# TECHNICAL DATA SHEET
# MACO EM FILMS

SPI Supplies
206 Garfield Avenue,
West Chester, PA 19380, USA

## About MACO™ Electron Microscope Films

MACO™
PHOTO PRODUCTS

### Technical Data: Overview

| | |
|---|---|
| **Sensitization:** | Orthochromatic up to 595 nm |
| **Speed:** | Nominal speed ISO 25 @ 15°C |
| **Spectral sensitivity:** | up to 595 nm |
| **Electronic sensitivity:** | 20 x 200 KV |
| **Base material:** | Polyester, 175 µm, clear |
| **Safelight:** | Dark Red, 15W, distance 1.2 m |
| **Examples of acceptable filters:** | Kodak GBX-2, Kodak Red #2, Ilford Filter 906 |
| **Resolving power:** | 300 Lines/mm at nominal speed and a contrast of 1:1000. |

Effective speed and contrast can be varied according to the needs of the user by choosing the suitable developer and developing time.

### Exposure, speed and contrast considerations

**General comments:**

Although electron micrographs are made on conventional photographic material and like with conventional photographic images, a positive print is made from the negative image, some important differences remain between the production of negatives using light and that using electrons.

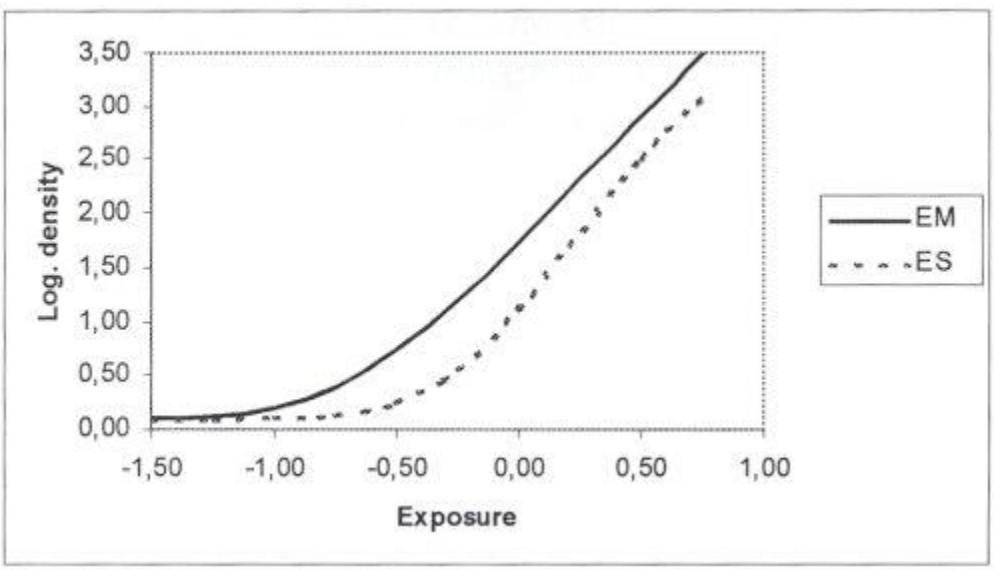
In conventional photography, the latent image on the film is produced by photons. For a silver halide crystal to become developable, it must usually be hit by 5 to10 photons.

For electron micrography, the situation is somewhat different. A single electron suffices to render up to 10 silver halide crystals developable. This difference is due to the different energies carried by a photon and an electron. While the typical photon in the visible light range carries an energy of about 2-3 electron volts (eV), an electron in an electron microscope carries about 50 to 100 KV, i. e., 25,000 to 35,000 time this energy. The film, accordingly will behave differently. While image noise, which is the pendant to grain in conventional photography, is essentially determined by the size of the silver halide crystals in conventional photography, it is determined by statistical fluctuations of electron beam intensity in electron micrography. The actual image signal, i.e. the useful information, increases as a linear function of exposure. Image noise, on the other hand, increases as the square root of exposure. This gives rise to some conclusions with regard to the best possible image quality, or best possible signal-to-noise ratio.

If the required image density and contrast are achieved by prolonging development, the signal-to-noise ratio is not improved, noise being amplified by the same factor as the useful signal. However, statistical fluctuations, the cause of the noise signal, become less significant as the number of electrons increases. Increasing the number of electrons, or increasing the sampling rate, therefore, results in a decrease of image noise and an improvement of detail resolution. A further factor of influence on the choice of exposure is the stability of the sample. Where the (in-)stability of the sample forbids extended exposure, reducing the device magnification (magnification of the microscope proper) and achieving the required magnification of the final print by optically enlarging the negative can be one way of improving image quality. Reducing the device magnification means that for the same exposure of the sample, more electrons are available for a unit of negative area. Consider, for example, a final magnification of 80, achieved, on the one hand, by using a device magnification of 80, and, on the other hand, by using a device magnification of 20 and optical enlarging of the negative by a factor of 4. Exposure may be as long as it takes in the case of a stable sample, and in that case, the first method would lead to optimum results. In the case of an unstable sample, allowing only limited exposure to electrons, however, a lower device magnification followed by optical enlarging, would yield better results.

This shows that films used for electron micrography must comply with different requirements than conventional photographic material. In particular, it must be possible to achieve similar values of density and contrast by pursuing different approaches (either weak exposure followed by energetic development or strong exposure followed by reduced development) determined according to the requirements of the sample.

## Curves: Log. Density vs. Exposure




## Processing

**Developers and Developing Times**
MACO EM and ES films can be developed in all commercially available developers. Electron micrography films will preferably be developed in high-energy developers. We recommend LP-

DOCUFINE HC and Kodak D-19, but also Ilford ID-11 and Kodak D-76. The following developing times are for guidance, serving as starting values for your own optimization. Due to the specifics of processing, the end user may have to adapt these values to meet specific needs.

| Developer | Developing time (min) |
| --- | --- |
| LP-SUPERGRAIN 1+9 | 5 |
| LP-DOCUFINE HC 1+7 | 4-5 |
| Kodak D-19 1+2 | 4 |

**Stop Bath**

The stop bath primarily serves to neutralize any alkalinity retained by the film in order to prevent a loss of fixing-bath activity due to increasing pH values. The following stop bath concentrates are recommended. On the other hand, Kodak® fixer should work just as well:

| Stop Bath | Time (min) |
| --- | --- |
| LP-CITRIN 1+19 | 1 |
| LP-CITRODUR 1+16 | 1 |
| LP-ECOSTOP 1+7 | 1 |

Where a stop bath is not used, two intermediate washing cycles of 30 s each, at 20°C (68°F) and permanent agitation, are recommended to avoid the carryover of developer into the fixing bath.

**Fixing**

For fixing MACO EM and EMS films we recommend LP-FIX SUPRA at a dilution of 1+7 to 1+9. This is a modern high-performance fixing bath on the basis of ammonium thiosulphate. The necessary fixing time can be found by determining the clearing time (fixing time = twice the clearing time). Where clearing time is not determined, fixing for three minutes in fresh fixing bath at 20°C is recommended.

**Washing**

Ensure that the water-supply temperature is approximately 20°C. Washing for 5 min in running water is then sufficient.

**Wetting Agent**

A final bath in demineralized, deionized, or distilled water (battery water) is recommended in order to avoid drying marks caused by water hardness and to reduce static charges. Static charges will cause the film to attract dust particles which will show as white spots on positive copies. It is recommended to use LP-MASTERPROOF 1+200 to 1+100 for one minute, without agitation. (This will avoid the formation of foam, see below.)

Overdosing wetting agents must be avoided. Wetting-agent solutions can only be re-used if several films are processed in one session. Foam tends to stick to the film surface and will hardly run off. Therefore, avoid foam formation when preparing wetting-agent solutions by adding the water slowly. Kodak® Photo-Flo 200 Solution should work quite nicely on both the MACO EM as well as the ES film.

**Drying**
Squeegeeing films is not advised as there is a great chance of scratching negatives. Following the wetting-agent treatment, try to shake off as much of the surface water as possible. Then hang the film to dry in a dust-free environment for several hours, e.g. over night. When drying films in a drying cabinet, it is recommended not to activate the heating. Drying using a hairdryer is not recommended, as, lacking a particle filter, hairdryers will tend to blow dust particles onto the wet, and still sticky surface of the film. Particles adhering to the film like that are difficult to remove without afflicting damage to the film.

**Note #1:**
After processing a more or less magenta to reddish tint appears on the film. This slight haze has no influence on the photographic parameters and will not manifest itself when a print is made from the negative. The reddish tint will disappear within minutes under sunlight or after a short time under daylight or UV light.

**Note #2:**
After processing a greyish haze can appear on the film. Reasons: The distance to the safelight was less than 1.2 m or the safelight was red/orange/yellow. Another reason could be that after the passing of years, there can be some deterioration of the organic pigments that are used in the making of the safelight filters and a new one should be obtained. To improve results: Control the power/watts to the safelight, perhaps with a dimmer switch and make certain that the distance is never less than 1.2 m. Make sure the film developer is up to acceptable strength. If the slight haze does not disappear also be using fresh photo chemistry, the concentration should be increased respectively and the developing time extended.

## Storage of exposed and unexposed film

As with all photographic materials, film should not be exposed to direct sunlight, intense heat,or high humidity.

For long term storage of film, refrigeration is recommended. Before using film that has been stored under refrigeration, allow the film to come to room temperature before removing the film from the package and exposing it to ambient air. If the film is considerably colder than the ambient air, humidity may condensate on the film.

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