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## Imaging materials — Lenticular lens sheet — Measurements and specifications of dimensions

*Matériaux pour l'image — Feuille lenticulaire — Mesurages et  
spécifications des dimensions*

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# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Measurement</b> .....	<b>3</b>
4.1 General.....	3
4.1.1 Outline.....	3
4.1.2 Standard ambient condition.....	3
4.2 Width of a lenticule.....	4
4.2.1 Measurement equipment.....	4
4.2.2 Measurement procedures.....	4
4.2.3 Reporting of the precision.....	4
4.2.4 Lens frequency (lpi).....	5
4.2.5 Precision within lot and lot-to-lot.....	5
4.3 Thickness of lenticule lense sheet.....	5
4.3.1 Measurement equipment.....	5
4.3.2 Measurement procedures.....	5
4.3.3 Reporting and classification of thickness of lenticular lens sheet.....	5
4.4 Temperature and humidity dependence.....	6
4.4.1 General.....	6
4.4.2 Measurement equipment and procedures.....	6
4.4.3 Measurement and calculation of temperature dependence.....	7
4.4.4 Measurement and calculation of humidity dependence.....	7
4.4.5 Classification of the temperature and humidity dependence.....	8
<b>Annex A (informative) Explanation of lenticular lens print</b> .....	<b>9</b>
<b>Bibliography</b> .....	<b>12</b>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#).

The committee responsible for this document is ISO/TC 42, *Photography*.

## Introduction

Lenticular lens are an array of magnifying lenses, which can generate a desired visual perception, including 3D effect, animation and flips, when the underlying interlaced printed image is viewed from different angles. The most widespread use of this technology is in lenticular printing, for use in packages, display posters, promotional buttons, magnets, coasters, collectibles, signs, menu boards, postcards and business cards.

It is reported that the market size of lenticular sheets is over 100 million m<sup>2</sup> and the market is growing. Moreover, the image qualities of lenticular printing have improved dramatically, and further improvement is expected in the future. While production of lenticular sheets with a lens frequency of 100 lines per inch (lpi) is routine, products with 200 lpi are also currently available. To produce the optimal perceptive experience, the right choice of lenticular sheet is crucial. Different use cases require different lens frequencies. For a 2D view application, a 200 lpi material can be optimal, and for multiview 3D effect viewed from one meter or further, a 12 lpi material can be optimal. On a separate note, lenticular sheets with higher lens frequency can be thinner; therefore, increasing its potential in high quality packaging and a variety of printings.

The multi-step process of lenticular printing involves creation of a lenticular image from at least two existing images and its combination with a lenticular sheet. The combining process can either be a 1) direct printing of the images on the lenticular sheets or 2) pasting the lenticular sheet and printed images. This process can be used to create various frames of animation (motion perception), offsetting the various layers at different increments (3D perception) or simply to show a set of alternate images which appear to transform into each other.

Major factors influencing the quality of a lenticular image is the precision in the dimensions of the lenticules in the lenticular sheet and the printed interlaced image and the precision in the positioning of the lens array and the interlaced images. Poor precision results in poor image quality and poor precision in the dimensions of lenticules in the lenticular lens sheet can result in low production yield, consequently resulting in higher costs.

Therefore, the demand for improving the precision in the dimensions of the lenticules in a lenticular lens sheet has been high. The standardization of the measurements of the dimension of the lenticules in a lenticular lens sheet has been requested from the market.

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# Imaging materials — Lenticular lens sheet — Measurements and specifications of dimensions

## 1 Scope

This Technical Specification specifies the measurements and specifications of the dimensions of a lenticular lens sheet. It describes measurement methods and specifies the nominal sizes and target dimensions with tolerance. It also describes methods to test the stability of dimensions of the lenticular lens sheet.

This Technical Specification is applicable to lenticular lens sheets used in lenticular prints, including those that give an image the illusion of depth or make images appear to change/move as the image is viewed from different angles. Both impact and non-impact printing can be used to generate the images. Examples of the former are off-set, gravure and flexography, while the examples of the latter are silver halide, inkjet, dye diffusion thermal transfer and electrophotography.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11359-2, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

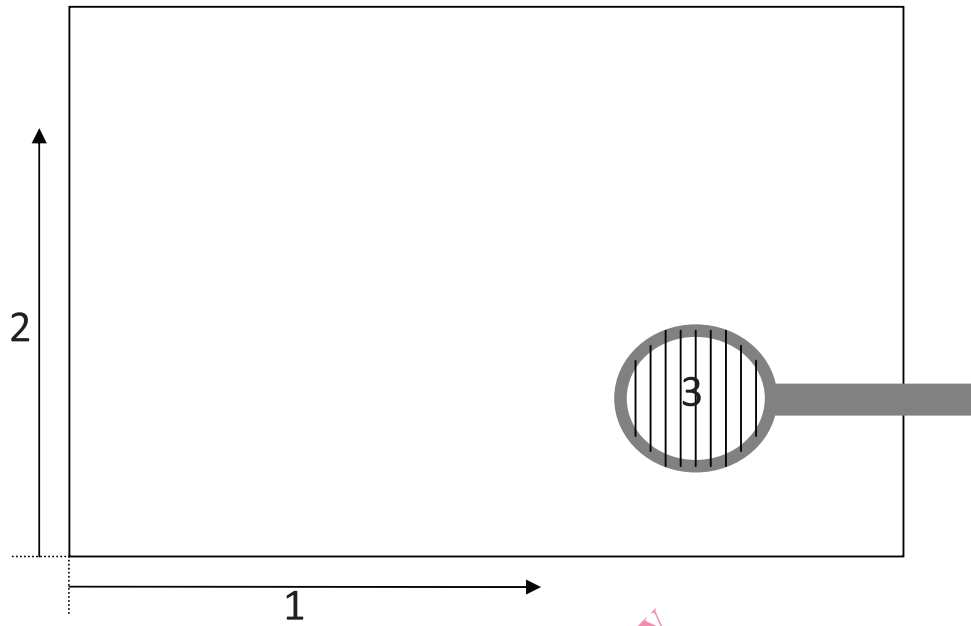
### 3.1

#### **lenticular lens**

array of magnifying semi-cylindrical lenses, designed to produce a desired perception, such as 3D, motion or morphing, to the underlying interlaced image

**EXAMPLE** This technique is widely used in lenticular printing, wherein the lenticular lens is used to provide an illusion of depth, change or motion to an underlying interlaced image when viewed from different angles.

Note 1 to entry: Schematic diagrams of a lenticular sheet is shown in [Figure 1](#) (top view) and [Figure 2](#) (side view).



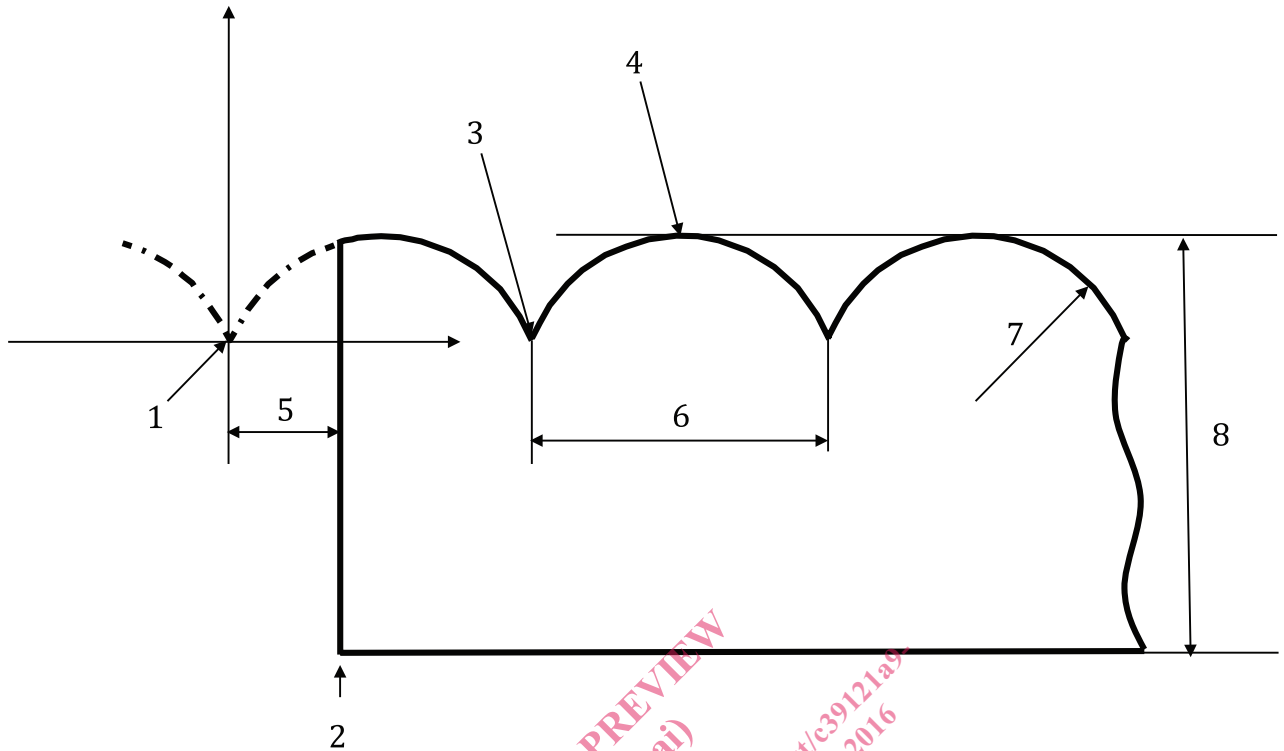
**Key**

- 1 length in X-direction
- 2 length in Y-direction
- 3 magnified lenticular pattern

**Figure 1 — Top view of a lenticular lens sheet**

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#### Key

- 1 origin (zero point) of the coordinate
- 2 cutting end
- 3 valley of a lenticule
- 4 peak of a lenticule
- 5  $L_c$ ; distance to the origin from the cutting end ( $\mu\text{m}$ )
- 6  $W_l$ ; width of a lenticule ( $\mu\text{m}$ )

Figure 2 — Side view of a lenticular lens sheet

## 4 Measurement

### 4.1 General

#### 4.1.1 Outline

Measurement procedures and specifications are described for the following parameters which determine the image quality of lenticular prints:

- a) precision in width of a lenticule;
- b) stability of the length of a lenticule under ambient conditions.

#### 4.1.2 Standard ambient condition

Standard ambient conditions shall be a temperature of  $25\text{ °C} \pm 2\text{ °C}$ , a relative humidity of  $50\% \text{ RH} \pm 5\% \text{ RH}$  and a pressure of  $96\text{ kPa} \pm 10\text{ kPa}$ .

## 4.2 Width of a lenticule

### 4.2.1 Measurement equipment

Calibrated dimension measurement equipment shall be used. The spatial resolution capability of the equipment shall be finer than 20 µm.

For example, a stylus type surface measuring instrument, used typically for measuring surface roughness and contour, can be used. An example for the stylus is 5 µm diamond stylus tip with 40° angle.

### 4.2.2 Measurement procedures

The sample should be equilibrated to the standard ambient conditions for one hour before measurements. The measurements should be made at the standard ambient conditions.

An area that includes 20 or more lenticules shall be measured. As shown in [Figure 2](#), a valley, represented by “3” is located between two lenticules. The width of a lenticule (*Wl*) is the distance between any two adjacent valleys. The measurement shall be performed both in the forward and backward directions.

The distance from the first valley to the 21<sup>st</sup> valley, i.e. the combined width of 20 lenticules, shall be measured.

The measured width of each lenticule shall be recorded and be expressed in µm.

### 4.2.3 Reporting of the precision

The following shall be reported:

- a) the measured average width of the lenticule;

Average *Wl* is calculated by dividing the combined length by the number of lenticules, as shown in Formula (1). The width shall be expressed in µm;

$$Wl(\text{average}) = \frac{\sum_{1}^{20} Wl}{20} \quad (1)$$

- b) the nominal width of the lenticule, calculated as shown in Formula (2);

$$[\text{Nominal\_width\_of\_lenticule}] = \frac{25\,400}{[\text{Nominal resolution (lpi)}]} \quad (2)$$

- c) the difference between measured average width and nominal width of the lenticules;  
 d) the standard deviation of the average width of the lenticules;  
 e) classification of the precision according to [Table 1](#).

**Table 1 — Classification of precision of lenticule width**

(Difference between average width and nominal width/Nominal width) × 100	Precision classification
2 % or over	Poor
from 1 % to 2 %	Medium
from 0,5 % to 1 %	High
Less than 0,5 %	Super high