Designation: ~~D7310 – 20~~ D7310 – 21

Standard Practice for Defect Detection and Rating of Plastic Films Using Optical Sensors[1]

This standard is issued under the fixed designation D7310; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice intends to provide standardized approaches and criteria for the observation and reporting of defects in various types of plastic film, by means of an optical scanning system. Scope includes the in situ inspection of defects in films fabricated for specific applications ~~as well as~~ after preparation of a suitable film ~~sample to characterize defects within plastic granules followed by inspection of the film sample.~~from plastic resin.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics
E456 Terminology Relating to Quality and Statistics
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2587 Practice for Use of Control Charts in Statistical Process Control

3. Terminology

3.1 *Definitions*—For definitions of terms that appear in this practice relating to plastics, refer to Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *defect*—for the purpose of this practice any entity in the film that is large enough to be detected by an optical sensor and is either polymeric in nature or caused by degradation, external contamination, undispersed additives or pigments, or similar sources.

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[1] This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.19 on Film, Sheeting, and Molded Products.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.1.1 *Discussion*—
In Appendix X1, some types of defects are shown (cross-linked material, un-molten polymer, pinholes). The defects can be classified in three groups:

3.2.1.1 *gel*—particle of plastic material in the film matrix not blended with the matrix and often acting as a miniature lens. Several types of gels exist.

3.2.1.2 *contamination*—any particle in or on the film matrix affecting irradiated light differently than the matrix (dirt, insects, oxidized additives or material, catalyst residues, solid particles, metallic particles, undispersed pigments or additives, etc.).

3.2.1.3 *structural defect*—visual deviation not caused by gels or contaminations, for example, air bubbles, wrinkles, die lines, film holes, sharkskin, arrowheads.

3.2.2 *pixel*

3.2.2.1 *in a picture*—smallest element of an image that can be individually processed by a video display system or a physical point in a raster image.

3.2.2.1 *Discussion*—
The greater the number of pixels per area, the higher the resolution.

3.2.2.2 *in a camera*—smallest single photo-electrical detector element of the camera sensor.

3.2.3 *effective pixel size*—actual size of the individual pixels in the analyzed image.

3.2.3.1 *Discussion*—
The effective pixel size of the optical system is determined by the physical pixel size of the sensor and a magnification factor caused by the lens of the camera.

3.2.4 *resolution*

3.2.4.1 *image*—the detail an image holds, also called pixel density.

3.2.4.1 *Discussion*—
Higher resolution means more image detail, often expressed in pixels per inch or dots per inch.

3.2.4.2 *camera*—resolution of the sensor: the sheer number of pixels on the sensor; the amount of detail that a camera can capture, measured in pixels (for example, 4k-camera).

3.2.5 *optical resolution*—describes the ability of an imaging system to resolve detail in the object that is being imaged.

3.2.5.1 *Discussion*—
It is the sum of all system effects, such as lateral resolution, lens resolution, etc.

3.2.6 *minimum detectable object size*—smallest number of pixels of a defect such that the defect can be reliably detected, typically pixel size × 3.

3.2.7 *defect size*—a length derived from the area of the defect.

3.2.7.1 *Discussion*—
Commonly equivalent circular diameter, longest elongation or longest axis through center of mass are used and may not yield a same value.

Pixel size depicted in Appendix X6 is effective pixel as defined in 3.2.3.

3.2.7.2 *equivalent circle diameter*—this is the diameter of a circle having the same area as the digitized image of the defect as depicted in Appendix X6.

3.2.7.3 *maximum extension*—the diagonal of a box circumscribing the defect as depicted in Appendix X6.

3.2.8 *sensitivity levels*—a threshold value (for example, % of grey value, brightness) to distinguish the pixels associated with the defect from the film matrix.

3.2.8.1 *Discussion*—
It is the threshold limit where the software detects/reports defects in the film. This may be defined by the vendor (factory setting) but this value can be optimized for your test material. If the value is too low it will not properly detect the defects in the film. If the value is too high it will lead to false detection.

3.2.9 *grey level*—value associated with a pixel representing the lightness from black to white. Usually defined as a value from 0 to 255, with 0 being black and 255 being white.

3.2.9.1 *Discussion*—
Other ranges are possible (vendor dependent).

3.2.10 *parcel*—a user-defined smallest area of inspected film for statistical analysis to which a detected defect can be attributed.
3.2.10.1 *Discussion*—
The statistical evaluation is based on number of parcels.

3.2.11 *total defect area*—sum of areas of defects (vendor dependent).

3.2.12 *inspected area*—total area of the film, inspected for evaluation.

3.2.13 *light source*—consistent source of light that shines through or on the film to provide a clear image for defect detection and measurement.
3.2.13.1 *Discussion*—
Different type of light sources can be used, for example, halogen, LED, fluorescent, laser.

3.2.14 *mean filter*—the mean filter is a sliding window value based on a defined number of film parcel areas inspected
3.2.14.1 *Discussion*—
During continuous measurement scenarios, the test is not usually stopped; therefore, a mean filter value should be used for reporting. A mean filter value is reported every time a new parcel area is inspected.

3.2.15 *neck-in*—difference between the width of the film compared to the width of the die.

4. Significance and Use

4.1 Defects in film are not acceptable to the end-user as there is a reduction in the fitness-for-use in many applications. This document is intended to be a practice to assist users in the inspection, quantification and observation of defects.

4.2 This practice is applicable in a laboratory environment, continuous inspection as a quality control or as a research tool. It is also appropriate for use in any commercial process used to produce film including extrusion, calendaring, etc.

4.3 This practice is also suitable for use as an evaluation or screening tool for materials intended to be used in other processes where defects of this nature are critical, such as fiber spinning non-woven, etc.

4.4 Results achieved by different ~~equipment's~~equipment, even from the same vendor in ~~different laboratories are~~ the same laboratory, are often not directly comparable ~~and may result in~~ as a bias exists that cannot be fully addressed through consistent operating ~~conditions, and results may shift as~~conditions. Results frequently shift when analyzer components are ~~upgraded for a given analyzer.~~ upgraded. Additionally, results ~~may~~ are often not ~~be~~ directly comparable between different product types. All results ~~should~~ are to be considered as relative values rather than absolute.

4.4.1 Therefore, it is not recommended to provide absolute results as part of a sales contract between the buyer and seller. For sales contracts, it is recommended to establish product grade designations based on the historical relationship of the absolute results reported, and fitness-for-use or based on a reference material agreed by both parties. This is attained by the collection of data over a time-period to establish acceptable control limits.

4.4.2 The defect size range of interest is usually different between resin supplier and converters. Total defect counts are not one to one comparable between small laboratory extrusion lines and commercial extrusion lines. Therefore, an individual correlation is the aim to get accepted results for fitness-for-use.

NOTE 2—This was tested on Brabender, Collin, Goettfert, and OCS systems.

4.5 For support in a basic interpretation of the different results the following points may be helpful for comparison.

4.5.1 Size classes (number and definition)

4.5.2 Reported defect types

4.5.3 Comparable units (gels/kg, gels/m^2, class system, index...)

4.5.4 Vendor (type of equipment, for example, cast or blown film...)

4.5.5 Camera settings (sensitivity, grey level, resolution...)

4.5.6 Extrusion parameters

NOTE 3—For attribute data such as defect counts, C-type control charts are most appropriate per recommendations within Practice E2587, Section 9.

5. Apparatus

5.1 *Extruder*—A device for melting polymer that produces a cast or blown (tubular) filmwith sizes varying from lab-scale to production-scale.

5.1.1 *Cast Film Extrusion*—An extrusion system that produces a flat film that is quenched immediately after extrusion by means of one or more cooling devices such as an air knife, chill roll or water bath.

5.1.2 *Blown or Tubular Extrusion*—An extrusion system that produces a tubular "bubble" of film from a circular die, usually equipped with an air-ring to cool the polymer.

5.2 *Screen Pack*—Although commonly used in commercial or semi-commercial environments, screen packs are not generally used in laboratory units intended for research or quality functions. Screen packs will change the appearance of the film and will change/reduce the number of defects. Therefore, screen packs should not be used when evaluating defect levels.

5.3 *Defect Detection System*—An optical scanning system with a light source, an analog or digital camera, and an image processor. The optical characteristics of the camera and lighting unit are critical for detecting small defects and it is important that the instrument manufacturer be informed of the detection needs when choosing a system.

5.3.1 *Transmission Mode (Transparent or Translucent Film Configuration)*—The camera is located directly across from the light source with the film passing between them. With this system, the film is illuminated and the camera captures images of the defects and sends them automatically to the image processor, which measures the size and occurrence of the defects. Fig. 1 is a basic outline of this setup.

5.3.2 *Reflection Mode (Opaque Film Configuration)*—The light source and camera are both located above and at equal angles, typically 45°, to the film. This allows the camera to detect the defect images by reflectance off the film, and the images are sent to the processor that measures the size and occurrence of the defects. Fig. 2 depicts a basic outline of this type of setup.

5.3.3 *Image Processor*—A computer grabbing signals or pictures from the camera, evaluating the signals or pictures, converting this information into detected defects, and reporting the test results.

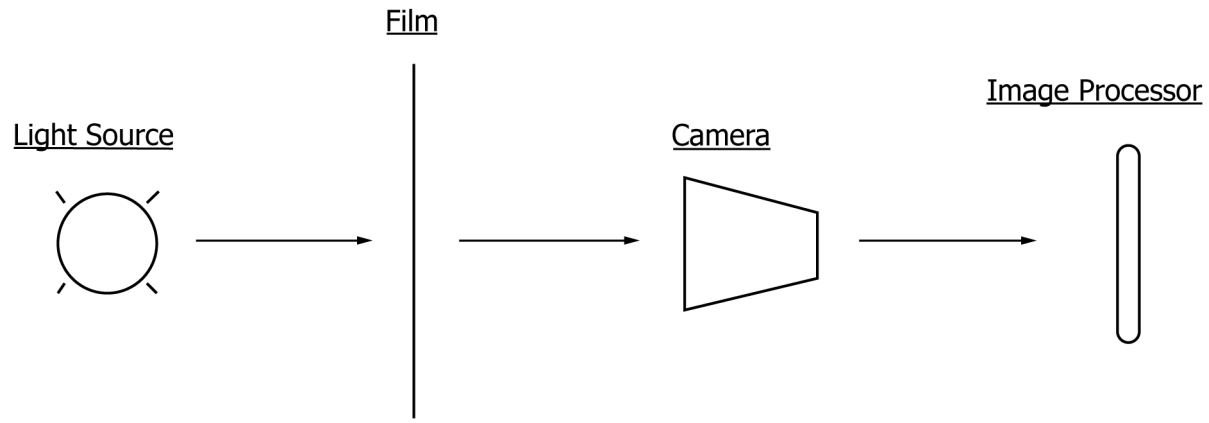


FIG. 1 Transmission Mode (Clear/Translucent Film)

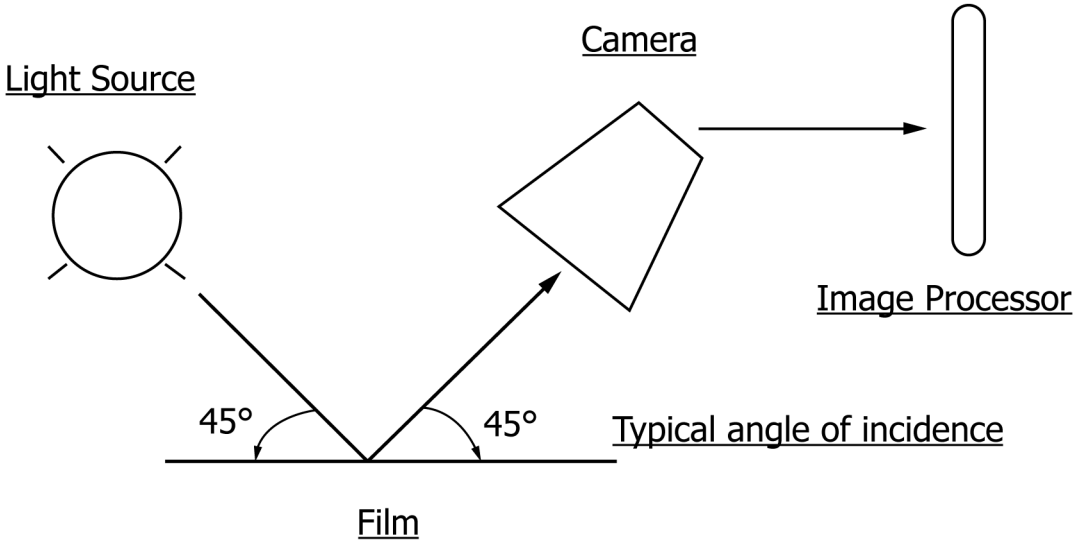


FIG. 2 Reflection Mode (Opaque Film)

5.4 *Take-off System*—A take-off unit generally consists of the following components:

5.4.1 *Temperature Controllable Chill Rolls*—The chill roll cools the polymer melt to form a film, Generally, the set up consist of two or three rolls, which are temperature controllable.

5.4.2 *Air Knife*—An air knife is a die, which produces a blade of air used to aid the neck-in and improve the film appearance. When an air knife is used, the mounted geometry should be fixed and flow controlled as different angles or air quantity affect the film.

5.4.3 *Guiding Rolls*—These are various rolls used to guide the film through the system to the winding roll.

5.4.4 *Camera and Light Source:*

5.4.5 *Winding Roll*—Final collecting roll for the film.

5.4.6 *Additional analysis equipment*—Thickness measurement, haze, FTIR, etc.

5.5 *Overview System*—A typical setup is shown in Fig. 3.

6. Procedure

NOTE 4—The practice is developed to be used for the analysis of defects on the film directly produced after the extrusion of polymer pellets. This scope does not include the direct defect detection on commercially available films.

6.1 *Extrusion of Film:*

6.1.1 *Evaluation of Plastic Resin*—To evaluate defect quality of plastic resin, a film must first be extruded and presented to the defect detection system for inspection. Laboratory determinations are much more controlled than determinations conducted in situ in production environments producing a fabricated film. The extruder ~~may be configured in~~ is either configured as an at-line operation for continuous quality control during production of the plastic resin, or alternatively ~~in~~ as an off-line operation where sample is fed into the extruder in a discreet amount. A generalized procedure for setting up an analysis for a new/ unknown material is described in Appendix X5.

6.1.1.1 *Extruder Conditions*—Specific extruder conditions and preconditioning of material are determined by the system used and the material being evaluated, in conjunction with guidance provided by the instrument manufacturer, material supplier, or material specification. Because the intent of this type of determination is to evaluate the quality of the plastic resin and not the film production process, the extrusion conditions are established such that a high quality film can be produced with minimal impact on the defect content in the material to be tested. Reported results are dependent on the specific extruder conditions. After these

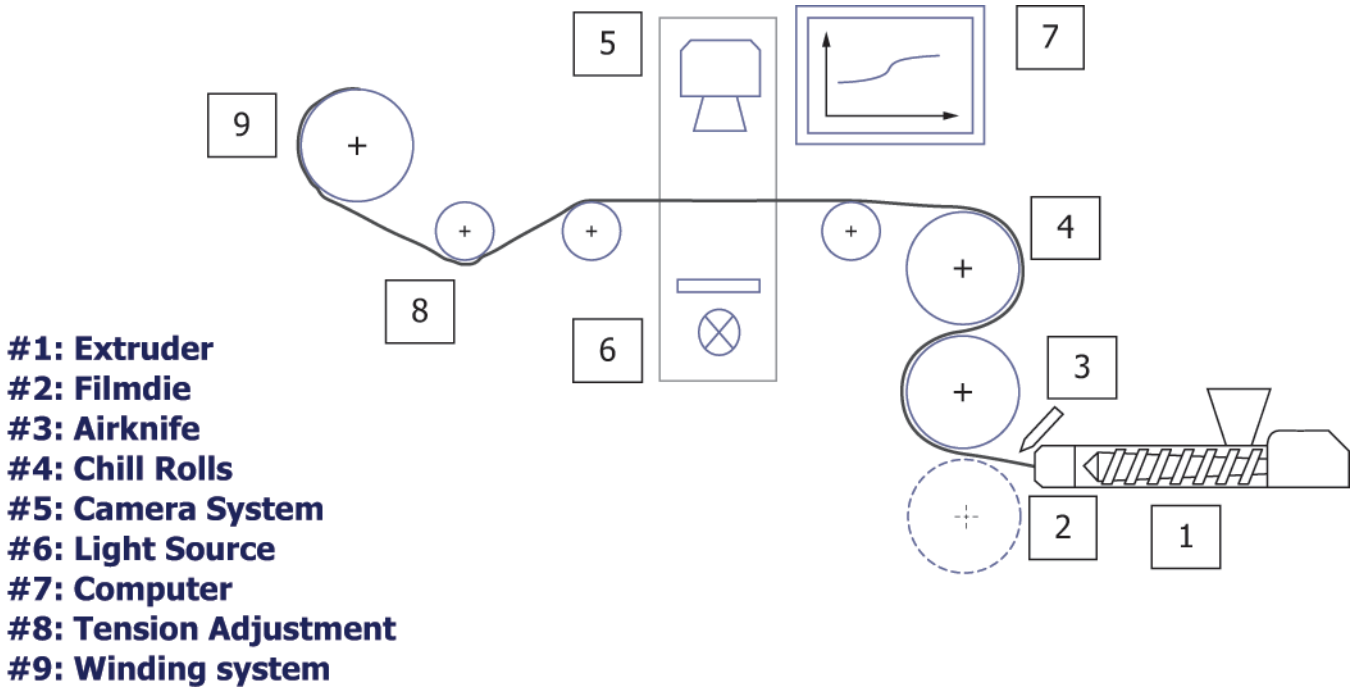


FIG. 3 Typical Analyzer Setup

conditions are determined for a given material type/grade, the same conditions must be used consistently to ensure repeatable results. Many factors ~~can~~ influence the results, including for example extruder temperatures, speed, ~~takeup~~take-up speed, chill roll temperature, screw geometry, frost line height (for blown films), the use of an air ~~knife, etc.~~ knife. Specific guidance for key parameters are given below.

(1) Preconditioning—Sample with high levels of volatiles ~~may~~ need to be devolatilized prior to introduction into the extruder to avoid creation of voids in the film, which ~~can be~~are possibly detected as defects.

(2) Temperature—Appropriate temperatures, especially in the die zone, must have been reached to melt and mix the sample. In general, it is best for the die set point temperature to be above the melt point of the polymer, but not enough above it to cause degradation of the material. Temperature set points should take into consideration the melting and degradation temperatures of all components in a formulated resin, including additives.

(3) Speed—Extruder screw speed shall be set such that the residence time of the polymer is adequate to entirely melt and mix the polymer, but not long enough to cause degradation.

(4) Film Thickness—The relation of the screw speed (extruder output) and take-up speed shall be set to produce film of suitable thickness to measure defects. Typical film thickness is 10 – 100 micron.

6.1.1.2 *Extruder Cleanliness*—The extruder shall be clean prior to the introduction of the material to be evaluated. Cleaning procedures are required when the extruder is started up, when the prior sample is dissimilar, or when there is evidence of degradation/contamination in the extruder. This is accomplished by various means, depending on the prior conditions (for example, material type, defect quality, etc.). One or more of the following options ~~may be used:~~ are examples on how to proceed:

(1) ~~Running~~Run a clean, highly stable, compatible material through the extruder until the film appears clear or when the defect count, as measured by the optical monitoring system, has stabilized.

(2) ~~Introducing~~Introduce some form of scrubbing compound, typically a concentrated additive mixture in a base resin.

(3) Open up the extruder and mechanically clean it.

6.1.1.3 After introducing the material to be evaluated into the extruder, allow enough time for the preceding material to completely purge. If studies of similar materials are being performed, the typical purge time is established prior to subsequent evaluations. (See Appendix X2 for guidelines on the use of a control resin.)

NOTE 5—The need for adequate equilibration cannot be overstressed. Not only must care be taken to provide adequate time for the system to stabilize after purging, but also to allow adequate monitoring time in cases where intermittent defect flurries occur in a stable system due to non-uniformity of the sample itself (see Appendix X2).

6.1.2 *Evaluation of Film Produced for Specific Application:*

6.1.2.1 The general purpose of optical sensors used in a production film fabrication environment is continuous, in-line monitoring of the film as produced for its intended application, both for the consistency of the product and to detect any disturbances in the systems or processes that introduce an unacceptable level of defects.

6.1.2.2 *Extruder Conditions*—When monitoring film produced on a commercial scale for a given application, the extruder conditions shall be determined by the constraints of the production and application requirements, that is, conditions are not changed from the normal operating conditions for the purpose of defect detection. When the intent is to evaluate the film for defects, it is important to have processes in place to ensure that proper operating guidelines are followed. Variables such as temperature, film gauge, etc. must be taken into account to achieve repeatable results.

6.1.2.3 *Extruder cleaning* —For commercial scale film extrusion equipment it is normally not possible to interrupt production to routinely purge or clean. In this case, the system must be set up to produce commercially acceptable product and the monitoring system essentially serves to track deviations from the acceptable levels. In this case, the acceptable levels shall be determined by the accepted fitness-for-use set by the application or by agreement between supplier and user.

6.2 *Evaluation of Defects:*

NOTE 6—General best practice guidelines and possible sources of test error are found in Appendix X2.

6.2.1 For laboratory evaluations, produce a sufficient quantity of film to ensure the defect frequency has stabilized.

NOTE 7—It is critical that the surrounding area not be disturbed during the evaluation, as dust and other foreign particulate matter are prone to causing erroneous measurements. Cover the extruder hopper during the evaluation to prevent the inclusion of any foreign materials.

6.2.2 Monitor the film with the optical scanning system.

6.2.3 *Observations:*

6.2.3.1 Record the results of the measurement of defects as detected by the specific inspection system.

6.2.3.2 Categorize and count the defects according to size classes or other specifications as defined by internal standards or agreement between supplier and user.

(*a*) Typical units for reporting include defects per square meter (or square foot), defect area in parts per million (PPM) Defect area = total defect area/total area measured), or any other method as defined by internal standards or agreement between supplier and user.

NOTE 8—Examples of data presentation for film defect detection and monitoring are shown in Appendix X4. The examples of the reports are from the same optical scanner and are provided as a means of demonstrating the type of information available.

7. Establishing Optical Sensor Settings

7.1 The user defined method setup is determined by defining the specific hardware and software settings of the defect detection system. Once a method setup has been established for a given product type/grade, the settings should not be altered.

7.2 *Camera Alignment*—The camera ~~should~~must be geometrically aligned to the film and lighting source, so that the intensity is homogeneously distributed across the sensor. The respective vendor sets this alignment.

7.3 *Light Source*—Various light source options are available, as described in 3.1.12. Selection of light source type and the wavelength(s) of the light source ~~may influence~~ influences the discrimination of defects in the matrix film and ~~should be~~ are chosen to meet customer requirements. The selection of the light source is very much setup dependent. Ideally, the selection should be done in close collaboration with the ~~vendor~~vendor.

7.4 *Software*—When establishing the method setup, optimized settings are defined for grey levels, defect detection threshold level(s). Size classes must also be defined, as well as groupings of size classes, if desired.

7.4.1 *Grey Level*—Grey level is adjusted to ensure that there is an adequate signal to distinguish defects from the surrounding background of the film.

7.4.2 *Defect Detection Threshold Level(s)*—A suitable grey-level threshold setting is determined to define the defect edges. Multiple levels may be established to distinguish different types of defects, if desired. Selection of threshold levels will affect the measured size of the defects, and suitable thresholds should ensure that artifacts of the film quality are not counted as defects.

7.4.3 *Sensitivity Optimization*—~~Vendor (factory) setting may work for your application; however~~ Even if the vendor (factory) settings initially work for the application, it is beneficial to optimize the sensitivity level for ~~you~~own product(s). Caution—Changes to sensitivity level settings influence the test values and historical specifications.

7.4.4 To determine the optimized level, testing of the product at different sensitivity level values is required. Initially a wide range is tested to determine the approximate optimal level. See Table 1, which uses the percent of the grey value. The small gel size categories $< \approx 250$ µm are more impacted by the sensitivity level and are usually more consistent in a defined area of film inspected.

7.4.5 For further improvement, a secondary sensitivity study with more focused range of values ~~can be used. A~~ must be performed. For example, a graph of the number of defects versus the sensitivity level can help to optimize a setting. In Fig. 4, the mid-point of the curve for the small gel category with the large gel category is used to determine the final sensitivity level. Once the sensitivity level has been set, the instrument size validation is recommended using the reference black dots.

7.4.6 *Defect Measurement:*

7.4.6.1 The primary measurement is the projected area of each defect, expressed in number of pixels. The size of the defect can be expressed as either the effective equivalent diameter or the longest dimension, expressed in microns. See Appendix X6. Other morphometric parameters ~~may~~are also ~~be determined~~ available for purposes of characterizing the type of the defect.

7.4.6.2 Defects are classified into size classes according to the measured size. User should define multiple size classes across the size range of interest. ~~The~~ Ensure that the width of each size class ~~should be~~ is larger than the pixel resolution of the defect detection system. Typically, the amount of defects will decrease monotonically with increasing size. Failure to exhibit this pattern ~~may be~~ is indicative that the size classes are too narrow.

8. Calibration and Verification

8.1 All film rating equipment require a calibration and a verification of its defect size measurement.

8.2 The initial calibration responsibility lies with the vendor.

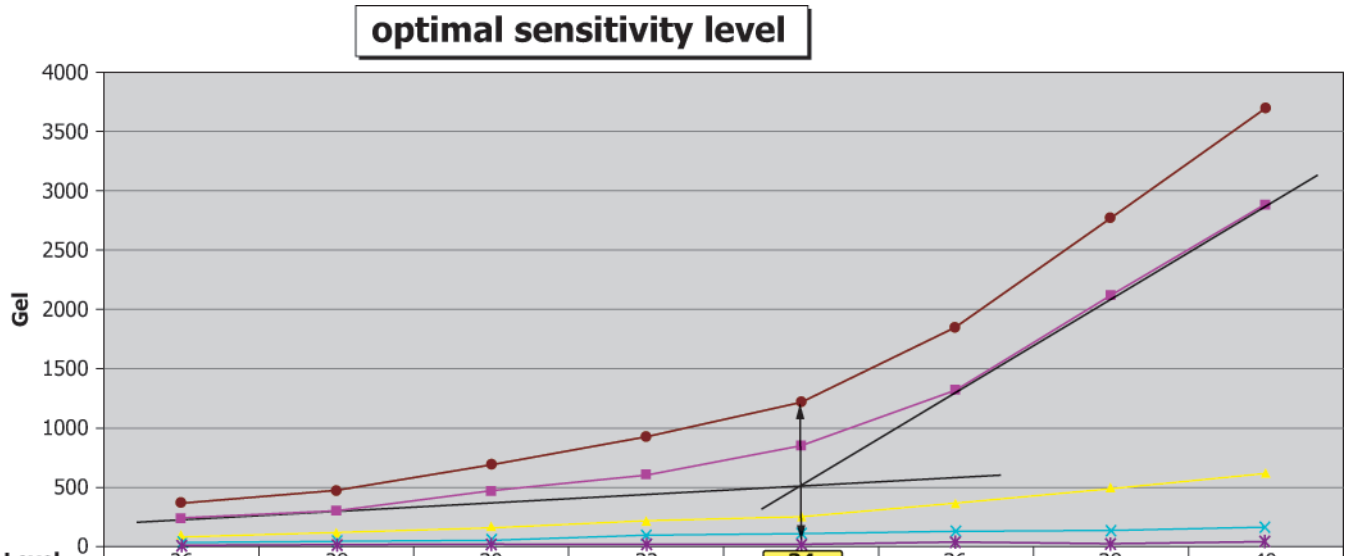
8.3 The test film must be well aligned with the camera system before calibration or verification. A striped film ~~can be used to do~~is often used for this the alignment.

8.4 To calibrate the system, a sharp edged reference item that ~~can generate~~ generates a clear and sharp image ~~in~~on the camera ~~should~~must be used. ~~This reference item can be:~~Possible reference items are:

8.4.1 A strip of calibration film with multiple sized round dots to determine size and hit rate of the system.

TABLE 1 Sensitivity Study Example 1

Sensitivity Level (% of Grey Level)	Total No. Gels	No. Gels <250 µm	No. Gels <500 µm	No. Gels <750 µm
10	58	56	1	1
20	358	346	12	0
30	750	734	16	0
40	1756	1744	9	3
50	3662	3637	25	0
60	9072	9049	22	1
70	53 249	53 218	30	1
80	795 635	795 518	115	2



Level →	26	28	30	32	34	36	38	40
–200	238.5	302.24	468.24	601.1	845.99	1320.86	2118.79	2878.04
–400	91.22	117.38	160.33	214.55	252.64	364.65	496.13	623.5
–800	33.17	45.78	51.93	95.25	100.44	130.68	135.15	155.87
>800	4.64	9.98	13.66	14.8	16.22	32.87	23.54	40.38
Total	367.54	475.37	694.16	925.7	1215.29	1849.05	2773.61	3697.79

FIG. 4 Sensitivity Study Example 2

8.4.2 A standard test body, such as a conical sided aluminium disk, with the sharp edged bottom surface placed on the film surface. For ease of use, a small cylinder-shaped structure on top of the disk is used as a handle.

8.5 The accurate diameter of these dots or disk is determined and certified by an accredited laboratory. The diameter can be selected in accordance with the test width and resolution of the system. It must be ensured that the diameter is smaller than the width of the inspection so that during calibration the whole test shape is captured by the camera. (Rule of thumb: less than the half of the test width). For example a nominal diameter can be 15 mm.

8.6 It is advisable to check with the equipment manufacturer for appropriate calibration and recalibration procedures.

8.7 A verification ~~can be~~ is performed by either user or vendor.

8.8 This verification must be based on the evaluation of individual reference samples or images.

8.9 Reference samples or images are typically ranging from 100 to 3000 microns. Ideal standards are close to the size of the typical defect size to be analyzed.

8.10 These reference samples or images with certified diameter value ~~may be~~are often acquired from vendors, ~~or~~but the diameter ~~can be set by~~is also settable using optical certified microscopy measurements.

8.11 Verification can be performed by sticking a substrate with verification shapes on top of the film to be inspected while it is running between the camera and the lighting unit.

8.12 Once the reference samples or shapes have passed through the camera inspection area and images have been captured, the diameters are measured by the instrument and compared with the reference values.

8.13 Once the test shape size and number of pixels are known, the resolution of the system ~~can be~~ is determined and corrected accordingly. ~~If the verification fails, check the test conditions and repeat the verification.~~

8.14 If the verification passes the second test, then repeat it a third time. After a second failure go through the troubleshooting guide. In some circumstances, a hardware recalibration may be required, but generally this is beyond the scope of the user and might be performed by the equipment manufacturer.

8.15 The system ~~should~~ is to be checked periodically, typically once a year, based on experience, or after maintenance, major cleaning, or even if unexpected results are ~~acquired.~~obtained.

9. Reporting

9.1 *Standard Report:*

9.1.1 Complete sample identification.

9.1.1.1 Type and brand name of test material and batch or lot number.

9.1.1.2 Date and time of sample taking.

9.1.2 Test Method/setup and test procedure used.

9.1.3 Date, start and end/stop time of the test.

9.1.4 Film settings.

9.1.4.1 Length/width and are of inspected film.

9.1.4.2 Film thickness (average value if measured during analysis, otherwise nominal value).

9.1.4.3 Film speed.

9.1.5 *Inspection Report*—The results can be displayed in tables or diagrams.

9.1.6 A report of the defects/kg is preferred. If number of defects/ m^2 are reported, the density needs to be reported for recalculation.

9.1.6.1 The total number of counted defects/kg or m^2 separated in size class (minimum 3 size classes better more, up to 10) should be reported.

9.1.6.2 Optionally, the software evaluation can separate the defects in types and/or report the defect areas of each defect type:

9.1.6.3 In that case the number of counted defects/kg or m^2 of each defect type and /or defect area/ inspected area of each defect type (ppm) should be reported separated in each size class (minimum 3 size classes better more up to 10) as shown in Fig. 5.

A graphical diagram of the defect distribution in running direction (Fig. 6) (see also Fig. X4.1) and in the width direction (Fig. 7) can indicate trends and in-homogeneities early in the analysis.

9.1.7 Report the defects, the type (if different types are defined) and size.

9.1.8 Exclude any defects with a reported size below the optical resolution established for the optical system, as defects of this size cannot be consistently detected by the system.

9.1.9 Present a statistical overview of the defects counts in a table as shown in Fig. 8.

9.1.9.1 Examples of possible reporting options/subsections are in Appendix X4.

9.1.9.2 *Optional*—Additional reporting of the process parameters of the film line, like temperatures, may be considered.

9.1.9.3 It is recommended to monitor and store also the process parameters over the testing time.

Analysis Flat Film

Black Specks [Particles per m²]		
Black Specks 1:	< 100 µm	1025,97
Black Specks 2:	101-200 µm	378,84
Black Specks 3:	201-300 µm	33,14
Black Specks 4:	301-400 µm	5,36
Black Specks 5:	401-500 µm	1,79
Black Specks 6:	501-600 µm	2,18
Black Specks 7:	601-700 µm	1,39
Black Specks 8:	701-800 µm	0,20
Black Specks 9:	> 800 µm	0,00

Gels [Particles per m²]		
Gels 1:	< 100 µm	77,59
Gels 2:	101-200 µm	26,20
Gels 3:	201-300 µm	8,33
Gels 4:	301-400 µm	2,18
Gels 5:	401-500 µm	0,40
Gels 6:	501-600 µm	0,99
Gels 7:	601-700 µm	0,20
Gels 8:	701-800 µm	0,20
Gels 9:	> 800 µm	0,00

Fisheyes [Particles per m²]		
Fisheyes 1:	< 100 µm	0,00
Fisheyes 2:	101-200 µm	0,00
Fisheyes 3:	201-300 µm	0,00
Fisheyes 4:	301-400 µm	0,00
Fisheyes 5:	401-500 µm	0,00
Fisheyes 6:	501-600 µm	0,00
Fisheyes 7:	601-700 µm	0,00
Fisheyes 8:	701-800 µm	0,00
Fisheyes 9:	> 800 µm	0,00

Holes [Particles per m²]		
Holes 1:	< 100 µm	0,60
Holes 2:	101-200 µm	0,60
Holes 3:	201-300 µm	0,00
Holes 4:	301-400 µm	0,00
Holes 5:	401-500 µm	0,00
Holes 6:	501-600 µm	0,00
Holes 7:	601-700 µm	0,20
Holes 8:	701-800 µm	0,20
Holes 9:	> 800 µm	0,40

FIG. 5 Analysis Flat Film

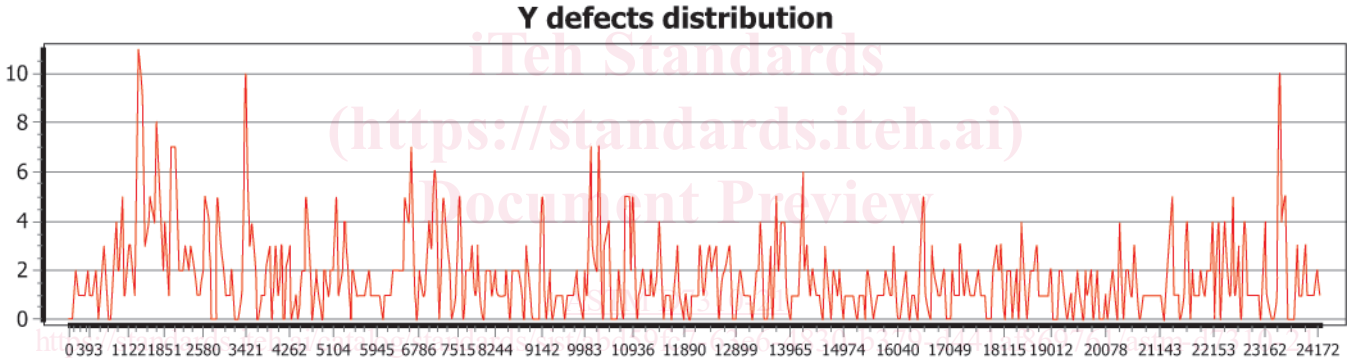


FIG. 6 Y Defects Distribution

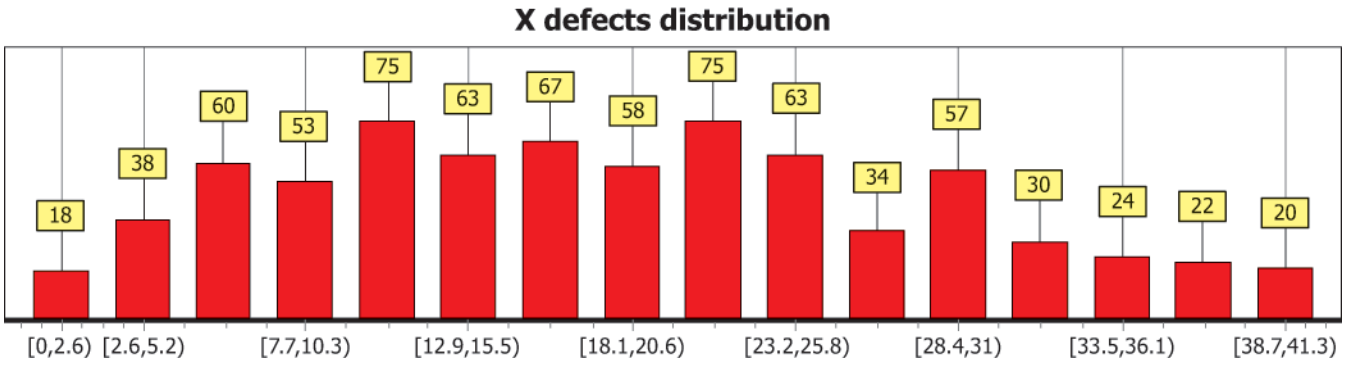


FIG. 7 Y Defects Distribution

9.1.10 *Identification of instrumentation used:*

9.1.10.1 A unique identifier (for example, serial number) is proposed to identify the instrument to avoid mis-comparison as the practise is a relative method as mentioned in 4.4.