHROME Process P-22, is compatible with Process P-5, but not vice versa.

ILFOCHROME MICROGRAPHIC FILM cannot be processed in ILFOCHROME COPY Process P-22, but only in Process P-5.