

Bayfol® HX121

Description and Application Information

Bayfol® HX121 is a light-sensitive, self-processing photopolymer film which can be used to manufacture reflection and transmission volume-phase holograms. Bayfol® HX121 film can be recorded with appropriate laser light within the spectral range of 440 nm to 680 nm.

Bayfol® HX121 film consists of a three layer stack of a substrate, the light-sensitive photopolymer and a protective cover film. A triacetate (TAC) substrate and a polyethylene terphthalate (PET) protective cover film are used.

Preliminary guide data

General properties

Property	Value	Unit of measurement	Method
Typical substrate thickness	60	microns	acc. to ISO 4593, 23°C
Typical photopolymer thickness	30	microns	IR Interferometer
Typical cover layer thickness	50	microns	acc. to ISO 4593, 23°C

Optical properties

Property	Value	Unit of measurement	Method
Transmittance (Unrecorded film, w/o cover foil)	See Annex graph 1, for details of the transmittance spectrum	%	ASTM E 01348

Holographic Performance Data:

Reflection Holograms in 2-Beam

Geometry

Property	Value	Unit of measurement	Method
Maximum refractive index modulation Δn_1 per recording wavelength λ			acc. to ISO 17901-2
$\lambda = 633 \text{ nm}$	> 0.04		
$\lambda = 532 \text{ nm}$	> 0.04	mJ/cm ²	
$\lambda = 457 \text{ nm}$	> 0.04		
Typical recording dosage needed to achieve above Δn_1 values	See Annex graph 2, for details of the recording dosage	mJ/cm ²	

Reflection Holograms in 2-Beam Geometry

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In this recording geometry the photopolymer film is laminated onto a glass plate (75 mm x 50 mm x 1 mm).

The holographic recording is done with two coherent and collimated laser beams (plane waves), which penetrate the prepared sample from its two different surfaces. Both laser beams have S-polarization to maximize the interference contrast (fringe visibility) of the holographic recording.

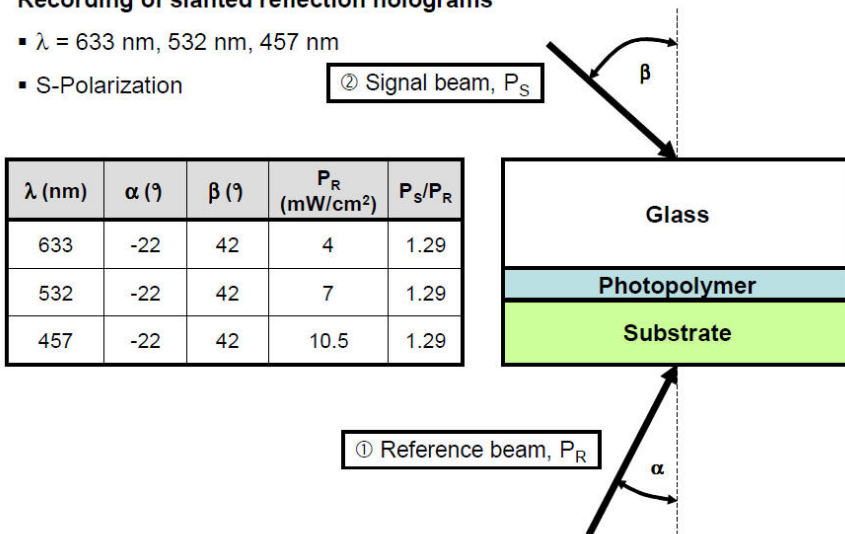
The holographic recording itself is done with dosages which correspond to the product of the total incident power density ($P_R + P_S$) multiplied by the individual exposure times, t . More detailed conditions are depicted in the two following figures.

The ratio (P_S / P_R) = 1.29 compensates for the different size of the projected beam cross sections onto the sample surfaces and the different losses due to Fresnel reflections at the air sample interfaces in such a way that inside the photopolymer layer the beam ratio is equal to 1. This again facilitates maximum fringe visibility during the holographic recording.

After the holographic recording, the material is bleached using a dosage of approx. 5 J/cm² in the UV spectral range and simultaneously approx. 5 J/cm² in the visible spectral range.

Recording of slanted reflection holograms

- $\lambda = 633 \text{ nm}, 532 \text{ nm}, 457 \text{ nm}$
- S-Polarization



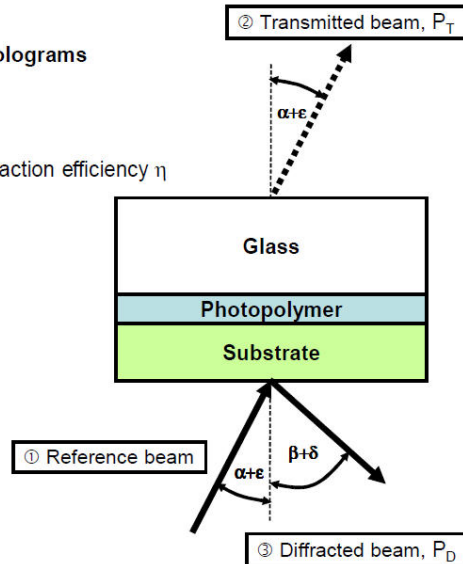
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Readout of slanted reflection holograms

- $\lambda = 633 \text{ nm}, 532 \text{ nm}, 457 \text{ nm}$
- S-Polarization
- Adjust ϵ and δ for maximum diffraction efficiency η

$$\eta = \frac{P_D}{P_T + P_D}$$

λ (nm)	α (°)	β (°)
633	-22	42
532	-22	42
457	-22	42



To determine the performance of the hologram, the diffraction efficiency η of the recorded hologram is measured with respect to the rotation angle α (the holographic film / glass sandwich is mounted on a rotation stage). The resulting Bragg curve $\eta(\alpha)$ is analyzed according to the Kogelnik theory*, to deduce the performance parameters η_{\max} , Δn_1 and the effective thickness shrinkage. The effective thickness shrinkage is obtained from the angular shift ϵ , which measures the deviation from the recording angle α to the angle at which η_{\max} is achieved. This thickness shrinkage is incorporated in the fit of Δn_1 according to Kogelnik theory.

The mean refractive index used for the calculation is 1.51.

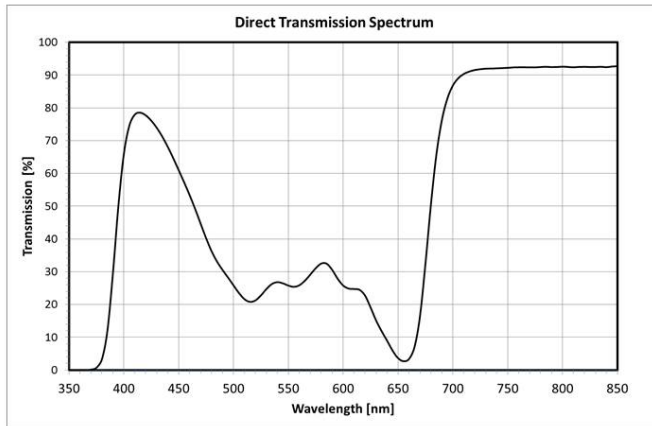
By varying the recording times the dosage response curves for Δn_1 at the different recording wavelengths, $\lambda = 633 \text{ nm}, 532 \text{ nm}$ and 457 nm , can be obtained.

Source: *Kogelnik, H., "Coupled wave theory for thick hologram gratings", The Bell System Technical Journal 48(9), 2909-2947 (1969)

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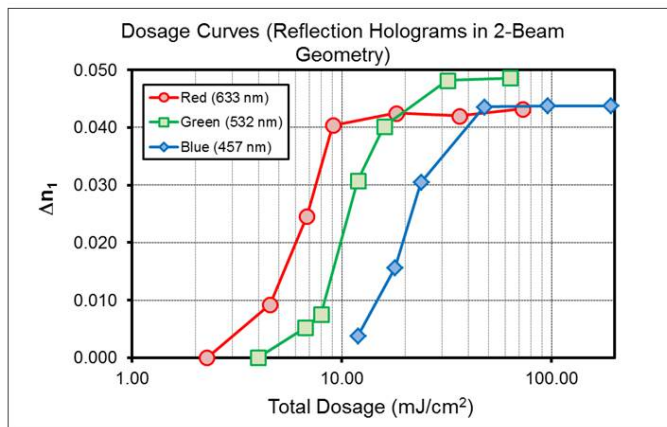
Graph 1: Transmittance

Graph 1



Graph 2: Index Modulation

Graph 2



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Storage conditions

The unrecorded photopolymer film should be stored in the original and sealed Covestro packaging that is used for delivery.

The unrecorded photopolymer film should be protected from light, humidity, heat, foreign materials and compressive load.

Recommended storage temperature: +15 °C to +25 °C.

Recommended relative humidity 45 % to 55 %

Storage time

Storage time 6 month.

Labeling and REACH applications

This product data sheet is only valid in conjunction with the latest edition of the corresponding Safety Data Sheet.

Any updating of safety-relevant information – in accordance with statutory requirements – will only be reflected in the Safety Data Sheet, copies of which will be revised and distributed. Information relating to the current classification and labeling, applications and processing methods and further data relevant to safety can be found in the currently valid Safety Data Sheet.

The manner in which you use and the purpose to which you put and utilize our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations, are beyond our control. Therefore, it is imperative that you test our products, technical assistance, information and recommendations to determine to your own satisfaction whether our products, technical assistance and information are suitable for your intended uses and applications. This application-specific analysis must at least include testing to determine suitability from a technical as well as health, safety, and environmental standpoint. Such testing has not necessarily been done by Covestro. Unless we otherwise agree in writing, all products are sold strictly pursuant to the terms of our standard conditions of sale which are available upon request. All information and technical assistance is given without warranty or guarantee and is subject to change without notice. It is expressly understood and agreed that you assume and hereby expressly release us from all liability, in tort, contract or otherwise, incurred in connection with the use of our products, technical assistance, and information. Any statement or recommendation not contained herein is unauthorized and shall not bind us. Nothing herein shall be construed as a recommendation to use any product in conflict with any claim of any patent relative to any material or its use. No license is implied or in fact granted under the claims of any patent.

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(1) Please see the "Guidance on Use of Covestro Products in a Medical Application" document.

(2) As defined in Commission Regulation (EU) 1935/2004.

This is a trial product. Further information, including amended or supplementary data on hazards associated with its use, may be compiled in the future. For this reason no assurances are given as to type conformity, processability, long-term performance characteristics or other production or application parameters. Therefore, the purchaser/user uses the product entirely at his own risk without having been given any warranty or guarantee and agrees that the supplier shall not be liable for any damage, of whatever nature, arising out of such use. Commercialisation and continued supply of this material are not assured. Its supply may be discontinued at any time.

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