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Method of sealing plastics food containers.

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A method of treating a food container having a plastics body portion and a lid sealed thereto for the purpose of ensuring that micro-organisms cannot penetrate into the interior of the container through any faults or imperfections in the seal between the lid and the body portion, which method comprises forming a polymeric coating layer over the external surface of the container in such a manner as to encompass completely the join between the lid and the body of the container, the resultant polymeric coating layer being a retortable polymer.

The method of the invention provides a substantial reduction in the number of failures of the seal between the lid and body portion of plastics containers for foodstuffs.

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METHOD OF SEALING PLASTICS FOOD CONTAINERS

The present invention relates to the packaging of foodstuffs. More particularly, the present invention relates to the packaging of foodstuffs in plastics containers and to a method for ensuring that foodstuffs packaged in such containers do not become spoiled or contaminated by harmful micro-organisms.

5 The packaging of foodstuffs in metal cans such as tin-plate cans is a very well established method of packaging foodstuffs. The lid of the can is usually double roll seamed on to the body of the container after the foodstuff has been introduced into the container. The double seam is designed to provide an hermetic seal, in particular by the inclusion of a suitable sealing compound within the seam which is applied beforehand to the can end.

10 Once the lid has been secured to the body of the can, the can and its contents are subjected to a suitable heat treatment (generally referred to as retorting) to sterilise the foodstuff and thereby destroy any micro-organisms which might cause spoiling or contamination of the foodstuff within the container. This type of packaging has been practised for a long time and the incidence of failure of the seals on such cans is very low.

15 Because double seaming technology has existed for a long time, the many possible causes of leakage are well understood in relation to the variability of cans and can ends. The double seaming process is controlled within limits which give a very small risk of leakage.

Processing variations which may lead to can seam failures are identified by use of statistical tests. Such tests are well established and permit a sampling frequency as low as one can in 40,000. Such a low level of testing does not adversely affect the rate at which the cans are filled and processed, which may be as high as 1000 cans per minute.

20 In recent years, use of plastics containers for packaging foodstuffs has become more prevalent. Such containers are typically in the form of a plastics body in the shape of a can, cup or tray to which is sealed a lid. Typically, the plastics body may be in the form of a multi-layered laminate material optionally incorporating a metal foil as one of the layers, whilst the lid may be made of plastics (usually a multiple-layer laminate material), of metal (e.g. a metal can end) or of a metal/polymer laminate. Unfortunately, sealing of such plastics containers is not as efficient as the sealing of metal cans. With the heat-sealing methods used at present, one finds that the failure rate of the seals can run up to 2%. Failure of a seal owing to discontinuity of the seal gives the risk of subsequent post-sterilisation contamination of the contents of the container. Such food spoilages can be extremely dangerous and can cause food poisoning.

30 Because of these problems, much time is wasted on checking each and every container to make sure that the seal between the lid and the body of the container is sound. Thus once the seal between the lid and the body of the container has been made, each container is checked to ensure that the seal is continuous.

There are two principal methods of checking that a sound and continuous seal has been obtained. The first method relies on a visual check to see whether the seal is continuous - if wrinkles are present in the seal area this can be an indication that the seal is faulty. The second method relies on the use of a pressure differential to test for leakage. In this method, the sealed container is subjected either to an external pressure or to a vacuum, and then inspected to see if leakage has occurred.

Both these methods are slow, and the second method has the additional disadvantage that it is relatively expensive to perform and relatively inefficient. Inspection of the sealed containers is usually no faster than 100 packages/minute. This is much slower than the speeds of 1000 cans/minute which usually obtain when foodstuffs are packaged in metal cans. It is possible that in a food-processing line which uses retortable plastics containers, a significant percentage of the costs is tied up with the inspection of the sealed containers. This is obviously a considerable drawback.

45 Furthermore, a failure rate of up to 2% which prevails with presently used heat-sealing techniques, means that there is much valuable foodstuff which has to be discarded. This waste detracts from the viability of the containers.

Finally, although careful checks are made to ensure that each container is properly sealed, the methods of detection are not necessarily foolproof. Failure of a seal is a potential health hazard and much effort is expended in ensuring that seals are sound.

50 According to the present invention there is provided a method of treating a foodstuffs container having a plastics body portion and a lid which has been heat-sealed thereto, which method overcomes the disadvantages discussed above. The method of the present invention relies on forming a plastics coating layer over the external surface of the container in such a manner as to completely encompass the join between the lid and the body of the container thereby to prevent ingress of any micro-organisms into the interior of the container.

Accordingly, the present invention provides a method of treating a food container having a plastics body portion and a lid sealed thereto for the purpose of ensuring that micro-organisms cannot penetrate into the interior of the container through any faults or imperfections in the seal between the lid and the body portion, which method comprises forming a polymeric coating layer over the external surface of the container in such a manner as to encompass completely the join between the lid and the body of the container, the resultant polymeric coating layer being a retortable polymer.

In this specification, the term "retortable polymer" is used to mean a polymer which will retain its properties as a barrier to micro-organisms after it has been heated at a temperature of at least 121 °C for 20 to 90 minutes, more preferably 30 to 60 minutes.

U.S. Patent No. 3438788 discloses a method of treating hermetically sealed food packages formed in substantial part with a preformed clear plastic container portion so as to provide an external layer which acts as a barrier to the penetration of oxygen into the container. The treatment consists in depositing onto the container a continuous coating of saran latex emulsion or saran solution and then drying the coating. Saran polymers are based on vinylidene chloride and can not withstand the conditions used when retorting containers in the food processing industry. Accordingly, the materials used in U.S. Patent No. 3438788 for use as the oxygen barrier layer are not suitable for use in the method of the present invention.

The polymeric coating layer used in the present invention may be formed from any polymeric material which is capable of acting as a barrier to micro-organisms, and which is capable of retaining its properties as a barrier to micro-organisms after it has been subjected to the processing steps used for retorting containers in the food processing industry. Typically, such retorting conditions consist of a heat treatment of at least 121 °C for 20 to 90 minutes. The heat treatment is usually performed using steam or hot water.

Examples of preferred polymeric coating materials are acrylic-based polymers, polyurethanes, polyesters, epoxy-resins, polypropylenes and copolymers thereof such as ethylene/propylene copolymers; or any thermosetting resin. Particularly preferred are thermosetting resins having one or two components, especially acrylic-based polymers.

The preferred coating composition comprises a water dispersed film-forming acrylic copolymer with carboxyl and/or hydroxyl functionality blended with low levels of crosslinking and additive polymers. The preferred monomer composition in this acrylic copolymer consists of a combination of soft types of monomer such as methyl, butyl or ethyl acrylates and 2-ethylhexyl acrylate and hard types of monomer such as methyl methacrylate and styrene at a level of up to 99.5% of the total monomer composition. These monomers are blended at appropriate ratios to produce a glass transition temperature sufficiently low to permit good film formation at the application temperature (typically 25 - 45 °C). The remainder of the monomer composition most preferably ranging from 0.5 to 7% consists of hydroxy functional monomers such as hydroxymethyl, hydroxyethyl and hydroxy propyl acrylates or methacrylates and/or carboxyl functional monomers such as acrylic, methacrylic or itaconic acids.

The terms "soft type" of monomer and "hard type" of monomer will be well understood by those skilled in the art but typically a "soft type" of monomer refers to a monomer which produces a homopolymer which exhibits a glass transition temperature T_g of 50 °C or less. Correspondingly, a "hard type" of monomer is one which produces a homopolymer which exhibits a glass transition temperature T_g higher than 50 °C, usually higher than 80 °C.

In order to avoid water sensitivity in the cured film, the use of low levels of surfactant are preferred, typically 0.1 - 2% by weight on total monomer content. Surfactant free emulsion polymers can also be advantageous.

The initiation of poly-merisation will typically be via thermal decomposition of sodium or ammonium persulphate and the redox reaction of these persulphates with reducing agents such as sodium bisulphite. This does not exclude the use of alternative polymerisation initiators well known by those skilled in the art.

In some cases it has been found advantageous to incorporate up to 20% by weight of epoxy polymers of relatively low molecular weight to enhance substrate adhesion and film integrity. Such polymers can be incorporated via co-emulsification or by partial solubilisation through reaction with amines or acid functional polymers.

Whilst the preferred polymeric coating is as described above, a wide range of film forming polymers can also provide films of the required integrity and sealing performance. Such materials include polyester, epoxy, polypropylene and vinyl copolymers and combinations thereof. These may be formulated as dispersions or solutions in aqueous or non-aqueous phase.

Crosslinking, often described as curing, of a polymeric coating is desirable to achieve excellent substrate adhesion and water resistance under subsequent steam sterilisation procedures which the package may undergo. The choice of crosslinking polymer will preferably include aminoplast or phenolic types at typical levels ranging from 0.5 - 20% and most preferably 1 - 5%. This does not exclude other

suitable crosslinking reactions well known to those skilled in the art. Two component coating compositions such as epoxy polyamide may also be effectively employed.

The crosslinking reaction of hydroxyl or carboxyl functional groups on the acrylic polymer via aminoplast or phenolic polymers may be catalysed by the use of acid catalysts such as para substituted sulphonic acids.

The polymeric coating material may be applied to the container in the form of a hot melt polymer, or alternatively, where appropriate, in the form of a curable composition of monomers, or pre-polymers.

The coating material is applied to the container by any convenient method. Examples of suitable application methods include spray application, dipping of the container into the polymer coating material, drape coating (curtain coating) of the polymer coating material onto the container, or use of a hot-melt jetting applicator to apply the polymeric coating material onto the container.

With some polymeric coating materials, it may be found necessary or advantageous to subject the area of the container to which the polymeric coating material is to be applied to a suitable pre-treatment to make the external surface of the container more receptive to the coating material. Thus the seal area may require a pre-treatment to promote adhesion of the coating material; for example, the seal area may be subjected to a flame treatment or a corona discharge treatment to promote adhesion of the polymer coating material.

In some cases it may be found necessary or advantageous to provide an anchor coating on the container to promote adhesion of the polymeric coating material to the container. A suitable anchor coating material is a polyurethane type polymer.

In some instances it may be desirable to use both an anchor-coating and a surface pre-treatment to improve adhesion or receptivity.

The containers which can be treated in accordance with the present invention include any plastics container intended for use in the packaging of foodstuffs. The container may have a rigid structure like a can or may be flexible like a bag of potato crisps. The invention is most likely to be used on containers which are trays or pots which have flanges to which a lid has been heat-sealed.

The body of the container may be made of any of the conventional plastics materials used in the food packaging field. For example, the containers may be shaped from monolayers based on polypropylene, polyesters, amorphous polyamides, or polycarbonates. Such monolayer materials would normally be used when an oxygen-barrier layer is not required.

For some containers, the presence of a layer which acts as a barrier to oxygen is needed. In these circumstances, it is usual to utilise a composite laminate material incorporating at least one layer which acts as a barrier to oxygen. Ethylene/vinyl alcohol (EVOH) copolymers are found to be suitable as oxygen-barrier layers. A typical laminate would be a layer of ethylene/vinylalcohol sandwiched between layers of polypropylene and secured thereto with adhesive. The polypropylene layers act as "carrier" layers to give structural integrity to the laminate.

In alternative arrangements, one or both of the polypropylene "carrier" layers can be replaced by layers formed from polycarbonates, polyamides, polyesters, or other polyolefins.

Alternative oxygen-barrier layers include vinylidene chloride copolymers, amorphous polyamides, aluminium foil or steel.

The lid of the container may be made of plastics, of metal or of a metal/polymer laminate. Typical metal lids are made from coated or uncoated tin-plate, tin-free steel or aluminium. Examples of suitable plastics materials are plastics laminates based on combinations of polypropylene, polyethylene, polybutylene, ethylene/vinylalcohol copolymers, vinylidene chloride copolymers, polyamides, polyesters.

When the lid of the container is made of a metal, the lid of the container is sealed to the body of the container by means of a rolled seam using known double seaming techniques. If the lid of the container is chosen to be a plastics laminate material, it can be sealed to the body of the container by using a variety of sealing techniques such as, for example, heat sealing, ultrasonic sealing or impulse sealing. If the plastics laminate incorporates a layer of metal foil such as aluminium or steel foil, an induction sealing method may also be used to achieve the seal between the lid and the body of the container.

The plastics coating material applied in accordance with the invention may be applied to a sealed container either before or after the sealed container has been sterilised, but usually the coating material would be applied as soon as possible after the lid has been sealed to the body of the container. Conventional processes are used to sterilise the containers.

The method of the present invention reduces the risk of spoilage and contamination of foodstuffs packages in plastics containers and enables a reduction in the amount of wasted foodstuff.

A further advantage of the present method is that packaging of foodstuffs in plastics containers can be performed at a more effective and less costly rate.

The present invention will now be illustrated in more detail by the following Examples.

Example 1

This example illustrates the use of an acrylic based polymer as the external polymeric coating layer.

Food containers in the form of circular shaped pots (depth: 35mm; internal diameter 80mm) and having a heat seal flange of a width of 6mm were used. The pots were made of a laminated material having a layer of polypropylene adhered to each of the two surfaces of a layer of an ethylene/vinyl alcohol copolymer (EVOH), i.e. a laminate having a layer of EVOH sandwiched between layers of polypropylene.

The lidding material for the pots was a peelable lidstock made from a laminate having a layer of a polypropylene copolymer, a layer of aluminium foil and a layer of a polyester. The overall thickness of the lidding material was 75 microns. The lidding material was used with the polypropylene copolymer layer facing the inside of the container.

In order to test the effectiveness of a seal obtained in accordance with the method of the present invention, the pots were filled with a nutrient medium consisting of fortified milk to which bromo-cresol purple had been added to act as an indicator. The pots were filled so that the contents in the pot reached a level up to 8mm below the rim of the pots and the nutrient medium was deliberately smeared over the sealing surfaces of the pots before the pots were sealed in order to generate deliberate seal failures.

Lids made of the lidding material described above were heat sealed to the heat seal flange of the pots by using a commercial vacuum heat sealing machine (supplied by APM Viseel) using a temperature of 215° C applied for 1 second, with vacuum being applied for 2 seconds.

The seals were trimmed with a punch to reduce the seal width to 3mm.

A polymeric coating layer was then applied to the external surface of each of the pots so as to encompass completely the join between the lid and the body of the pot.

The polymeric coating layer was formed from an acrylic film-forming copolymer. The acrylic film-forming copolymer was made from the following components:

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	Parts by weight
Methyl methacrylate	22.50
Butyl acrylate	19.35
Hydroxyethyl methacrylate	2.25
Acrylic acid	0.90
Ammonium persulphate	0.10
Alkyl aryl polyethylene oxide sulphate	0.90
Deionised water	54.00

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The acrylic film-forming copolymer was made up into a coating formulation of the following composition:

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	Parts by weight
Acrylic film-forming copolymer (as described above)	75.00
Deionised water	10.00
Epikote 828 (ex Shell Chemicals)	5.00
Santolink EP560 (ex Monsanto)	5.00
n- butanol	3.50
Dimethyl amino ethanol	1.00
Phosphoric acid	0.30
Dapro DF881-S (defoamer) ex Daniel Products Inc	0.20

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The said coating formulation was applied in the following manner:-

The surface of the container in the immediate vicinity of the seal between the lid and body of the container was subjected to a flame treatment for 1-2 seconds so as to give a surface tension of 40 ± 2 dynes/cm². The coating lacquer was applied to this area using a fine brush and was applied in sufficient

amount to provide a coating layer with a coating weight of 35 - 40 g/m². The pots were then heated for 5 minutes at 95 °C in order to dry the coating layer. Finally the coating layer was flame treated for 1 - 2 seconds to cure the layer and form a polymeric coating layer.

After the external polymeric coating layer had been applied to the pots, the pots were sterilised in a steam-air retort for 20 minutes at 121 °C. The effectiveness of the seal on the pots was then tested by immersing the pots for 2 hours in a suspension of *Enterobacter cloacea* in water (at a concentration of approx. 10⁶ cells/ml). The pots were removed from the suspension and thoroughly washed with cold water and drained; the pots were then incubated at 30 °C for 7 days.

After incubation all pots were inspected for bacterial spoilage. Bacterial spoilage is present if the pots have inflated as a result of gas generation and/or if the bromo-cresol indicator in the nutrient medium has changed colour from purple to yellow.

69 pots were prepared in the manner described above. By way of comparison, a further 56 pots were filled and sealed in the same way, but no additional external polymeric coating layer was applied to these pots. The comparison pots were sterilised, washed, and incubated in the same manner as that described above.

The results obtained were as follows:-

Pots with external polymeric coating layer in accordance with the invention	Comparison Pots with no external polymeric coating layer
1 seal failure out of 69 pots	13 seal failures out of 56 pots

In each case the pots which exhibit seal failures were inspected and pots having gross seal contaminations (i.e. seals which exhibited channels or pathways having a width greater than 1mm) were eliminated from the test.

These results were as follows:-

Pots in accordance with the invention	Comparison Pots
0 failures out of 68 pots	10 failures out of 53 pots

These results illustrate the effectiveness of the external polymeric coating layer of the invention in providing an enhanced seal.

Similar results were obtained with a second coating formulation made with the acrylic film-forming copolymer described above. The second coating formulation had the following composition:

	Parts by weight
Acrylic, film-forming copolymer (as described above)	85.00
Deionised water	10.00
Cymel 301 ex Cyanamid or BIP 3745	4.70
Dapro DF881-S (defoamer) ex Daniel Products Inc	0.30

Example 2

This example illustrates the use of a commercial reactive hot melt adhesive as the external polymeric coating layer.

The procedure described in Example 1 was repeated, but instead of deliberately smearing the nutrient medium over the sealing surfaces of the pots to generate seal failures, seal failures were generated by contaminating the sealing surfaces by laying a 0.2mm copper wire across the seal between the lid and the

body of the pot and then removing the wire after the lid had been heat sealed to the pot. This procedure results in a channel or pathway of approx. 0.22mm diameter in the seal of each pot.

A polymeric coating layer was applied to the external surface of each pot in such a manner as to encompass completely the join between the lid and the body of the pot. The polymeric coating layer was formed from a hot melt adhesive which is a moisture-curing polyurethane hot melt adhesive obtained from the Adhesives Division of National Starch and Chemical Limited (product Reference No. : 78-4533).

The polymeric coating layer was applied by use of a commercially available hand-held jetting applicator in sufficient amount to give a coating weight approximately 50mg/cm length and the coating was then allowed to cure at room temperature over a period of 30 minutes. The coated pots were sterilised, washed and incubated in the same manner as described in Example 1.

The results obtained were as follows:-

Pots with external polymeric coating layer in accordance with the invention	Comparison Pots
0 failures from 70 pots	52 failures from 70 pots

Claims

1. A method of treating a food container having a plastics body portion and a lid sealed thereto for the purpose of ensuring that micro-organisms cannot penetrate into the interior of the container through any faults or imperfections in the seal between the lid and the body portion, which method comprises forming a polymeric coating layer over the external surface of the container in such a manner as to encompass completely the join between the lid and the body of the container, the resultant polymeric coating layer being a retortable polymer.

2. A method according to claim 1, wherein the polymeric coating material is an acrylic-based polymer, a polyurethane, a polyester, an epoxy-resin, a polypropylene or a copolymer thereof such as an ethylene/propylene copolymer; or a thermosettable resin.

3. A method according to claim 2, wherein the polymeric coating material is formed from a film-forming acrylic copolymer formed from the following monomeric components:

Methyl methacrylate
Butyl acrylate
Hydroethyl methacrylate
Acrylic acid

4. A method according to claim 2, wherein the polymeric coating composition is formed from a film-forming acrylic copolymer formed from a combination of from 93 to 99.5% by weight, based on the total weight of the monomer composition, of a "soft" type of monomer such as methyl acrylate, butyl acrylate, ethyl acrylate or 2-ethylhexyl acrylate or of a "hard" type of monomer such as methyl methacrylate or styrene, together with from 0.5 to 7% by weight, based on the total weight of the monomer composition, of a hydroxy functional monomer such as hydroxymethyl-, hydroxyethyl- or hydroxypropyl- acrylates or methacrylates- and/or a carboxyl functional monomer such as acrylic, methacrylic or itaconic acids.

5. A method according to claim 3 or 4, wherein the film-forming acrylic copolymer has the following composition:

	Parts by weight
Methyl methacrylate	22.50
Butyl acrylate	19.35
Hydroxyethyl methacrylate	2.25
Acrylic acid	0.90
Ammonium persulphate	0.10
Alkyl aryl polyethylene oxide sulphate	0.90
Deionised water	54.00

6. A method according to any one of the preceding claims, wherein the polymeric coating layer is formed over the said external surface of the container by spray application of the coating material, dipping of the container into the polymer coating material, drape coating (curtain coating) of the polymer coating material onto the container, or use of a hot-melt jetting applicator to apply the polymeric coating material onto the container.

7. A method according to any one of the preceding claims, wherein the external surface of the container to which the coating layer is to be applied is pre-treated to make the external surface of the container more receptive to the coating material.

8. A method according to claim 7, wherein the said external surface is subjected to a flame treatment or a corona discharge treatment to promote adhesion of the polymer coating material.

9. A method according to any one of the preceding claims, wherein an anchor coating is provided on the container to promote adhesion of the polymeric coating material to the container.

10. A method according to claim 9, wherein the anchor coating is a layer of a polyurethane type polymer.

11. A method according to any one of the preceding claims, wherein the container is of a rigid construction.

12. A method according to any one of claims 1 to 10, wherein the container is flexible.