INTERNATIONAL STANDARD

ISO 5412

First edition
2022-09

Plastics — Industrial compostable plastic shopping bags

Plastiques — Sacs à provisions en plastique compostables en compostage industriel

Reference number
ISO 5412:2022(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 14, *Environmental aspects.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Increased use of plastic shopping bags can cause several environmental problems, such as terrestrial pollution and contamination of soil, water and marine environment pollution. These pose a severe risk to ecosystems, biodiversity and human health. Recently, many countries, regions, and cities have enacted legislation to ban or severely reduce the use of plastic shopping bags to help tackle these issues.

This document does not aim to bypass this legislation; it aims to specifically address the following aspects where plastic shopping bags suitable for industrial composting can be appropriate for specific uses:

a) offering methods for testing industrial compostability, followed by demonstrating the impact of industrial compostable shopping bags on the ecological environment;

b) providing a reference for the evaluation of industrial compostable plastic shopping bags for industrial composting.

Development of this document is expected to improve the quality control of plastic shopping bags suitable for industrial composting, in countries, regions, and cities where industrial composting is available. Furthermore, this document ensures provision of industrial compostable shopping bags to be stronger.

Plastics — Industrial compostable plastic shopping bags

1 Scope

This document specifies the requirements, test methods, test regulations, packaging, transportation and storage of industrial compostable plastic shopping bags.

This document is applicable to plastic shopping bags made from industrial compostable plastic resin as the main raw material, processed by heat sealing or bonding, etc.

This document does not apply to industrial compostable plastic bags such as industrial compostable roll bags (also known as tear bags or point break bags made from above materials) and other bags that are only used in packaging and are not used for carrying shopping.

This document enables to characterise the compostable plastic bags following two testing approaches that bring to the definition of two classes (class I and class II).

NOTE In some regions, industrial composting is referred to as professional composting.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 4592, *Plastics — Film and sheeting — Determination of length and width*

ISO 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*

ISO 7765-1:1988, *Plastics film and sheeting — Determination of impact resistance by the free-falling dart method — Part 1: Staircase methods*

ISO 17088, *Plastics — Organic recycling — Specifications for compostable plastics*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
industrial compostable plastic shopping bags
bags made of industrial compostable plastic resin as the main raw material, and having a structure suitable for carrying goods, which are intended to use for packaging and carrying shopping (as groceries in stores, restaurants and other places) and intended for industrial composting when the use is finished

3.2
industrial composting
composting process performed under controlled conditions on industrial scale with the aim of producing compost for the market

Note 1 to entry: In some regions, industrial composting is referred to as professional composting.

[SOURCE: ISO 17088:2021, 3.13]

4 Requirements

4.1 Dimension deviation

4.1.1 Types and dimensions

Shopping bags are classified into two categories: class I and class II according to sealing strength and stress at break requirements (refer to 4.3 for detail). Class II consists of bags that have a sealed bottom and are punched to form handles (often called "T-shirt bags"). Class II shopping bags are divided into four types according to their volume as indicated in Table 1.

Table 1 — Types and dimensions

Type	Denomination	Volume V litres
L	Large bag	$V > 25$
M	Medium bag	$15 \leq V \leq 25$
S	Small bag	$9 \leq V < 15$
XS	Extra small	$V < 9$

The volume in litres is calculated according to Formula (1) that refers to Figure 1.

$$V = \frac{W^2}{\pi} \times \left(L - \frac{W}{\pi} \right) \times 9 \times 10^{-7} \quad (1)$$

where

$L = (l_1 - l_2)$

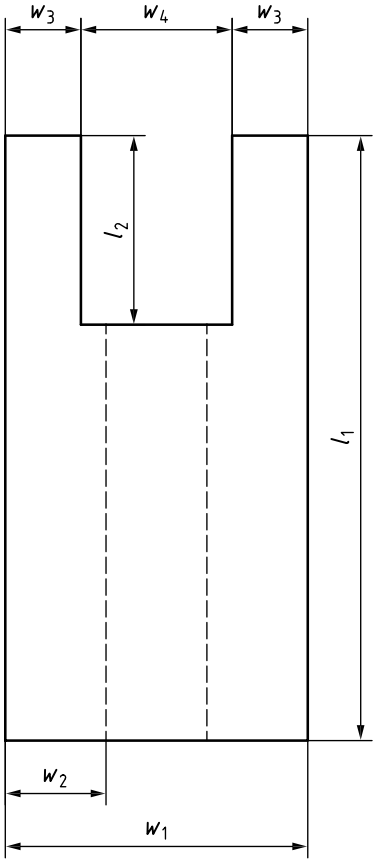
$W = (w_1 + 2w_2)$

w_1 is the total width, in millimetres (mm);

w_2 is the gusset width, in millimetres (mm);

l_1 is the total length, in millimetres (mm);

l_2 is the cutting length, in millimetres (mm).



Key

w_1 total width
w_2 gusset width
w_3 handles width
w_4 cutting width
l_1 total length
l_2 cutting length

Figure 1 — Schematic representation showing each parameter of a shopping bag for volume calculation

4.1.2 Thickness and deviation

For class I, the thickness limit deviation and the average deviation shall be in accordance with the requirements of Table 2.

Table 2 — Thickness deviation

Nominal thickness e mm	**Thickness limit deviation** mm	**Range** mm	**Average thickness deviation** %
e=0,015	+0,010 -0,006	0,016	+20 -6
0,015 < e ≤ 0,020	+0,010 -0,008	0,018	+20 -6

Table 2 *(continued)*

Nominal thickness e mm	Thickness limit deviation mm	Range mm	Average thickness deviation %
0,020 < e ≤ 0,025	+0,010 -0,008	0,018	+15 -10
0,025 < e ≤ 0,030	+0,010 -0,008	0,018	+15 -10
0,030 < e ≤ 0,035	+0,010 -0,008	0,018	+15 -10
0,035 < e ≤ 0,040	+0,009 -0,009	0,018	+14 -9
0,040< e ≤ 0,100	+0,010 -0,010	0,020	+14 -9

For class II, the average tolerance on thickness must be within the range −5 % and +15 % of the declared nominal thickness (as described in 5.2.1.3).

4.1.3 Width deviation

The width deviation of industrial compostable plastic shopping bags shall be in accordance with the requirements of Table 3.

Table 3 — Width deviation

Nominal width w mm	Limit deviation mm
w ≤ 380	±20
380 < w < 600	±25
w ≥ 600	±30

4.1.4 Length deviation

The length deviation of industrial compostable plastic shopping bags shall be in accordance with the requirements of Table 4.

Table 4 — Length deviation

Nominal length l mm	Limit deviation mm
l ≤ 380	±20
380 < l < 600	±25
l ≥ 600	±30

4.2 Print quality

4.2.1 Appearance of print

For industrial compostable plastic shopping bags with prints, the printing ink shall be even, and the pattern and text shall be legible and intact.

4.2.2 Stripping rate

The stripping rate shall be less than 20 % of tested area.

4.3 Physical and mechanical properties

The physical and mechanical properties shall be in accordance with the requirements of Tables 5, 6, 7 and 8.

Table 5 — Physical and mechanical performance requirements

Test item	Requirement	
	Class I	Class II
Lifting test	None of the three bags breaks	None of the three bags breaks
Drop test	None of the three bags breaks	Not required
Water leakage	None of the three bags leaks	None of the three bags leaks
Sealing strength	Shown in Table 6	Shown in Table 7
Dart impact	Number of none breakage ≥ 8	Number of none breakage ≥ 8
Stress at break	Not required	Shown in Table 8

Table 6 — Sealing strength requirement for class I

Nominal load bearing m kg	Requirements N/15 mm
$m \leq 2$	≥ 2
$2 < m \leq 6$	≥ 4
$6 < m \leq 10$	≥ 6
$m > 10$	≥ 8

Table 7 — Sealing strength requirement for class II

Type	Requirements N/15 mm
L	≥ 5
M	
S	≥ 3
XS	

Table 8 — Stress at break requirements for class II

Direction	Requirement N/mm^2 (MPa)
MD	≥ 20
TD	≥ 18
MD Machine direction i.e. longitudinal to the direction of extrusion TD Transverse Direction i.e. direction transverse to the direction of extrusion	

4.4 Industrial compostability

The fitness to industrial compostability of industrial compostable plastic shopping bags shall be evaluated in accordance with ISO 17088.

5 Test methods

5.1 Sample condition adjustment and test environment

Test shall be carried out according to the standard environment (temperature 23 °C ± 2 °C, humidity 50 % ± 10 %) as specified in ISO 291. Time for the condition adjustment shall be no less than 88 h.

5.2 Dimension deviation

5.2.1 Thickness deviation

5.2.1.1 General

Open the industrial compostable plastic shopping bag, cut it off, spread it on one side, and measure the thickness of the single-sided film with a thickness gauge in accordance with the provisions of ISO 4593. Measure 8 points uniformly along the width direction of the bag and calculate the thickness limit deviation and average deviation of thickness according to Formula (2) and Formula (3) respectively. For industrial compostable plastic shopping bag having embossing, the embossing shall be flattened, and the thickness of the flattened place shall be measured.

5.2.1.2 Calculation of thickness limit deviation (only for class I)

$$\Delta e = e_{\text{min or max}} - e \tag{2}$$

where

Δe is the thickness limit deviation, in millimetres (mm);

$e_{\text{min or max}}$ is the measured minimum or maximum thickness, in millimetres (mm);

e is the nominal thickness, in millimetres (mm).

5.2.1.3 Calculation of average deviation of thickness

$$\Delta \bar{e} = \frac{\bar{e} - e}{\text{e}} \times 100 \tag{3}$$

where

$\Delta \bar{e}$ is the average thickness deviation, expressed as a percentage (%);

$\bar{e}$ is the average thickness, in millimetres (mm);

e is the nominal thickness, in millimetres (mm).

5.2.2 Width and length deviation

5.2.2.1 General

Spread the industrial compostable plastic shopping bag flat on horizontal surface (unfold the fold in case there is an edge fold), measure width and length in accordance with the provisions of ISO 4592 using a ruler with a scale of 1 mm, along the length side and width side of the sample. Measure the width and length of the effective use area of the plastic bag at equal distance, at least 4 times-points.

For industrial compostable plastic shopping bag with a hem, open the hem, and level the bag horizontally to measure the overall width of the bag.

Calculate the width limit deviation according to Formula (4) and calculate the length limit deviation according to Formula (5).

5.2.2.2 Calculation of width limit deviation

$$\Delta w = w_{\text{min or max}} - w \tag{4}$$

where

Δw is the width limit deviation, in millimetres (mm);

$w_{\text{min or max}}$ is the measured minimum or maximum width, in millimetres (mm);

w is the nominal width, in millimetres (mm).

5.2.2.3 Calculation of length limit deviation

$$\Delta l = l_{\text{min or max}} - l \tag{5}$$

where

Δl is the length limit deviation, in millimetres (mm);

$l_{\text{min or max}}$ is the measured minimum or maximum length, in millimetres (mm);

l is the nominal length, in millimetres (mm).

5.3 Print quality

5.3.1 Print appearance

Observe visually the uniformity of the printed ink, legibility and integrity of pattern and text under natural light.

5.3.2 Stripping rate

Cut off a portion of the bag having more printing ink for print peeling rate test. In the test, fix the sample on a smooth surface with the print side facing up using transparent tape to expose the part for test having dimensions of 100 mm × 100 mm. Do not touch the measurement part by hand during operation and apply a 180° adhesive tape having peel strength of (1 N to 3 N)/10 mm, to the printed side of the sample. Fold the tape with dimensions of 15 mm wide and 175 mm long at 180° angel and 75 mm from

the end. Roll back and forth once at the bonding position with a 1 kg roller and then, peel the tape off quickly by hand. Measure the peeled area and the residual area of the printing ink with a steel scale having a scale interval of 0,5 mm, and calculate the stripping rate of the printing ink according to Formula (6). Test three (3) times, take the average, and round the result to 1 %.

$$\Delta s = \frac{s}{s_0} \times 100 \tag{6}$$

where

Δs is the stripping rate of the printing ink, expressed as a percentage (%);

s is the peeling area, in square millimetres (mm^2);

s_0 is the tested area, in square millimetres (mm^2).

5.4 Physical and mechanical properties

5.4.1 Stress at break (only for class II)

The mechanical traction characteristics are determined according to ISO 527-3, on Type 2 specimens obtained directly from the bag in both longitudinal and transversal directions, in areas that do not have bends or welds.

5.4.2 Lifting test

For class I, put a simulant (such as sand, rice, etc.) equivalent to a nominal load-bearing capacity and not exceeding two-thirds of the effective volume of the bag in the bag, and then hang the loaded bag on the testing machine with amplitude of 30 mm ± 2 mm, at a frequency of 2 Hz (120 beats / min) for 500 times. Observe bag body and handle for any damage and record the observed phenomenon. Perform the tests three times.

For class II, the loading unit is represented by a typical 1 kg packet of table salt, i.e. a cardboard box in the shape of a rectangular parallelepiped containing 1 kg of salt. Other 1 kg packs of similar dimensions can be used. The bag under testing is filled with a number of packs needed to reach the total load indicated in Table 9, according to the bag's size. Hang the loaded bag on the testing machine with amplitude of 60 mm ± 2 mm, at a frequency of 2 Hz (120 beats/min) for 600 times. Observe bag body and handle for any damage and record the observed phenomenon. Perform the tests three times.

Table 9 — Loading mass used for lifting test for class II

Type	Loading mass kg
L	8
M	7
S	5
XS	1

5.4.3 Drop test (only for class I)

Put a simulant (such as sand, rice, etc.) equivalent to a nominal load capacity and a volume not exceeding two-thirds of the effective volume in the bag.

Then evacuate the air in the vacant portion. Seal the bag with an adhesive tape while keeping the upper bag film sufficiently loose. Allow the bottom of the bag drop freely from a height of 0,5 m from the ground. The test ground shall be smooth, flat and hard. Observe the bag for any leaking out of any simulants (i.e. sand, rice, etc.) and record the observed phenomenon. Test three times.

Perform no such test for the plastic shopping bags which due to requirement for special functions were partially heat-sealed and thus showing stress concentration in the bag, e.g. a partially heat-sealed shopping bag (such as a partially heat-sealed beverage bag) for separating or supporting the contents in the bag.

5.4.4 Water leakage test

Fill 500 ml of water (water temperature 23 °C ± 2 °C) slowly into the plastic shopping bag, hang the bag and keep the bottom horizontally for 1 min. Observe the bottom of the plastic shopping bag for any water drops leaking, and record the observed phenomenon. Test three times.

Perform no such test for plastic shopping bags that are designed for special function and needs no water leakage-proof.

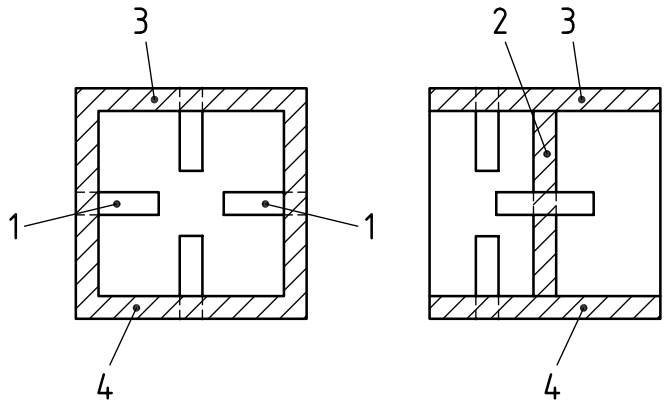
This test is only for plastic bags that require water leakage performance.

5.4.5 Sealing strength test

As shown in Figure 2, samples are randomly taken in a direction vertical to the heat-sealed portion. Shape and size of sample used in sealing strength test is shown in Figure 3.

Test method can be done according to methods described in ASTM F88.

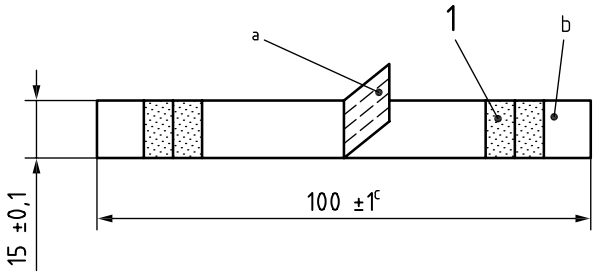
Sealing strength of shopping bags is calculated by the arithmetic mean of 10 samples, expressed in N/15 mm, rounded to three significant figures.



Key

1 side heat seal
2 back heat seal
3 top heat seal
4 bottom heat seal

Figure 2 — Position of sampling for sealing strength test



Key

1 adhesive tape

a Heat-sealed portion.

b Same material of bags.

c Unfolded length.

Figure 3 — Shape and size of sample used for sealing strength test

5.4.6 Dart impact test

Perform the dart impact test in accordance with ISO 7765-1:1988, method A, single-piece sample method instead of step method. Determine the number of undamaged samples by using dart of fixed mass as shown in Table 10. Use 10 pieces of samples.

Table 10 — Mass of dart

Nominal thickness e mm	Mass of dart G g
$0{,}015 \leq e < 0{,}025$	20
$0{,}025 \leq e < 0{,}030$	25
$0{,}030 \leq e < 0{,}035$	40
$0{,}035 \leq e < 0{,}040$	60
$e \geq 0{,}040$	80

5.5 Industrial compostability

Industrial compostability testing shall be in accordance with ISO 17088.

Industrial compostability test shall be conducted in the case of product declared as an industrial compostable shopping bag.

6 Testing regulations

6.1 Batch

Products are accepted in batches. Products produced continuously using the same process from raw materials of the same grade, specification and formula.

6.2 Inspection classification

6.2.1 Factory inspection

Factory inspection items include print quality, thickness, width, length, drop and leak test.

6.2.2 Type test

The type inspection items include dimension deviation, print quality, physical and mechanical properties. In one of the following cases, the type inspection shall be carried out:

a) first batch production;

b) when the raw material variety, product structure, production process or equipment changes;

c) when the factory inspection result is significantly different from the previous type inspection result;

d) when production resumes after suspension of production for more than 6 months;

e) continuous production for one year;

f) when required by relevant national quality supervision authorities.

6.3 Sampling plan

6.3.1 Dimensional deviation

A double sampling plan for normal inspection of ISO 2859-1 shall be used. The inspection level (il) is the general inspection level ii, and the reception quality limit (AQL) is 6,5. The sample and judgment array are shown in Table 11. Take each unit package as a sample unit. The unit package can be box, bundle, bag, piece, etc. During the test, randomly take one sample plastic bag from each unit package for sampling inspection.

Table 11 — Sampling plan

Lot size	Sample	Sample size	Cumulative sample size	Acceptance number	Rejection number
< 50	First	5	5	0	2
	Second	5	10	1	2
51-90	First	8	8	0	3
	Second	8	16	3	4
91-150	First	13	13	1	3
	Second	13	26	4	5
151-280	First	20	20	2	5
	Second	20	40	6	7
281-500	First	32	32	3	6
	Second	32	64	9	10
501-1 200	First	50	50	5	9
	Second	50	100	12	13
1 201-3 200	First	80	80	7	11
	Second	80	160	18	19
3 201-250 000	First	125	125	11	16
	Second	125	250	26	27

6.3.2 Print quality, physical and mechanical properties, industrial compostability

Take randomly a sufficient number of samples from the extracted samples for testing.

6.4 Decision rule

6.4.1 Qualification

6.4.1.1 Dimensional deviation

The determination of the unit sample test results for dimensional deviation shall be performed in accordance with 5.2.

The batch inspection results for marking, dimensional deviation was determined in accordance with Table 11. For the first sample quantity given by the first sampling test, if the number of non-conforming products is less than or equal to the first acceptance number quantity, the item is judged as qualified; if the number of non-conforming products is greater than the first rejection number, then it is judged unqualified. If the number of non-conforming products is between the first acceptance number and the first rejection number, a second sampling inspection is performed. After the second sampling test gives the total number of second samples, if the total number of non-conforming products from two samplings is less than or equal to the second acceptance number, the item is judged as qualified; If the total number of non-conforming products from two samplings is greater than the second rejection number, the item is judged as unqualified.

6.4.1.2 Print quality, physical and mechanical properties and industrial compostability

The determination of the test results of the print quality, physical and mechanical properties and industrial compostability of the senses shall be carried out according to 5.3, 5.4 and 5.5. If all test results are qualified, the test shall be judged as qualified; if there are any unqualified indicators, two-fold samples shall be taken from the original batch to re-examine the unqualified indicators, and the results of all the re-examination results shall be judged as qualified; otherwise the item failed.

6.4.2 Determination of qualified batch

If the marking, dimensional deviation, print quality, physical and mechanical properties, and industrial compostability are all qualified, the batch is judged as qualified; otherwise, unqualified.

7 Packaging, labelling on packaging, transportation, storage

7.1 Package

Industrial compostable plastic shopping bags are generally packaged in plastic film, woven bags or cartons. Other packaging materials can also be negotiated between the supplier and the buyer.

7.2 Mark on packaging

Required marking shall include name of manufacturer, production date, “industrial compostable”, maximum load, shopping bag type (i.e. L, M, S, or XS, only for class II), reference to the present document, and reference to the applied testing approach (i.e. class I or class II).

7.3 Transport

Industrial compostable plastic shopping bags should be kept away from heat sources above 50 °C during transportation. Exposure to sun, rain, trampling, mechanical collisions and contact with sharp objects should be avoided. Further it is strictly prohibited to mix with toxic, harmful, and odorous substances. The outer packaging shall be kept in good shape during handling.

7.4 Storage

The product should be stored in a ventilated, cool, dry warehouse to avoid exposure to sunlight and rain, and away from sources of pollution, heat sources above 50 °C, moisture, rats, and insects. A reasonable shelf life shall be determined based on the performance of the industrial compostable plastic shopping bag. The shelf life of the storage shall be the period that mechanical properties meet requirements.

Bibliography

[1] ISO 12846, *Water quality — Determination of mercury — Method using atomic absorption spectrometry (AAS) with and without enrichment*

[2] ISO 17294-2, *Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) — Part 2: Determination of selected elements including uranium isotopes*

[3] ISO 18606, *Packaging and the environment — Organic recycling*

[4] EN 13432:2000, *Packaging—Requirements for packaging recoverable through composting and biodegradation—Test scheme and evaluation criteria for the final acceptance of packaging*

[5] EN 14582, *Characterization of waste — Halogen and sulfur content — Oxygen combustion in closed systems and determination methods*

[6] EN 14995, *Plastics — Evaluation of compostability — Test scheme and specifications*

[7] EN 17033, *Plastics — Biodegradable mulch films for use in agriculture and horticulture - Requirements and test methods*

[8] AS 4736, *Biodegradable plastics — Biodegradable plastics suitable for composting and other microbial treatment*

[9] ASTM F88, *Standard Test Method for Seal Strength of Flexible Barrier Materials*

[10] ASTM D6400, *Standard Specification for Compostable Plastics*

[11] ASTM D6868, *Standard Specification for Labeling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities*

[12] AS 5810, *Biodegradable plastics — Biodegradable plastics suitable for home composting*

[13] BNQ 9011-911-I/2007, *Compostable products certification program*

[14] GB/T 35795-2017, *Biodegradable mulching film for agricultural uses*

ICS 83.140.99

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