



The challenge of evaluation of the optical quality of polymers

Presented by
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Structure

- Background and participants
- Defined starting goal
- Basics
- First round robin test
- Review and follow up round robin
- Results and evaluation round robin 2
- Conclusions
- Next steps
- Acknowledgements

Background and participants

What do we measure? How do we count?

This question was raised in an open house of an optical sorting equipment manufacturer in 2013.

The following discussion on this topic showed that the final results of the classification was given in gels/kg, gels/m² or classes/indexes. Sometimes all 3 results were present within one polymer producer, provided for different kind of polymers or at different production locations.

A search for a common approach provided only a standard guide by ASTM. Harmonized methods or other standards were not available.

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Background and participants

By sending out invitations to participants of this open house as well as network connections several interested parties came forward to participate in a group work for reviewing the ASTM standard guide D7310.

For the group the aim was to combine polymer producers, test equipment manufactures and polymer consumers to allow the different requirements to be presented.

After the first meetings the following active participants remained.

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Active participating companies

INEOS
THE WORD FOR CHEMICALS

BOREALIS
Keep Discovering

REPSOL

DOW

NOVA Chemicals

Formosa Plastics

Nexans

ExxonMobil

سابك
sabik

COLLIN C
LAB & PILOT SOLUTIONS

OCS
Optical
Control
Systems

GÖTTFERT
THIS IS RHEOLOGY

Brabender

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Defined starting goal

- Review existing documentation
- Define parameters that are critical for the influence on the quality of the film production in a round robin approach
- Define key parameters for camera inspection and its evaluation

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Basics

Optical defects – what are gels?

Definition by ASTM D7310-18

3.1.1.1 Gels- *A 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.*

Some examples

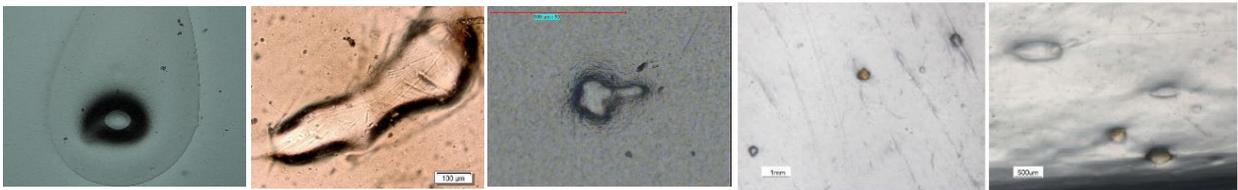
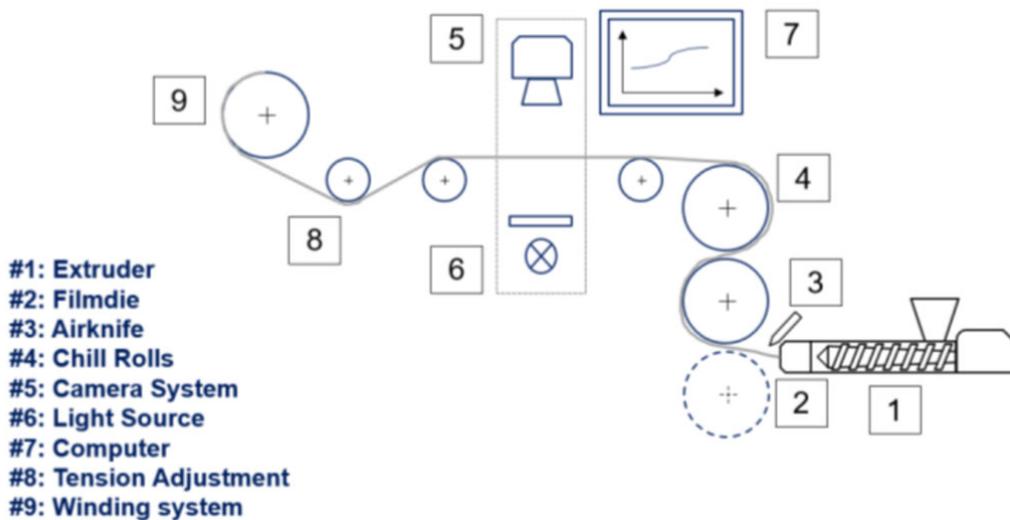


Figure 10. Photographs of crosslinked gels in a LDPE film.

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Basics

A typical set up for inspection of the film quality



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First round robin test

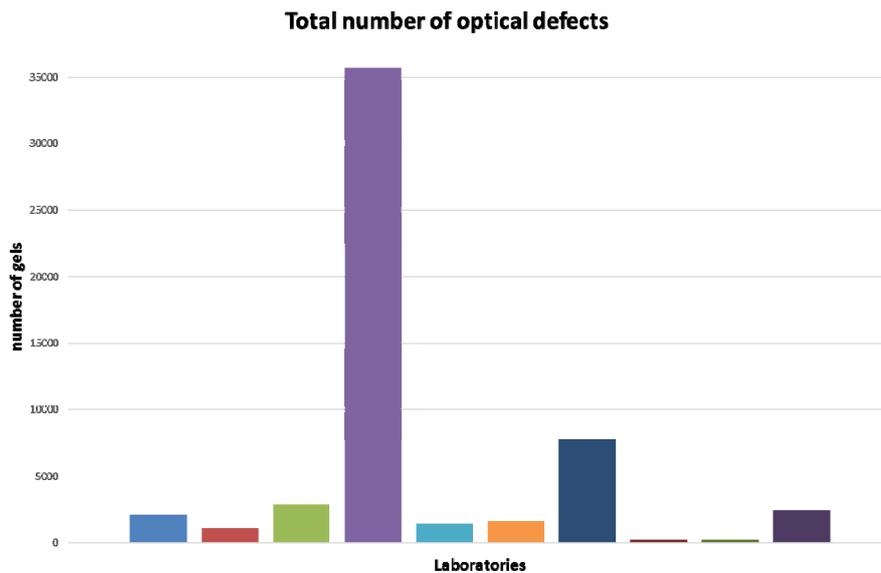
A round robin was agreed to review the results of different internal film testing methods.

10 different laboratories participated by testing one batch of LDPE provided in neutral shipping organized by equipment manufactures.

General information on the equipment set up was provided with the final results.

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First round robin test – results of RR1



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Review and follow up round robin

While every test in itself showed repeatable results, a comparison of the results between different laboratories was not possible.

After reviewing the results as well as the provided equipment information in a group meeting the following parameters have been defined as significant impact:

- Temperature profile of the extruder and film die
- Pressure in the extruder and torque
- Camera setting: Sensitivity and grey levels
- Light source
- Chill roll surfaces and air knife
- Screw mixing elements

In addition the way of evaluation (size of classes) has to be defined.

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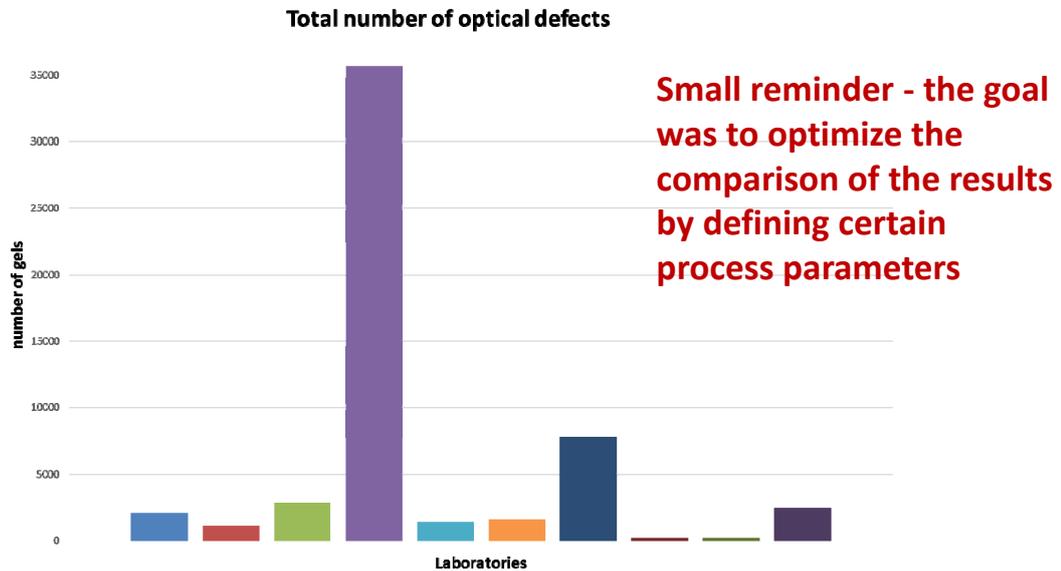
Review and follow up round robin

For a second round robin (RR2) certain defined settings for the film test equipment have been agreed in addition to the way of reporting as well as the use of different polymer types.

Testing parameter	HDPE	PP	LDPE
Temperature profile	x	x	x
Screw speed	x		x
Film thickness	x	x	x
Sensitivity level	x	x	x
Grey level	x	x	x
Chill-roll temperature	x	x	x
Chill-roll speed	x		x
Film tension	x	x	x
Winder tension	x	x	x
Air knife	x	x	x
Analysed surface	x		x
Output		x	

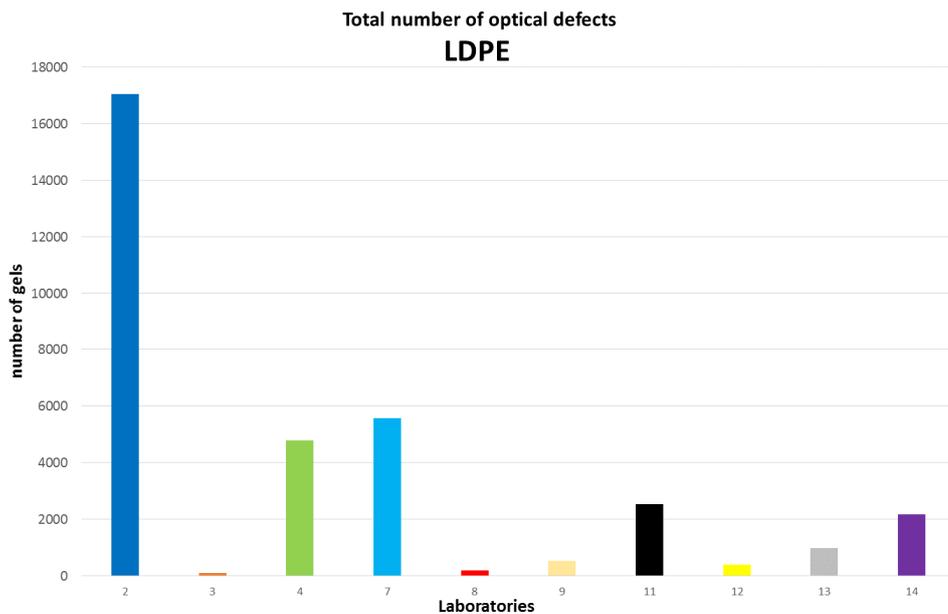
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First round robin test – results of RR1



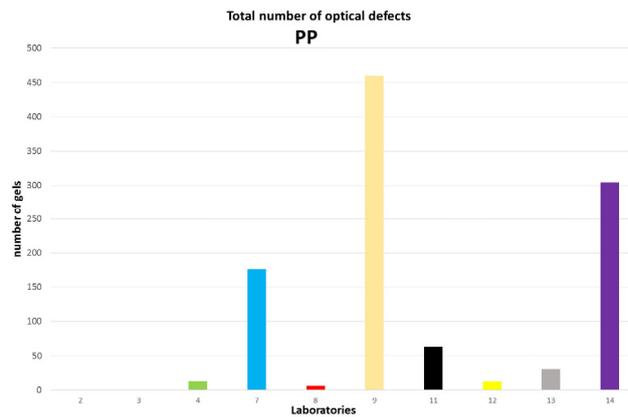
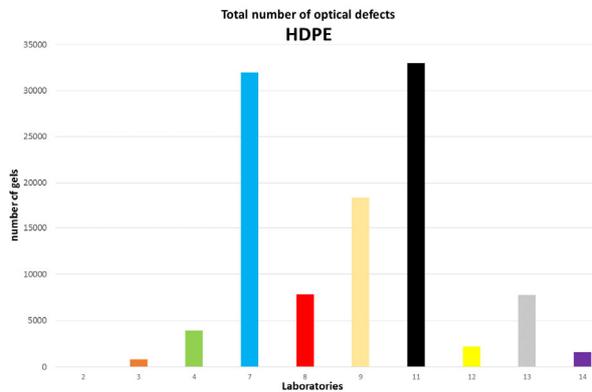
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Results and evaluation RR2



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Further results RR2



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Conclusions

- There have been misunderstandings in the way that the required information needed to be filled out
- Since round robin 2 was run with support of an ASTM service and in a anonymous reporting, misinterpretation of the result form could not be corrected
- Nevertheless the results of the second round robin confirmed what has been noticed in the first round robin already. Even with providing general setting guidelines the results of the film testing in between different laboratories can be considered as not comparable
- The results of the film testing within one laboratory provided comparable results

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What else?

- Even so we had to accept that setting up a method for film testing is not possible, there are several topics we have learned
 - The spread of results is valid for all polymers tested (LDPE, HDPE and PP)
 - An open discussion and best an exchange of material is mandatory to compare results of film testing
 - There is no standard material on the market, that could function as base line for a comparison. At the ASTM meeting the possibility of 3D printing was discussed as a possibility for the future
 - The best way to check if material is fit for purpose is to keep a reference sample of polymer that has been successfully been used in this application

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Next steps

- Details of the work have been published at the ASTM online Journal, the printed version will be issued in November 2019 in Volume 47, issue 6

Title:

Interlaboratory Study to Determine Precision for Defect Detection and Rating of Plastic Film Using Optical Sensors According to ASTM D7310

- Rewrite the ASTM practice
 - The final approval of good or bad is with the final application and user
 - Results coming for example from different suppliers can not be compared

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Thank you for your attention

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