

Technical bulletin on the testing of packaging systems

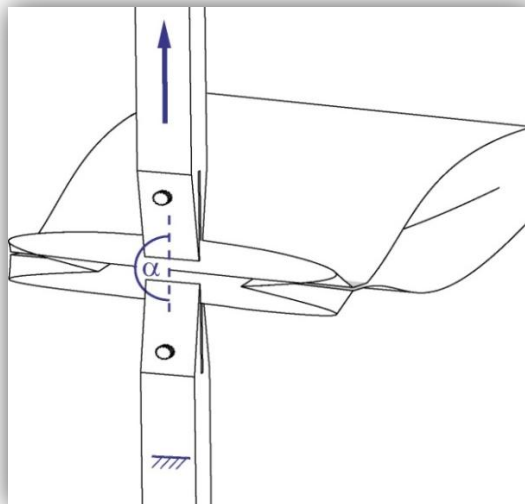
Published by the Industrievereinigung für Lebensmitteltechnologie und Verpackung e.V. (IVLV)
(Industrial Association for Food Technology and Packaging)



Technical Bulletin No. 103/2010 - Part 2

Test method for determining the opening forces for peelable packaging systems

Test class II: Flexible Packaging systems



Published by the supervisory committee of the joint research projekt entitled
"Easy Opening peelable packaging systems"
Of the work group "Filling and packaging systems", October 2010

Fraunhofer Applications Center for Processing Machines and Packaging Technology
Dresden, Germany

Technical bulletin on the testing of packaging systems

Published by the Industrievereinigung für Lebensmitteltechnologie und Verpackung e.V. (IVLV)
(Industrial Organization for Food Technology and Packaging)

Technical bulletin no. 103/2010 - Part 2

Test method for determining the opening forces for peelable packaging systems

Test class II: Flexible packaging systems

Published by the supervisory committee of the joint research project entitled
"Easy opening peelable packaging systems"
of the IVLV work group "Filling and packing of food products", October 2010

1. Introductory remarks

The testing of films for packaging purposes is described in DIN 55529 "Packaging – Determination of the strength of sealed seams of flexible packaging materials". This standard applies for testing the sealed seams on 15 mm wide strips of film made of flexible packaging materials. The result of the test in accordance with DIN 55529 is influenced by the packaging material (packaging film) and the sealing material that is used, as well as the process parameters used for the sealing process. The geometry of the sealed seam, which influences the opening of a peelable packaging, is not considered here. This means that a separate test method is required to determine the opening forces for peelable packaging systems.

Peelable sealed seams on packaging systems allow users to open the packaging by hand, without any opening aids, by peeling away the peel closure. Specific requirements are placed on such packaging systems to enable easy opening. A key factor is the opening force that has to be exerted by the consumer. The shape of a packaging determines the nature of the hand movements required to open the packaging. Analyses of the opening actions on real packaging systems have shown that there are clear differences for flexible and rigid packaging systems. Depending on the sequence of movements there are different opening parameters (e. g. tear angle), which in turn affect the force that has to be exerted on the packaging in order to open it $/3/$, $/4/$. In order to take account of this, two test classes have been defined, each with different requirements on the test set-up and test procedure.

Technical bulletin no. 103/2010 is split into two parts, each describing a test method for determining the opening forces on peelable packaging systems:

- Technical bulletin no. 103/2010 - Part 1 for rigid packaging systems (test class I),
- Technical bulletin no. 103/2010 - Part 2 for flexible packaging systems (test class II).

The information given in this technical bulletin resulted from the R&D project entitled "Development of a standardized test method for determining the peel forces and opening forces on heat-sealed, peelable packaging systems and specification of reference values for user-friendly opening forces" (Project 15261 BR/1, project term 2007 - 2009). This project was undertaken at the Fraunhofer AVV, Dresden.

In January 2010 an application for standardization was submitted to the DIN Packaging Standards Committee, work group "Flexible, flat packaging systems - films, sacks, bags, carrier bags" (NA 115-02-01). The information in this technical bulletin forms part of the standardization work.

2. Purpose and area of application

The test is used to determine the opening forces on peelable packaging systems under near-real conditions. This Part 2 of the test procedure concerns flexible packaging systems such as bags and flexible deep-drawn packaging systems.

The manufacture of the packaging systems can be carried out using a laboratory sealing machine or a packaging machine. The test method has relevance for direct quality assurance monitoring of the packaging process and also for monitoring after transport, transfer, and storage as well as for comparative tests and for checking previously determined target values.

3. Explanation of terms

Peelable packaging: Packaging closed by a sealed seam that can be opened by pulling with the hand (without any auxiliary aids).

Flexible packaging system: A packaging system that has low intrinsic stability and whose shape changes when subjected to even a small force and during intended use /1/. Such packaging systems include bags and so-called "soft" deep-drawn packaging systems.

When opening flexible packaging systems both hands are active and must move roughly symmetrically to open the packaging (pulling the sealed seam apart). The effective tear angle on the sealed seam is determined by the position of the hands and fingers.

Rigid packaging systems: Packaging systems having high intrinsic stability and whose shape does not change or changes inconsiderably when normal forces are applied and during intended use /1/. The test method in accordance with technical bulletin no. 103/2010 - Part 1 covers rigid packaging systems such as boxes, cups, trays, and some bottles.

For these packaging systems the dominating hand is active (namely the right hand for a right-handed person), and pulls the cover film away from the lower part of the packaging. The non-dominating hand is passive and exerts the counter force on the lower part of the packaging.

Tear angle α : Angle of separation at the sealing seam during the tearing process (see Figure 1).

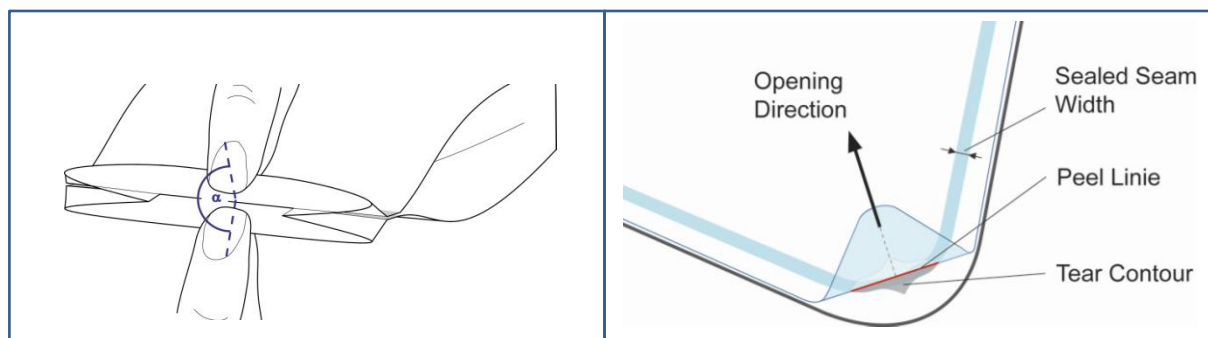


Figure 1 Schematic representation of the tear angle α on a flexible packaging system

Figure 2 Schematic representation of sealed seam width, peel line, and tear contour

Opening force: The force that has to be applied to open the packaging. This is preferably applied by pulling away the sealed seam. In some circumstances the opening force may also contain force components that lead to deformation of the packaging or to tearing or further tearing of the packaging. The opening force F_{opening} changes during the opening process as a function of the opening distance s .

Sealed seam width: Width of the sealed seam separating the inside of the packaging and the surroundings (see Figure 2).

Tear contour: The shape of the sealed seam (produced by the sealing tool) in the tear region (see Figure 2). Careful shaping of the sealed seam results in a lower opening force.

Peel line: Length of the boundary line between the still closed and already open seam at right angles to the direction of opening (see Figure 2).

4. Recommendations for preparing for and carrying out the tests

Preliminary tests to determine criteria for ending the test: Test-end criteria are specified based on preliminary tests. The test must be ended when the packaging is sufficiently wide open to allow the consumer to comfortably remove the contents. With bags it is particularly important to ensure that the test is at the latest ended after complete pulling open of the sealed seam but before the start of stretching of the packaging.

Test specimens: It is preferable to use filled packaging for the tests in order to take account of any influences from the manufacturing and filling processes (contents, machinery, and packaging). It is permissible to test empty packaging but this must be noted in the test protocol.

Preparation of the test specimens: Filled packaging systems may be emptied prior to the test, by opening or separating the base or the side opposite the tear contour, and removing the contents. The intactness of the sealed seam must be ensured. Alternatively, filled packaging can be tested. In this case attention must be paid to maintaining the tear angle (see Figure 5). In order to avoid contact with the test rig, the length of the packaging must, if necessary, be shortened.

Number of test specimens: The number and selection of the test specimens must be such that a statistically reliable result can be obtained. Ten specimens per test series are recommended. For empty packaging systems, 5 specimens per test series may suffice depending on the variance of the measured values.

Test conditions: The test specimens are normally tested under standard conditions (23°C, 50% r. h.). Depending on the specific packaging, it may be necessary to carry out the test under the intended conditions of use. For example, the opening force of a microwave packaging must be tested after appropriate heating in a microwave oven. For frozen packaging intended for opening by consumers in the frozen state, the opening test must be carried out under these conditions. The testing of packaging for sterile goods is carried out after the sterilization process.

Time point of testing: In order to ensure that the final seam strength has been reached, a period of 40 hours must always elapse between the manufacture of the packaging and the testing of the seam. Tests on an ongoing production process serve to check quality parameters, with the opportunity to be able to respond quickly if there are any fluctuations in the quality. In this case it is therefore sensible to carry out the tests immediately after manufacture. In order to be able to make a statement about the best before period (shelf life) of the packaging, it is advisable to repeat the test at different time points within the best before period.

5. Test equipment/technology

The measurements are made using a tensile testing machine, which permits measurement and plotting of the force at a constant peel speed and constant peel angle. The opening force must be able to be measured and plotted to an accuracy of $\pm 1\%$.

Secure, play-free **clamping** of the packaging must be guaranteed. Any deformation of flexible packaging caused by the opening process must not be hindered, because the forces which act here also have to be applied by consumers and are hence relevant for opening the packaging.

For bags, the width of the clamps has a demonstrable effect on the resulting opening force. Hence for clamping bags use **20 mm wide film clamps**.

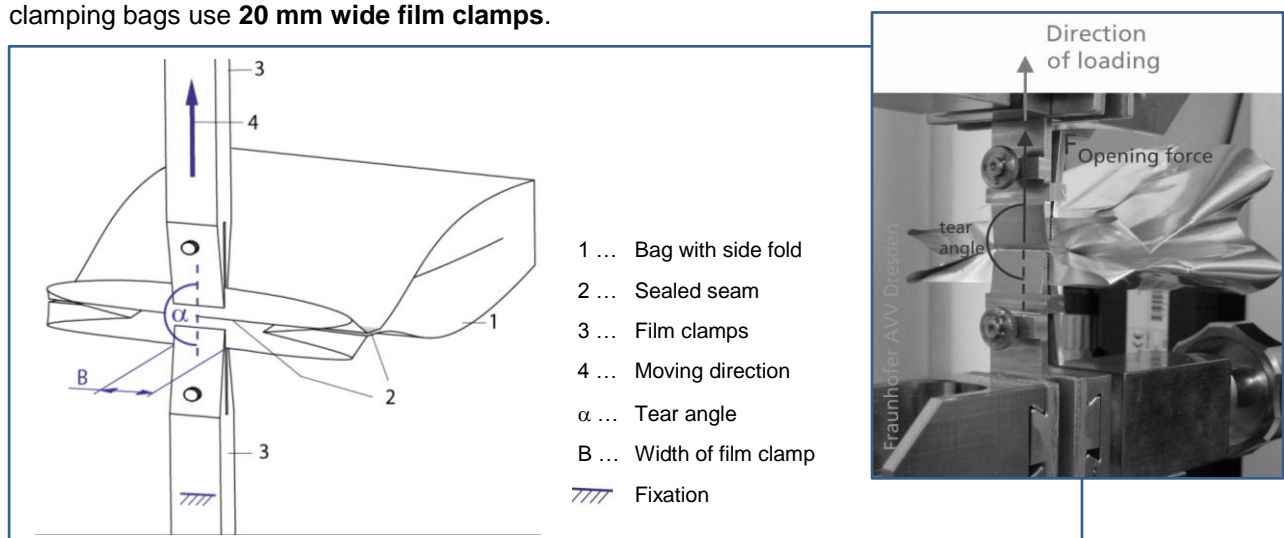


Figure 3 Schematic representation of the test set-up for test class II - Flexible packaging systems; Test set-up (see insert)

6. Test parameters for test class II

Tear angle: 180°

Test speed: 600 mm/min

Other test speeds can be used but this must be noted on the test protocol. It must be remembered that the opening force is very dependent on the test speed, meaning that it is only possible to compare results if the test speed is constant.

7. Test procedure

Setting up the test equipment

- Set as high as possible sampling rate for recording measurement values
- Switch off pre-load
- Align the clamps parallel and centered to each other

Preparing/mounting the test specimens

- Open filled packaging, if necessary at the base, and remove the contents
- If necessary shorten bags in order to avoid contact with the test rig
- Clamp the packaging without damaging the sealed seam
- After clamping one side of the packaging (in the clamp on the force gauge) zero the force value
- The alignment of the bag and tear contour on "soft" deep-drawn packaging systems must be centered/symmetrical to the film clamps (see also Figure 4)

Note: When clamping the packaging it must be ensured that the set peel speed is only reached after certain acceleration (crosshead travel).

Testing

- Support the packaging with the hand in order to guarantee a tear angle of $90^\circ + 90^\circ = 180^\circ$ during the whole opening process
 Note: For (empty) packaging that has adequate intrinsic stability there may be no need to support the packaging with the hand, provided preliminary tests demonstrated that the packaging aligns itself symmetrically during the test (see also Figure 5).
- plot the opening force required to open the sealed seam as a function of the opening distance in a force/distance graph
- end the test at the onset of stretching of the packaging after successful opening of the sealed seam (specially for bags)

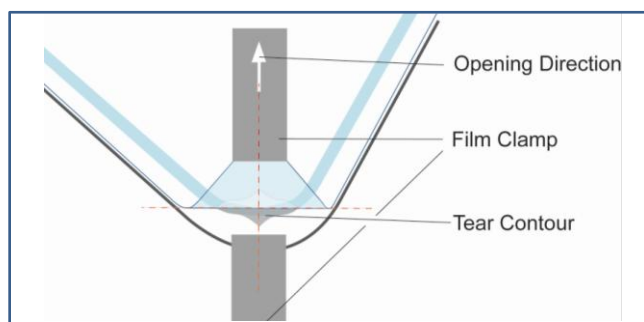


Figure 4 Illustration of the clamping of packaging with alignment of the clamp to the tear contour

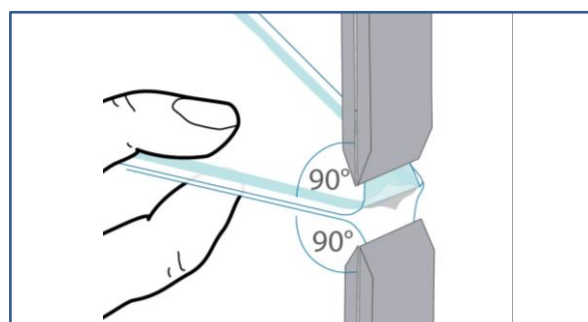


Figure 5 Method for supporting the packaging with the hand during the test

8. Evaluation

The maximum opening force is read off the graph. It must be noted that the maximum opening force generally occurs before or on first complete exceeding of the sealed seam width (see Figure 7 and Figure 8, measurement point 3).

For bags there is typically subsequent opening of the sealed seam along the sealed seam width. The force required for this is generally less because the length of the peel line decreases. A further force increase, above the maximum opening force, may occur once the sealed seam is open and stretching of the side region of the bag occurs (see Figure 8, measurement point 6). This force increase is not a component of the opening force and must not be evaluated.

Besides the measurement values, the opening patterns (e.g. thread-free peel, opening of the longitudinal seam, packaging material torn) must be described and if necessary photographed. Information about the opening of the packaging which could aid interpretation of the measurement results must be added (e.g. the packaging was not completely opened or was opened up to ... , tear edge slipped out of the film clamp).

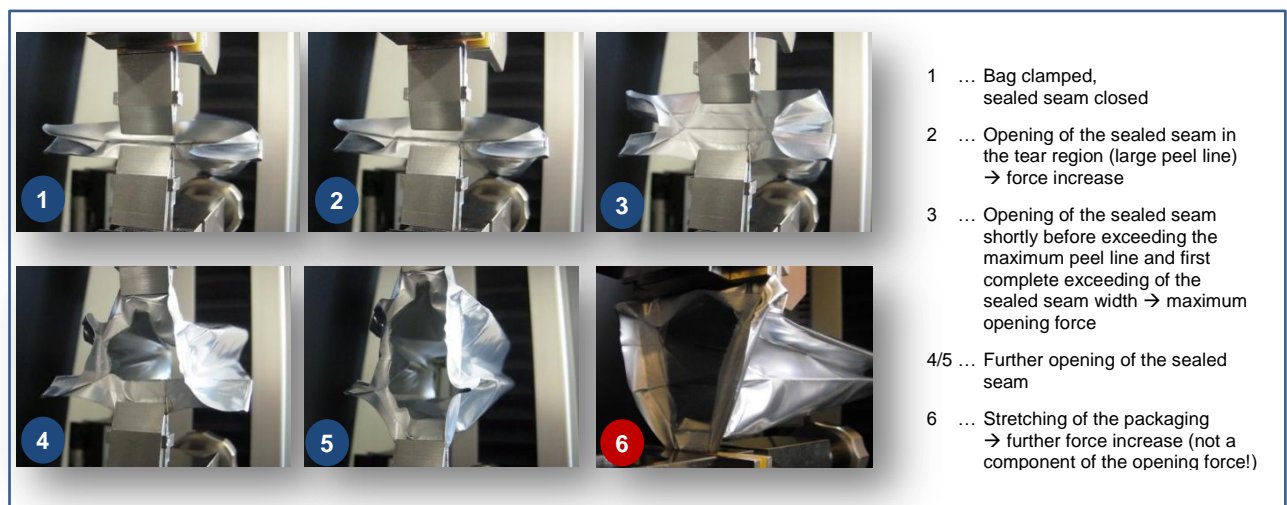


Figure 6 Visualization of the opening steps using the example of a bag (Assignment of the steps to typical opening force / opening distance curves by labeling the measurement points 1 to 6, see Figure 7 and Figure 8)

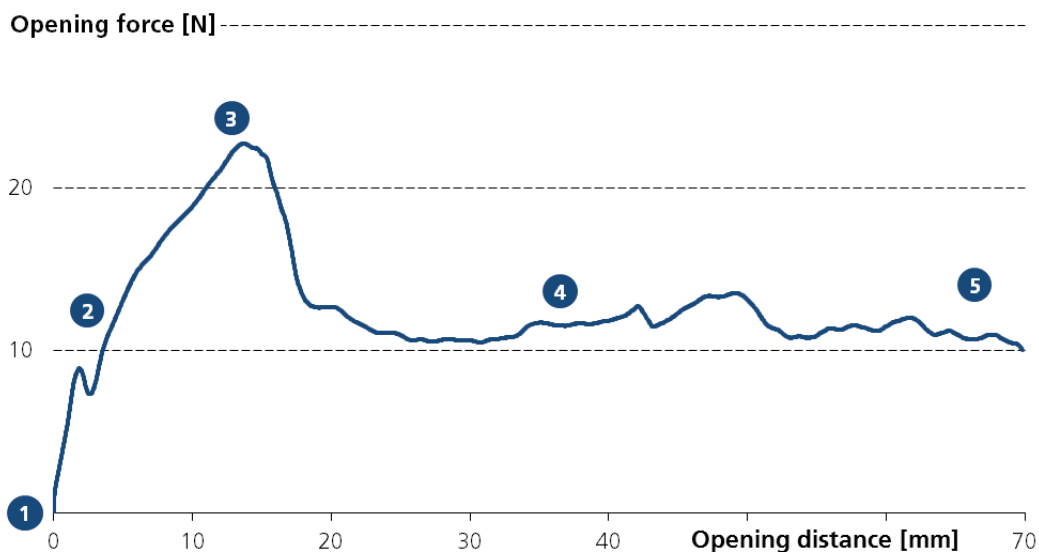


Figure 7 Example of a graph of opening force versus opening distance

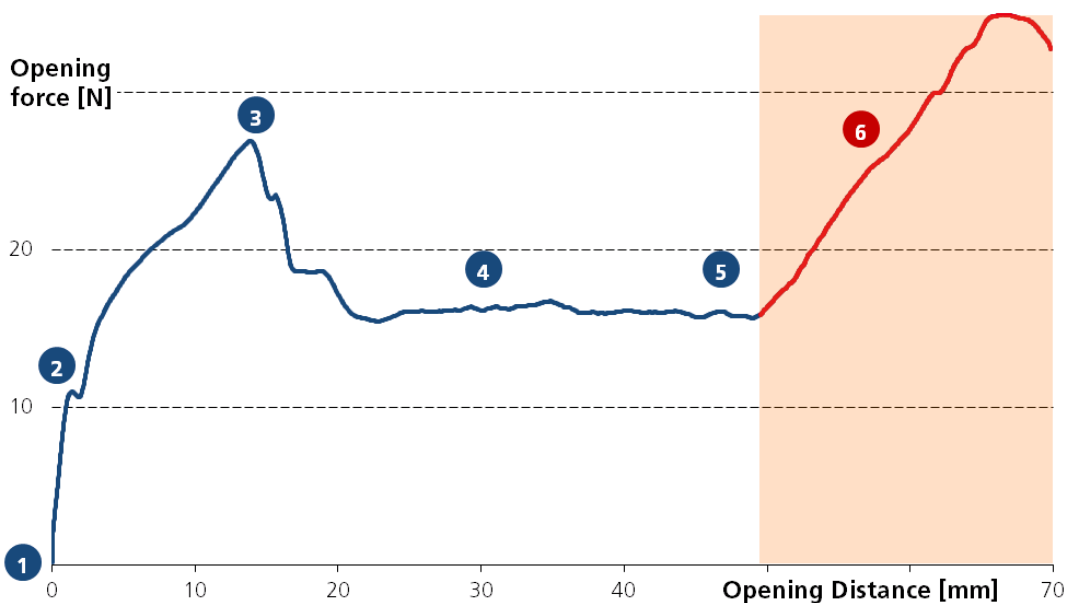


Figure 8 Example of the opening force plotted against the opening distance with a further force increase due to stretching of the packaging

9. Test protocol

The following must be indicated in the test protocol, with referral to this technical bulletin:

- a) Name of the test specimens
- b) Specifications of the packaging (dimensions, packaging material, bag with/without side fold)
- c) Packaging content present or empty packaging
- d) Purpose of the packaging (e. g. packaging which can be resealed, packaging suitable for microwave oven, packaging suitable for deep-freeze)
- e) Date of manufacture
- f) If applicable, the best before date
- g) If applicable, specification of the machine (machine type, packaging line, track, sealing station)
- h) Sealing conditions:
 - Sealing parameters (temperature, pressure, time),
 - Sealing tool (shaping, coating, contour),
 - Sealed seam width,
 - If necessary photos
- i) Preparation of the test specimen (e. g. heating in the microwave)
- j) Test parameters: Tear angle, test speed
- k) Criteria for ending the test (e. g. opening distance, force)
- l) Number of test specimens
- m) Average values of the maximum opening force; standard deviation (2 sigma); coefficient of variation; in some cases minimum and maximum values
- n) Information about the opening of the packaging
- o) Description of the opening pattern
- p) If relevant, any agreed deviations from the test guideline
- q) Test organization, date, name of tester

10. References

- /1/ Bleisch, G.; Goldhahn, H.; Schricker, G.; Vogt, H.: *Lexikon Verpackungstechnik*. Behr's Verlag 2002
- /2/ DIN 55529: Packaging – Determining the sealed-seam strength of sealings made of flexible packaging material. (2005)
- /3/ Liebmann, A.; Schreib, I.: *Entwicklung eines standardisierten Prüfverfahrens zur Ermittlung von Peel- bzw. Öffnungskräften an heißgesiegelten, peelbaren Verpackungen und Erarbeitung von Richtwerten für verbraucherfreundliche Öffnungskräfte*. AiF-Abschlussbericht, Vorhaben-Nr. 15261 BR/1, IVLV München, 09/2009
- /4/ Nase, M.; Langer, B.; Baumann, H.J.; Grellmann, W.: *Fracture Mechanics on Polyethylene/Polybutene-1 Peel Films*. Polymer Testing, 27 (2008), 1017–1025

The following have assisted in the drawing up of this IVLV-technical bulletin:

Authors:

Andrea Liebmann and Ina Schreib

Fraunhofer Application Center for Processing Machinery and Packaging Technology (AVV),
Dresden / Germany

Members of the supervisory project committee:

CFS Germany GmbH
Constantia Hueck Folien GmbH & Co. KG
Du Pont de Nemours (Germany) GmbH
Innoform GmbH/ Testservice
Kraft Foods Germany GmbH
NORDENIA Germany Halle GmbH
ofi Technologie & Innovation GmbH
ORBITA-FILM GmbH
Robert Bosch GmbH, Packaging Technology
Sealpac GmbH
Wipak Walsrode GmbH & Co. KG
Wipf AG
Zwick GmbH & Co. KG

Funding and acknowledgements:

The R&D project no. 15261 BR/1 of the Industrievereinigung für Lebensmitteltechnologie und Verpackung e. V. (IVLV), Schragenhofstr. 35, 80992 Munich, Germany, was funded via the German Federation of Industrial Research Associations (AiF) under the program for funding joint industrial R&D of the German Federal Ministry of Economics and Technology (BMW), following a decision by the German Parliament.

We thank the BMWi for this funding. We also acknowledge the helpful support of the AiF and IVLV.

The final report of the R&D project entitled "Development of a standardized test method for determining the peel forces and opening forces on heat-sealed, peelable packaging systems and specification of reference values for user-friendly opening forces" (project no. 15261 BR/1, project term 2007 – 2009) can be obtained from the IVLV e. V..