

# Optical Density

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## Definition

**Optical density**, which ExxonMobil **measures with a Transmission Densitometer**, is another representation of a material's **light-blocking ability**. The **optical density scale** is **unitless** and **logarithmic**, and it enhances the data resolution for materials that transmit **only a small fraction** of incident light. ExxonMobil uses optical density measurements with metallized films only.

## Relevance to Performance

**Transmission densitometers** have traditionally been used to evaluate the light transmission properties of photographic film, but the same test **is now also used to represent the thickness of the aluminum layer of vacuum-metallized films**. Since **layer thickness affects important performance-related properties** like **film barrier, light transmission, and appearance**, optical density provides **critical data** for process control of the metallizing process.

Depending on the product design, **ExxonMobil metallized films** have optical density values ranging from 2.0 to 3.0, which is equivalent to light transmission values of 0.1% to 1.0%.

## What Affects the Optical Density of Metallized Films

Metallizing process parameters and base film characteristics control the aluminum layer thickness and uniformity, and therefore the optical density.

## Test Principles

ExxonMobil data are provided by commercial densitometers that meet standard conditions defined by **ANSI**. A **unidirectional, perpendicular light beam** is directed unto the film sample, and the light that is transmitted through the film is collected, measured, and **logarithmically amplified**; Finally, the densitometer calculates and displays the optical density value. ExxonMobil uses the **Tobias** TBX transmission densitometer and Macbeth models TD903 and TD932.

The optical density values is represented by the following calculation and shows its relationship to **% light transmission** :

$$\text{Optical Density (unitless)} = \log_{10} \left( \frac{\text{Incident light}}{\text{Transmitted light}} \right) = \left( \frac{100}{\text{Light transmission (\%)}} \right)$$

**Optical Density values** are reported to **two** decimal places. **Table 11 below** compares optical density values to light transmission values in the range that exists **for ExxonMobil Metallized Films**.

<b>Optical Density</b>	2.00	2.10	2.20	2.30	2.40	2.50	3.00
<b>Light Transmission (%)</b>	1.0	0.8	0.6	0.5	0.4	0.3	0.1

**Table 11:** Light Transmission values at various Metallized Film Optical Densities

## Related Terminology

**ANSI:** ANSI stands for the **American National Standards Institute**.

**Light transmission:** Light transmission is the percentage of incident light that passes through a film sample. It can be calculated from optical density values.

**Opacity:** Opacity is a common paper measurement that describes a substrate's light-blocking ability. A perfectly opaque paper has an opacity value of 100%. Because white opaque films are replacing paper in some applications, ExxonMobil measures TAPPI opacity for some OPPalyte films.

**TAPPI:** TAPPI stand for the **Technical Association of the Pulp and Paper Industry**.