# Bayfol® HX202

## Product description

Bayfol® HX202 is a light-sensitive, self-developing photopolymer film. It comprises a three-layer stack: A cellulose triacetate film (TAC) substrate, a light-sensitive photopolymer layer, and a polyethylene film (PE) protective cover. The PE cover can be removed from the photopolymer layer.

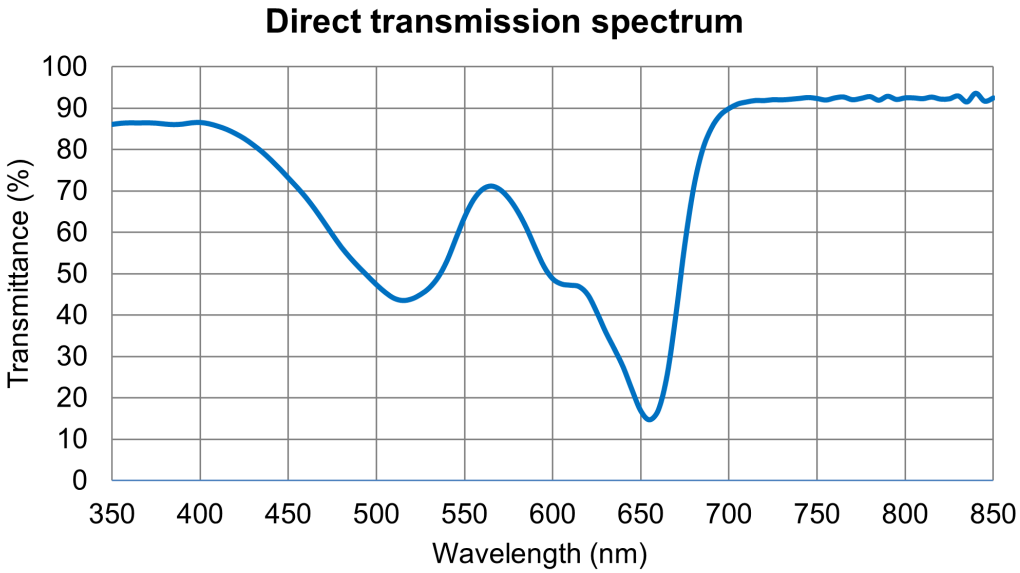
## Applications

Bayfol® HX202 is used for producing phase holograms, specifically volume reflection holograms and volume transmission holograms. The product is applicable to various types of volume holograms. Its self-developing property and the ability to record across a range of visible light wavelengths make it suitable for different holographic applications in both research and industrial settings. Bayfol® HX202 is designed to be recorded with laser light within the visible spectral wavelength range of 440 nm to 680 nm. For the formation of the hologram no further post treatment is necessary (i.e. neither wet nor thermal treatment).

## Typical Values

| Typical Stack Composition: | | | | |
|---|---|---|---|---|
| **Property** | **Test Condition** | **Value** | **Unit** | **Standard** |
| Typical substrate layer thickness | | 60 | micron | acc. to ISO 4593, 23°C |
| Typical photopolymer layer thickness | | 16 | micron | white light interferometer |
| Typical cover layer thickness | | 40 | micron | |

| Optical Properties: | | | | |
|---|---|---|---|---|
| **Property** | **Test Condition** | **Value** | **Unit** | **Standard** |
| Transmittance of unrecorded film, w/o cover foil | | see Direct Transmission Spectrum below | % | ASTM E 01348 |




Transmittance vs. wavelength.

| Reflection Holograms in 2-Beam Geometry: | | | | |
|---|---|---|---|---|
| **Property** | **Test Condition** | **Value** | **Unit** | **Standard** |
| Maximum refractive index modulation $\Delta n_1$ at λ = 633 nm | Applied total dosage approx. 15 mJ/cm² | > 0,03 | | ISO 17901-2 |
| | | | | |
| Maximum refractive index modulation $\Delta n_1$ at λ = 532 nm | Applied total dosage approx. 15 mJ/cm² | > 0,03 | | ISO 17901-2 |
| | | | | |
| Maximum refractive index modulation $\Delta n_1$ at λ = 457 nm | Applied total dosage approx. 40 mJ/cm² | > 0,03 | | ISO 17901-2 |

**Conditions for Reflection Holograms in 2-Beam Geometry**

**Summary:**

- **s-polarized beams, external angles of incidence -22° (object beam), +42° (reference beam) in air**
- **typical power density: 9 – 23 mW/cm$^2$**

**Details:**

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.

To achieve maximum interference fringe visibility during holographic recording, an intensity ratio of 1:1 between signal and reference beams is required inside the photopolymer layer. Accordingly, the beam ratio is optimized with a combined correction factor - the external power ratio (PS/PR) is set to 1.29 to compensate for:

- Different projected beam cross-sections at the recording angles
- Fresnel reflection losses at the air-photopolymer interfaces

This ensures that the effective power density ratio inside the photopolymer layer equals 1:1, while the total exposure dosage corresponds to the product of the total external power density (PR + PS) multiplied by the individual exposure times, t. The total external power density is typically set to values of 9 – 23 mW/cm².

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.

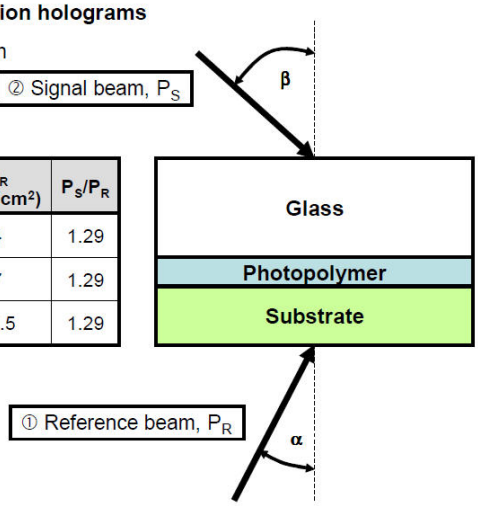
To determine the performance of the hologram, the diffraction efficiency η of the recorded hologram is measured with respect to the rotation angle α (the holographic film / glass sandwich is mounted on a rotation stage). The resulting Bragg curve η(α) is analyzed according to Kogelnik's theory [Kogelnik, H., "Coupled wave theory for thick hologram gratings", The Bell System Technical Journal 48(9), 2909-2947 (1969)], to deduce the performance parameters $\eta_{max}$, $\Delta n_1$ 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 $\eta_{max}$ is achieved. This thickness shrinkage is incorporated in the fit of $\Delta n_1$ according to Kogelnik's theory. The mean refractive index used for the calculation is 1.51. By varying the recording times the dosage response curves for $\Delta n_1$ at the different recording wavelengths, λ = 633 nm, 532 nm and 457 nm, can be obtained.

**Recording of slanted reflection holograms**

- λ = 633 nm, 532 nm, 457 nm
- S-Polarization

| λ (nm) | α (°) | β (°) | $P_R$ (mW/cm²) | $P_S/P_R$ |
|---|---|---|---|---|
| 633 | -22 | 42 | 4 | 1.29 |
| 532 | -22 | 42 | 7 | 1.29 |
| 457 | -22 | 42 | 10.5 | 1.29 |

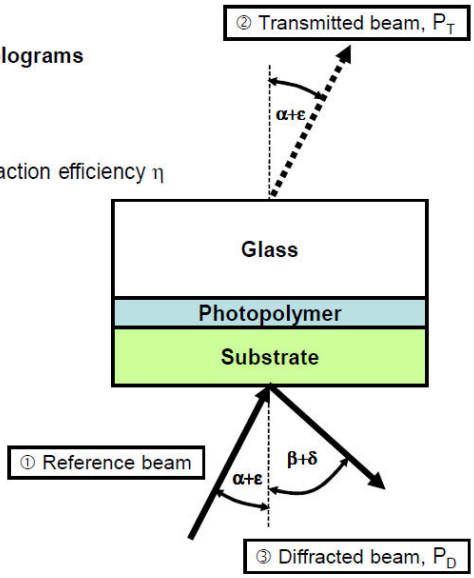


**Readout of slanted reflection holograms**

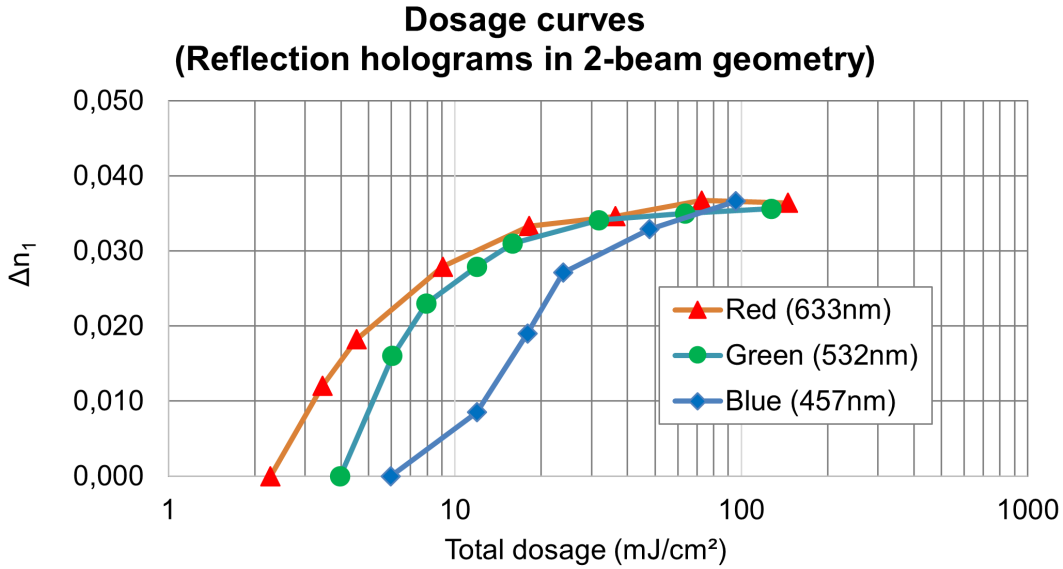
- λ = 633 nm, 532 nm, 457 nm
- S-Polarization
- Adjust ε and δ for maximum diffraction efficiency η

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

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




**Dosage Response**




Refractive index modulation $\Delta n_1$ vs. total exposure dosage.

## Storage

The unrecorded photopolymer film should be stored in the original and sealed Covestro container that is used for delivery, whenever possible. The storage temperature shall be kept at ≥15°C and ≤ 27 °C. While the recorded film is quite stable, the unrecorded photopolymer film should be protected from light, humidity, heat and foreign materials.

## Storage time

Six months storage time is recommended.

## Processing

### General instructions for yellow lit environment handling

The product is light sensitive. Exposure to light prior to the holographic exposure might diminish the refractive index modulation $\Delta n_1$ and diffraction efficiency η. Examples for tolerable expositions in dark room environment (dim yellow monochromatic LED light) without diminishing holographic performance are given in table below. Test condition: Photopolymer film laminated on glass and illuminated with illuminant positioned at a distance of 30 cm above.

| Illuminant | Maximum exposure intensity | Maximum exposure time |
|---|---|---|
| OSRAM PARATHOM DECO CLASSIC A Yellow 1 Watt LED E27 | $2{,}6 \cdot 10^{-6}$ W/cm² | 5 min |
| PHILIPS AccentColor Miniglobe Yellow 1 Watt LED E27 | $0{,}8 \cdot 10^{-6}$ W/cm² | 30 min |

## Health and Safety Information

Before working with this product, you must read and become familiar with the available information regarding its risks, proper use, and safe handling. This information is provided in various formats, including the current Safety Data Sheet (SDS) and product label. SDS can be accessed via the following link:

Safety Data Sheets (SDS) for Covestro products | Covestro

For further questions, please use the contact information provided on this technical data sheet.

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### Typical Value

These values are provided as typical data only and do not constitute binding specifications or warranted performance, unless explicitly agreed by Covestro in writing. Performance may vary depending on factors including, but not limited to, mold/die, processing conditions and coloring/pigmentation. Unless otherwise stated, values are based on standardized test specimens at room temperature.

### Sample

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### Contact Information

Please use our contact form or contact us directly by sending an e-mail to technical-datasheets@cx.covestro.com .