TENTATIVE DATA*

data release

P-311

Kodak Holographic Plate, Type 120-02, and *Kodak* Holographic Film (*Estar* Base) SO-173

DESCRIPTION

These holographic recording materials share a microfine-grain emulsion with excellent dimensional stability, improved speed-grain ratio, and high sensitivity in the 600- to 750-nanometer region. They are recommended for conventional side-referenced holography and related techniques involving exposure with helium-neon, krypton, and ruby lasers.

When compared with KODAK Spectroscopic Plate and Film, Type 649-F, these products offer the following improvements:

- Finer grain
- Lower reconstruction noise
- Comparable reconstruction ratio
- 2 to 4X higher speed at 633 nm
- Considerably higher speed at 694 nm
- High dimensional stability

APPLICATIONS

- 3-D holographic displays
- Holographic interferometry
- Holographic information storage
- Spatial filters (plates)
- Holographic microscopy

PHOTOGRAPHIC AND PHYSICAL PROPERTIES

Spectral Sensitivity

Double-peaked sensitivity at approximately 640 and 710 nm provides excellent response to such laser emissions as: He-Ne (633 nm), krypton (647 nm), and ruby (694 nm). High inherent sensitivity in the blue-UV region may make these materials useful also for applications involving He-Cd lasers (442 nm). Type 120-02 Plates have been used successfully in specialized procedures involving exposure with ruby lasers — both direct and doubled, i.e., at 694 and 347 nm.

Speed Characteristics

The effective speeds of KODAK Holographic Plate, Type 120-02, and KODAK Holographic Film SO-173 are dependent upon both processing time and laser wavelength. Therefore, it is impractical to recommend a single exposure that leads to maximum reconstruction ratio. For this reason, we suggest that you derive from the spectral sensitivity curve an approximate exposure value for the wavelength of interest and then use this value as midpoint for an exposure series, using the processing conditions you have elected to follow. (See "PROCESSING" on page 3.)

Like most microfine-grain materials, these products exhibit significant latent image fading during the first few hours after exposure, resulting in a loss in speed. Because of this, the time between exposure and processing should be held to a minimum. When making an exposure series, the interval between exposing and processing test samples should be held constant, and the time interval should be comparable to that which would prevail during normal operations. For example, a plate that is optimally exposed for processing a half hour later will be grossly underexposed if processing is deferred until the next day.

Image Structure Characteristics

Like KODAK Spectroscopic Plate and Film, Type 649-F, the Type 120-02 Plate and SO-173 Film are among the finest grain photographic products commercially available. Micrographic analysis reveals that these holographic materials contain silver halide grains measurably smaller than those in Type 649-F emulsion. A comparison of granularity values based on classical methods for measuring rms granularity is not a reliable indicator of holographic system performance.

* This information is based upon limited testing, is subject to change, and is intended only as a guide or starting point for using the product described. The information has been carefully prepared and is believed to be accurate at the time of publication.

Similarly, resolving power values determined by conventional means do not provide a reliable indicator of holographic resolving power. See the discussion on resolving power in Kodak Pamphlet No. P-110, a copy of which may be obtained by writing to Scientific Photography at the address shown on the last page of this pamphlet.

Emulsion Thickness and Stability

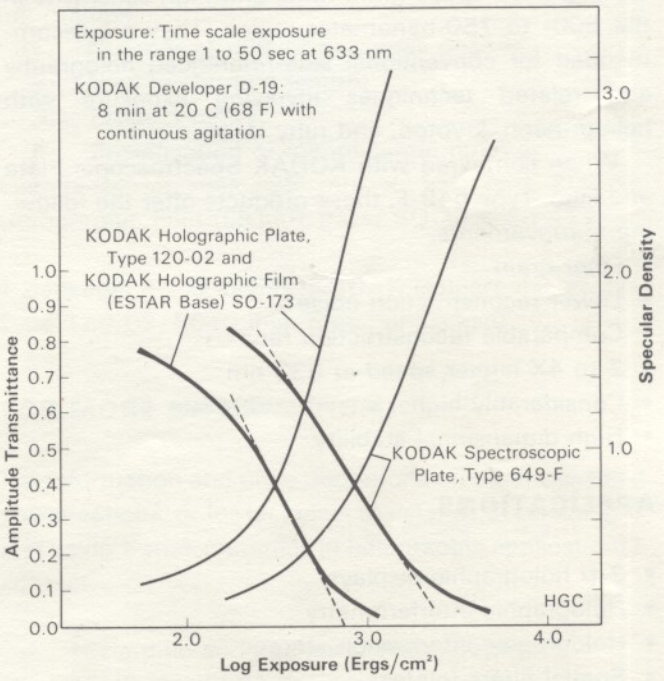
The nominal emulsion thickness before processing for both the Type 120-02 Plate and SO-173 Film is 6 μm. This is approximately the same as for Type 649-F *Film* (7 μm) but substantially lower than for Type 649-F *Plates* (17 μm).

Most photographic emulsions tend to shrink during processing. This shrinkage results from the removal of unexposed silver halide grains and from tanning of the gelatin. In addition to a decrease in average emulsion thickness, the emulsion tends to shift toward the center of the plate or film. Both changes can be especially troublesome in holography.

In certain modern emulsions, however, the gelatin can be stabilized to significantly reduce shrinkage. Such a technique has been used in manufacturing the plate and film described in this pamphlet. The combination of a relatively thin, low-shrinkage emulsion layer and either of two very dimensionally stable supports — glass plates or Estar base — has resulted in two holographic products with substantially improved stability characteristics.

NOTE: The curves shown for these holographic emulsions were plotted from single-test data; those shown for Type 649-F Film are believed representative of average product. Variations in speed and contrast between film and plate products of the same type, differences between production lots of a particular product, or differences resulting from processing variables may yield an effective speed ratio at any given wavelength greater or less than that depicted. While the curves are intended to illustrate the relative merits of the two emulsion types and to provide a guide for initial exposures of one product based on experience in use of the other, we strongly recommend that you run an exposure series to determine the optimum operating point for a particular product under your exposure and processing conditions.

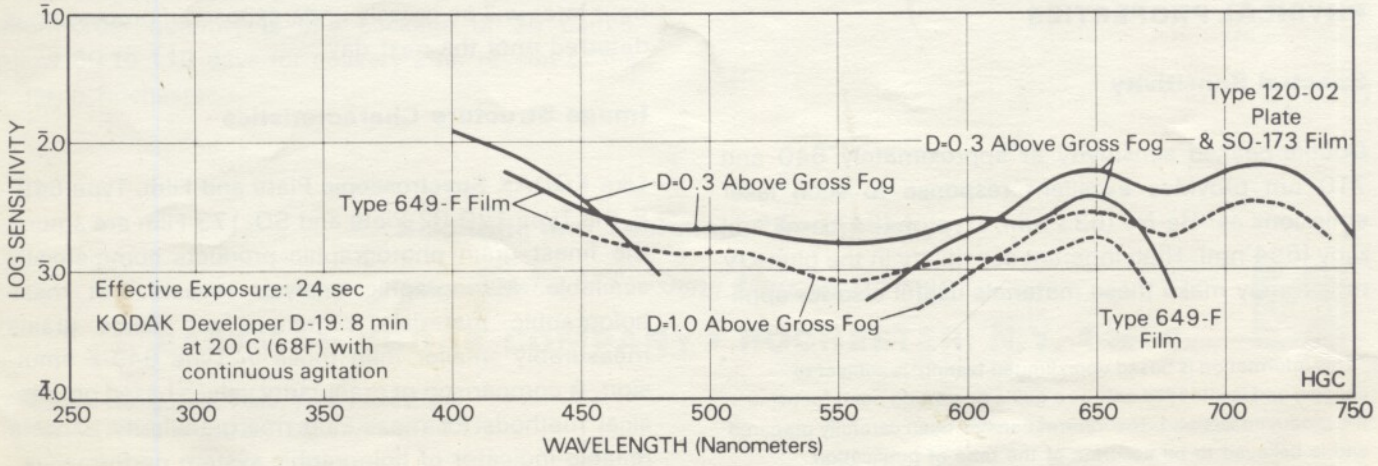
AMPLITUDE TRANSMITTANCE — D-LOG E CURVES



KODAK Spectroscopic Film, Type 649-F

SPECTRAL SENSITIVITY

KODAK Holographic Plate, Type 120-02, and KODAK Holographic Film (*Estar* Base) SO-173



Sensitivity is defined as the reciprocal of exposure, in ergs/cm², required to produce a density (D) above gross fog when the material is processed as recommended.

Base Materials

Unless otherwise specified, KODAK Holographic Plate, Type 120-02, will be supplied on .040-inch standard flatness glass *without antihalation backing.* Requirements for Type 120 Plates on glass of other thickness, of higher quality, or with antihalation backing (designated Type 120-01 Plate) should be reviewed with a Kodak Technical Sales Representative or Product Specialist familiar with plate specifications and the Type 120 product in particular.

KODAK Holographic Film SO-173 is furnished on .004-inch Estar polyester support with a dyed antihalation gel backing. The dye bleaches readily during development, leaving a clear gel pelloid on the back of the film base. This results in minimum curl of the film when handled in sheet form.

Safelight

Total darkness required. While these materials are very slow by conventional photographic standards, it is recommended that they be handled in total darkness. The practicality of using a KODAK Safelight Filter No. 3 (dark green) or a No. 7 (green) after development is half completed has not been evaluated by Kodak.

Storage Recommendations

For best storage, keep unopened packages of plates or film in a cool place, preferably 21°C (70°F) or below. For extended storage, unopened packages may be kept in a refrigerator at 5 to 10°C (41 to 50°F). If stored in a refrigerator, remove packages at least 3 hours before opening in order to avoid condensation on the emulsion surface. Freezing is not recommended.

PROCESSING

Careful attention should be given to proper processing techniques. While exposure conditions can be varied to achieve good holographic performance over a relatively broad range of development, it is generally advantageous to standardize on processing conditions —developer condition, time, temperature, and agitation — in order to minimize the effects of processing variability.

Uniform agitation during development, in both manner and amount, is especially important. For a complete description of agitation techniques for processing plates and films, see *Processing Chemicals and Formulas,* Kodak Publication No. J-1. We also recommend *Practical Processing in Black-and-White Photography,* Kodak Publication No. P-229. These publications are available from photo dealers.

Processing Procedure

Develop: These holographic materials in KODAK Developer D-19, or equivalent, for 5 to 10 minutes at 20°C (68°F) with continuous agitation. (Development for 10 minutes yields higher speed than does development for 5 minutes although a moderate increase in noise may be expected upon reconstruction.)

Rinse: In running water or with agitation in KODAK Indicator Stop Bath, or equivalent, at 18.5 to 21°C (65 to 70°F) for 30 seconds.

Fix: With frequent agitation in KODAK Fixer, KODAK Fixing Bath F-5, or equivalent, for 5 to 10 minutes at 18.5 to 21°C (65 to 70°F).

Wash: With moderate agitation for 15 minutes at 18.5 to 21°C (65 to 70°F). A more rapid wash can be achieved by using a clearing agent such as KODAK Hypo Clearing Agent. Used after recommended fixing, Hypo Clearing Agent reduces washing time and conserves water. First, remove excess hypo by rinsing the film or plate in water at 18.5 to 21°C (65 to 70°F) for 10 seconds. Then bathe the film or plate in Hypo Clearing Agent solution for 15 seconds with moderate agitation. Follow this with a 30-second wash at 18.5 to 21°C; allow at least one change of fresh running water during this time.

NOTE: For highest quality holograms, keep all processing solutions, including the wash water, at the same temperature. In this way, image movement due to random shifts in the emulsion layer as the gelatin alternately swells and shrinks during processing will be minimized.

Dry: In a dust-free atmosphere. Drying marks can be minimized by treating the plates or films in a water bath containing a wetting agent such as KODAK PHOTO-FLO Solution after washing, or by wiping the surfaces carefully with a soft, viscose sponge or a damp KODAK Photo Chamois, The use of PHOTO-FLO Solution will also aid in the uniform drying of plate and film surfaces. For best results, dry the plates or film slowly at room temperature.

Special Processing Notes:

1. *Do not use KODAK HRP Developer.* This developer, which is frequently used for processing KODAK High Resolution Plates and other extremely fine grain materials, is specifically *not* recommended for use with the Type 120 Plates or SO-173 Film.
2. The emulsion used in these products exhibits a pale-green residual dye stain following normal processing. This stain can be reduced significantly by bathing the hologram for 1 to 3 minutes in 75 percent methanol or certain other alcohols following the normal wash. For more information, see Coblitz and Carney, "Dye Removal from Holographic Films," *Applied Optics,* 13, No. 9, September 1974, 1994.
3. The reversal bleach process for generating phase holograms (described in Kodak Pamphlet No. P-230) was optimized for use with Type 649-F Plates. Experience indicates that it works well with the Type 120/SO-173 emulsion only with modifications which vary with the end usage of the hologram. For a convenient bleaching process reported to work efficiently with these products, see A. Graube, "Advances in Bleaching Methods for Photographically Recorded Holograms," *Applied Optics,* 13, No. 12, December 1974, 2942.

SIZE DATA AND ORDERING INFORMATION

KODAK Holographic Plates, Type 120-02, are stocked in Rochester in the size most commonly specified by holographers: 4 x 5 inches. The minimum order quantity is one package of 36 plates.

NOTE: KODAK Holographic Plate, Type 120-01, *with* an antihalation backing, is also available. This backing is designed to be especially effective at 633 nm. Type 120-01 Plates are not stocked; they are produced only upon receipt of a customer order. The minimum-order quantity is one package of 36 plates. Allow 60 to 110 days for delivery after receipt of the order in Rochester.

KODAK Holographic Film (ESTAR Base) SO-173 is stocked in two formats:

4 x 5-inch sheets (25 sheets per package). Minimum order quantity is one package.

35 mm x 150-foot rolls, Sp 417. (Bell and Howell perforations on two edges, wound emulsion in on a No. 10 spool with integral leader and trailer.) Minimum order is one roll.

These products must be ordered through your local photo dealer for professional photographic materials or through dealers who specialize in serving the holographic market. When ordering, include the following information:

1. Number of rolls or packages desired
2. Size (width and length)
3. Product name
4. Specification or identification number

Examples: 2 rolls, 35 mm x 150 feet KODAK Holographic Film (ESTAR Base) SO-173, Sp 417

1 package, 4 x 5 inches, KODAK Holographic Plates, Type 120-02, (.040-inch glass, unbacked)

FOR MORE INFORMATION

For information and price quotations on other sizes and specifications, or for technical assistance in selecting and using Kodak materials in holographic applications, contact:

Scientific and Technical Photography
Eastman Kodak Company
343 State Street
Rochester, New York 14650
Telephone: (716) 724-4345

Scientific and Technical Photography

Professional and Finishing Markets Division

EASTMAN KODAK COMPANY • ROCHESTER, N.Y. 14650

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