

INTERNATIONAL STANDARD

**ISO
6221**

Third edition
1996-12-15

Photography — Films and papers — Determination of dimensional change

*Photographie — Films et papiers — Détermination des variations
dimensionnelles*



Reference number
Documents
ISO 6221-1996(E)
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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6221 was prepared by Technical Committee ISO/TC 42, *Photography*.

This third edition cancels and replaces the second edition (ISO 6221:1991), which has been technically revised.

Annexes A, B and C of this International Standard are for information only.

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Case postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Introduction

Photographic films and papers exhibit temporary or reversible dimensional changes as well as permanent dimensional changes. This International Standard is designed to provide uniform methods for treating the samples and for expressing the dimensional changes which occur with changes in atmospheric conditions and those which occur in processing and ageing.

Temporary or reversible dimensional changes are the result of changes in equilibrium moisture content (which is determined by the relative humidity of the surrounding atmosphere) or changes in temperature. Permanent dimensional changes occur as the result of processing and ageing. The rate of permanent shrinkage of film generally increases with temperature but decreases with time. The rate of shrinkage may also be greatest at either high or low relative humidity, depending on the type of film. Some materials, particularly photographic film on polyester base, can show a swelling after a high humidity exposure.

The increasing use of photographic films in recent years, in applications where dimensional stability is critical, has emphasized the importance of an accurate measure of dimensional properties. For example, in photo-mechanical reproductions a dimensional change of as little as 0,01 % may be of practical importance. In the case of aerial mapping, uniform shrinkage is not serious since it can be easily corrected by a change in magnification, but any difference in shrinkage in the two principal directions is a source of error. Any localized or non-uniform changes in dimension are of practical concern.

The dimensional change properties of any film or paper depend not only on their composition and method of manufacture but also on their thermal and moisture content history. Accurate evaluation of such properties requires some control over the sample history as well as very precise control over the conditioning and measuring procedures. Film and paper dimensions are also subject to hysteresis effects. These are relatively more important with the more stable materials such as polyester photographic base films.

Additional information on the dimensional characteristics of photographic films and papers and on methods of measurement may be found in the bibliography (see annex C).

Photography — Films and papers — Determination of dimensional change

1 Scope

This International Standard gives a method for determining the dimensional change of photographic films and papers caused by

- a) variations in equilibrium moisture content due to change in the relative humidity of the atmosphere (humidity coefficient of expansion);
- b) change in temperature (thermal coefficient of expansion);
- c) processing;
- d) ageing.

This International Standard deals with the moisture content and thermal history of the samples before measurement, the atmospheric conditions during measurement, and the treatment of the data. It does not describe the various experimental techniques used to make the measurements.

This International Standard is not suitable for determining the dimensional change of instant photographic film.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 humidity expansion (or contraction): Dimensional change caused by the gain (or loss) of moisture following changes in the relative humidity of the ambient air at constant temperature.

2.2 humidity coefficient of expansion: Change in dimension per unit length per 1 % change in relative humidity at constant temperature.

2.3 thermal expansion (or contraction): Dimensional change caused by a rise (or fall) of temperature at constant relative humidity.

NOTE — This is an apparent thermal expansion since the moisture content of film varies slightly with temperature at constant relative humidity. However, the primary effect is thermal expansion. Thermal expansion is less important for paper because of the small changes involved, particularly compared to humidity effects.

2.4 thermal coefficient of expansion: Change in dimension per unit length per 1 °C change in temperature at constant relative humidity.

2.5 dimensional change due to processing: Permanent dimensional change caused by photographic processing. This may be the conventional wet chemical processing, vapour processing or heat processing. It is

measured after conditioning at the same relative humidity and temperature as used for the original measurement and is expressed as a percentage.

2.6 dimensional change due to processing plus ageing: Permanent dimensional change which occurs as a result of processing plus ageing of the processed material. It is measured after conditioning of the processed, aged film or paper at the same relative humidity and temperature as used for the original measurement and is expressed as a percentage.

2.7 length direction: Direction of the film or paper parallel to its forward movement in the film- or paper-making machine. This is also termed "grain" or "machine direction" in the case of papers.

2.8 width direction: Direction of the film or paper at right angles to the length direction. This is also termed "cross direction".

2.9 differential dimensional change: Difference between the dimensional changes of the material in the two principal directions (length and width).

NOTE — Polyester-based films frequently have maximum and minimum dimensional changes in directions other than the length or width. These can be determined by rotating and viewing the uncoated base between a pair of crossed polarizers. When the direction corresponding to either the maximum or minimum dimensional change is coincident with the optical axis of one polarizer, there is minimum light transmission through the base.

2.10 conditioning: Exposure of a sample to air at a given relative humidity and temperature until equilibrium is reached.

2.11 preconditioning: Establishment of a moisture content history by conditioning the sample at a relative humidity above or below the conditioning relative humidity used for measurement. The purpose of preconditioning is to control the effects of hysteresis (see 2.12).

2.12 dimensional hysteresis: Difference in the absolute dimensions of a sample in equilibrium with air at a given relative humidity, when conditioned from a higher relative humidity and when conditioned from a lower relative humidity (see annex B).

3 Measurement technique

There are a number of different techniques used for measuring the dimensional change of sensitized materials. Specifications of measuring equipment are beyond the scope of this International Standard, but several approaches are described in annex A.

4 Sampling

4.1 Selection of samples

Samples intended for dimensional stability tests shall exhibit no obvious physical defects, be representative of the whole of the material being tested, be handled in the same manner as in actual use, and be treated uniformly. When different materials are to be compared, they shall preferably have been subjected to the same conditioning history. The length direction should be indicated if known.

4.2 Handling of specimens

Specimens shall be prepared under controlled conditions and then separated into groups which are subjected to different atmospheric conditions. The operator shall take care not to breathe on the specimens and shall wear moisture-resistant gloves while handling them since moisture from the skin may reduce the accuracy of the results.

4.3 Processing of specimens

Specimens shall be exposed and processed by methods and equipment normal for the product. When the effects of processing machines, tensions, or drying conditions are being investigated, the film or paper shall be processed in the sizes of practical interest. Specimens may be developed as negatives or as positives, but this can affect the dimensional change properties of some materials. Silver-gelatin films generally show less dimensional change when they have low density rather than high density.

5 Conditioning

5.1 Constant humidity chamber

Either a walk-in constant humidity room or a cabinet may be used.

5.1.1 Constant humidity room

The relative humidity (RH) shall be held constant to ± 1 % RH or better in areas of the room where specimens are measured. The room shall be vapour sealed and insulated on all six sides. The room shall be mechanically air-conditioned and the air circulated at a linear velocity of at least 15 cm/s. The number of personnel permitted in the room at any one time during testing shall be limited. The relative humidity of the room shall be checked regularly, preferably by means of an electric hygrometer calibrated by a dew-point method.

5.1.2 Constant humidity cabinet

A convenient size for a humidity cabinet is approximately 1 m in height and 0,5 m in width and depth. It shall be constructed of materials which will ensure good insulation. Suitable provision shall be made for thermostatically controlling the temperature within the cabinet. Air shall be circulated throughout the cabinet at a linear velocity of at least 30 cm/s. The cabinet shall be equipped with ports filled with moisture-impermeable (e.g. rubber or plastic) gloves for entrance of the operator's hands. The relative humidity of the cabinet shall be checked regularly, preferably by means of an electric hygrometer calibrated by a dew-point method.

The relative humidity within the cabinet shall be controlled as closely as possible. Where the cabinet is mechanically air-conditioned, the relative humidity shall be constant to ± 1 % RH or better. Where a saturated salt solution is used for control, provision shall be made at the bottom of the cabinet for inserting suitable trays, which shall hold about 1 litre of salt solution. A solution tray with a large surface area is needed and about 100 cm² is suitable.

5.2 Standard temperature and humidity

The standard temperature shall be $23\text{ }^{\circ}\text{C} \pm 0,5\text{ }^{\circ}\text{C}$ except for the test specified in clause 7. The relative humidity is specified in the respective test procedure subclauses and depends upon the property being measured.

5.3 Conditioning of specimens

5.3.1 General

Specimens shall be suspended in the conditioning atmosphere by means of a hook or a rod through a hole in the middle of one end near the edge of the specimen. The specimens shall be separated to prevent contact with each other. An alternative method of conditioning is to place specimens in racks spaced so that there is free circulation of the air on both sides of the material. The specimens shall not be removed from the conditioning atmosphere for measuring. Condition specimens until practical moisture equilibrium has been reached.

The time required to achieve this shall be established by actual measurements on representative specimens or based on prior experience.