

A LID FOR A CONTAINER AND A PROCESS FOR MAKING SAME

Technical Field

The present invention relates to a lid for a container and to a process for making the lid.

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Background of the Invention

Lids for containers are generally known. For example, lids for disposable beverage containers, such as foam or paper cups, are known. Such containers are generally used for containing heated beverages such as tea, coffee or hot chocolate, or for containing cold or chilled beverages such as soft drinks, juice or water.

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It is known to provide lids with small printed or embossed warning signs such as HOT or COLD on top of the lids to indicate that the contents contained in the container are hot or cold, respectively. However, such embossing or printing does not provide a true indication of the actual temperature of the contents of the container.

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In order to provide an indication of the actual temperature, it is known to provide coextruded (two layered) thermochromic beverage lids in which one of the layers of the lids contain a thermochromic substance, such as a thermochromic pigment which changes under the application of heat or cooling to provide an indication of the temperature of materials contained in a container contained by the lid and indicate when the contained material is too hot or too cold for handling or safe consumption. One example of such a lid is described in PCT/AU02/00029 by the present applicants', which is incorporated herein by reference. However, such lids suffer from a number of disadvantages.

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One disadvantage is that, unlike the use of thermochromic materials in plastic drink bottles, spoons and containers which have relatively thick substrates and where the use of thermochromic substances is relatively straightforward, hot container lids, such as coffee cup lids, are composed of thin substrates of the order of less than 1mm, more particularly of the order of less than 0.5mm and typically of 100 to 400µm thickness; accordingly the properties of the lid by inclusion of thermochromic materials by conventional means are compromised.

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Another disadvantage is that significant amounts of thermochromic material must be added to produce a desired colour coverage. Standard pigment dyes can be added to lids to produce a desired colour by well known processes, with the standard dye in a encapsulated form added to the masterbatch with minimal add rates (2-3%). When a thermochromic dye is used however, in order to achieve the desired and effective colour, add rates in excess of 12% are typically required for thin substrates such as lids (lower

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add rates of 3% to 4% of thermochromic can effectively be used with thick substrates but such add rates are not suitable for use with lids). Further, when not enough thermochromic material is added, the resulting colour is insufficient in density and it is necessary to increase the add rate even further in order to produce a denser colour. The use of add rates in excess of 12% compromises the structural integrity of the lid because typical thermochromic dyes naturally have an enlarged particle size compared to standard dye pigments. Also some lids are formed from high impact polystyrene which contains a rubber component to allow the lid to be flexible and suited for hot beverage container lids. The particle size of the thermochromic particles causes a loss of lid flexibility and lids become brittle and have a tendency to tear and thus are unsuitable for the application for which they are intended

A further disadvantage is with translucency. Because lids are typically formed from thin substrates of the order of less than 1 mm in thickness and because the lids include in excess of 10-12% of the thermochromic substance in order to achieve the desired colour result, whilst the lid may display the appropriate colour in a "cold state", on heating such lids to a hot state the lids become translucent with no actual defined colour present. This is because the nature of thermochromic substances is that when the thermochromic substance changes from its cold ambient colour under heat, the first colour disappears to an almost clear translucent state with only a pale light colouring. The problem with translucency is not improved by adding higher add on rates of up to 20% of the thermochromic substance which makes no difference to the translucency of the lids and which, in view of the high volume of the enlarged particles of the thermochromic material in the thin substrate adversely affects and weakens the structural integrity of the lid resulting in lids that are brittle and which tear/crack easily and which are not durable, flexible or bendable. In addition such lids may show pitting or holes from exploding thermochromic particles during manufacture. Such pitting or holes compromise both the strength and flexibility of the lid and are visually undesirable.

The problem of translucency is exacerbated by the inclusion of regrind from off-cuts recycled in the bottom of the lid layers which regrind may be included as a standard step in lid manufacture as a cost-cutting measure. When a thermochromic substance is applied to a top layer of a lid and regrind is included as a bottom layer, and the lid is heated to the hot state, the colour change results in both layers resulting in loss of colour and translucency in both layers. This is particularly evident when high impact polystyrene (HIPS), which is inherently translucent, is used as the layers of the lid. High impact polystyrene is the most dominant material used to make lids such as hot beverage

lids because it has a rubber content which aids in durability and flexibility. HIPS is also a cost efficient material and differs from other raw plastic materials, such as poly(phenylenesulphide) (PPS), which are too brittle for cup lids.

To minimise translucency, products using thermochromic materials typically rely
5 on a secondary underlying colour to communicate a desired end colour. However, such steps are not successful in application to the thin substrates of lids. For example, most products employ a thermochromic micro-encapsulated dye in which a secondary underlying colour is infused within the capsule. However, HIPS used to manufacture lids, as provided commercially, is opaque and slightly translucent. In this regard HIPS is
10 naturally a cloudy off white colour (which may be grey when regrind is included) and the white pigment is typically added to the mix on making lids in order to prevent the lids from becoming transparent. However, the pigment detrimentally affects the thermochromic colouring ability by adverse colour mixing in the layer and through light refraction. For example when a blue to red colour change is desired, the cold (ambient)
15 state will present the appropriate cold blue colour but in the hot state, instead of the desired red, a translucent pink colouring results because the thermochromic substances do not change to a distinct deep colour. Instead a pale semi-clear colour, lighter than the cold colour results, and the natural off-white pigment of HIPS mixes with the pale colour to make the resulting colour even paler. This result is undesirable and results in a
20 confusing colour change such that a user can almost see into the cup when it is in the hot state and the colour of the liquid in the cup (for example coffee or tea) can alter what the user actually sees as the hot colour.

Another disadvantage is that on the lid becoming translucent, condensation from the contents contained in the cup may attach to the underside surface of the lid making the
25 semi-translucent lid even more translucent in the parts where the condensation is attached.

An example of an existing product in the market place that has failed to overcome this translucency problem is thermochromic straws. These straws work by contact of the straw with a cold beverage which results in a change in the colour of the straw. Thermochromic straws are thin by nature and do not have a distinct cold (ambient)
30 colour. On cooling with contact of the beverage, the colour seems to disappear and no real new colour becomes apparent. The colour is more the colour of the liquid being sucked up the straw than any other colour.

The problems referred to above are not solved by using mono-layer lids. A mono-layer lid is produced as a single layer from one film of plastic and the layer is thicker than
35 layers making up multi-layered lids. With a mono-layer lid, thermochromic material

needs to be applied to the entire thickness of the layer of the lid and significant amounts of thermochromic material needs to be applied so as to achieve a sufficiently dense colour. Therefore the cost of producing a mono-layer lid is substantial and not commercially viable. The cost of producing a mono-layer lid including a thermochromic material may be 5 to 10 times that of producing a multi-layered lid where thermochromic material is included in only one of the layers.

There is a need for methods for making thermochromic lids in a commercially viable manner such that a distinct colour results in both the ambient and heated and cooled states.

Summary of the Invention

Embodiments of the present invention seek to overcome or substantially ameliorate at least one of the above disadvantages or to provide a suitable alternative.

According to a first aspect of the present invention, there is provided a lid for a container, the lid comprising a first plastic layer and a second plastic layer disposed on top of the first layer and optionally one or more additional plastic layers, the first layer including at least one portion comprising at least one coloured pigment, the second layer including at least one portion comprising at least one thermochromic substance which is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container so as to reveal at least one of the portions comprising the coloured pigment of the first layer, at least the first and second plastic layers being co-extruded.

According to a second aspect of the invention, there is provided a lid for a container, the lid comprising a first HIPS layer and a second HIPS layer disposed on top of the first layer, the first layer comprising at least one portion having at least one coloured pigment, the second layer including at least one portion having at least one thermochromic substance in an amount up to 12wt% of the layer and having a reduced particle size, which thermochromic substance is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container so as to reveal at least one of the portions comprising the coloured pigment of the first layer, the second layer having a thickness substantially less than the thickness of the first layer.

According to another aspect, there is provided a lid for a container, the lid comprising a layer comprising at least one portion having at least one reversible or quasi-reversible thermochromic substance which is adapted to change colour and/or become substantially translucent upon reaching a predetermined temperature(s) in response to heat transfer from or to contents

of the container, the layer being provided in at least one portion with at least one coloured pigment, which portion is observable at said predetermined temperature(s) and non-observable at a temperature other than the predetermined temperature(s), the colour of said pigment being the same or substantially the same colour as that of said thermochromic substance at a temperature other than the predetermined temperature(s) or which portion becomes non-observable at said predetermined temperature(s) and observable at a temperature other than the predetermined temperature(s), the colour of said pigment being the same or substantially the same colour as that of said thermochromic substance at the predetermined temperature(s).

According to another aspect of the invention, there is provided a process for preparing a lid for a container comprising:

co-extruding a first plastic layer and a second plastic layer and optionally one or more additional plastic layers, the first layer comprising in at least one portion at least one coloured pigment, the second layer comprising at least one portion comprising at least one thermochromic substance which is adapted to become substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container to reveal at least one of the portions having the coloured pigment of the first layer.

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Definitions

The following definitions are intended as general definitions and should in no way limit the scope of the present invention to those terms alone, but are put forth for a better understanding of the following description.

Unless the context requires otherwise or specifically stated to the contrary, integers, steps, or elements of the invention recited herein as singular integers, steps or elements clearly encompass both singular and plural forms of the recited integers, steps or elements.

Throughout this specification, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated step or element or integer or group of steps or elements or integers, but not the exclusion of any other step or element or integer or group of elements or integers. Thus, in the context of this specification, the term "comprising" means "including principally, but not necessarily solely".

Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. It is to

be understood that the invention includes all such variations and modifications. The invention also includes all of the steps, features, compositions and compounds referred to or indicated in this specification, individually or collectively, and any and all combinations or any two or more of said steps or features.

5 All the references cited in this application are specifically incorporated by reference are incorporated herein in their entirety. Inclusion herein of any given reference is not intended to indicate that the reference is generally known in Australia or elsewhere.

By "plastic" is meant any synthetic or natural organic material which may be shaped when soft and then hardened such as resins, resinoids, polymers, cellulose
10 derivatives, casein materials and proteins.

By "ambient temperature" is meant the room temperature of the environment in which the lid is situated.

By "substantially translucent" means that the thermochromic material is capable of allowing light to pass therethrough but diffusing it so that objects on the other side cannot
15 be clearly distinguished. The material however may not become totally transparent and may retain some colour.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

20 Fig. 1 is a partial perspective view of a lid in accordance with one embodiment of the present invention and a container;

Fig. 2 is a perspective view of the lid of Fig. 1 including a cut away section showing the cross-section of the layers of the lid;

25 Fig. 3 shows the cross-section of the cut away section of the lid of Fig. 2 in more detail;

Fig. 4 shows the cross-section of the cut away section of another lid of a less desirable embodiment of the invention in which condensation occurs on the inner surface of the lid;

30 Fig. 5 is a perspective view of another lid in accordance with a less desirable embodiment of the invention including a cut away section showing a cross-section of the layers of the lid and in which pitting is shown on the surface;

Fig. 6 shows the cross-section of the cut away section of the lid of Fig. 5 in more detail;

Fig. 7 shows the cross-section of a cut away section of a lid in accordance with another embodiment of the invention; and

Figures 7A and 7B show perspective views of the lid in accordance with Fig. 7 at ambient temperature (Fig. 7A) and at a predetermined non-ambient temperature (Fig. 7B).

Detailed Description of Preferred Embodiments of the Invention

There is disclosed herein a lid for a container, the lid comprising a first plastic layer and a second plastic layer disposed on top of the first layer, the first layer comprising at least one portion having a coloured pigment, the second layer comprising at least one portion having at least one thermochromic substance which is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container and reveal at least one of the portions having the coloured pigment of the first layer.

The lid may optionally include additional plastic layers i.e., the lid may comprise two or more layers. For example, the lid may be formed from two, three, four, or more layers. When more than two layers are used at least one layer is the first layer and at least one layer is the second layer and the additional layers are suitably positioned below the first layer. The additional layer(s) may include a coloured pigment and/or regrind. For example the additional layer(s) may be a darkened layer, which by virtue of light refraction will cause the first layer to appear darker. Using additional darkened layers may decrease light refraction between the layers, thereby enabling less thermochromic material to be used which may make the lid more economically viable to manufacture.

The lid of the present invention may be for a hot or cold cup or container and may be for a lid for a beverage cup or container, such as a disposable beverage container for containing a hot or cold substance such as heated or chilled beverage (coffee, tea, hot chocolate, iced chocolate, soft drink, soup, food or foodstuff, although this list is by no means comprehensive). The lid may be for use with foam, polystyrene or paper cups commonly used in the sale of heated or chilled beverages such as coffee. In this regard with heated beverages, it is the heat (or steam) from the beverage which suitably effects the change in the thermochromic material and thereby the colour of the lid such that one can identify whether the beverage is at a desired temperature or is too hot to drink. With chilled beverages, the proximity of the cold liquid to the lid or the actual contact of the cold liquid with the lid may effect a change in colour of the thermochromic material and thereby the colour of the lid so that one can determine if the drink is cold enough or is being served or stored at a desired temperature. Also, the change in colour may be

effected by placing the lid in a heated or chilled environment such as in an oven or refrigerator.

The layers of the lid may be in the form of thin substrates of the order of micron to millimeter thickness. Typically each layer of the lid may range from about 100 μ m up to
5 about 400 μ m thickness, with the total thickness of the lid for a two layer lid being of the order of about 200 μ m to about 800 μ m. The thickness of the lid is largely determined by the process of manufacture and equipment used and whether a thicker, sturdier high-quality lid or a cheaper, thinner lid is desired for the end application. For example the total thickness of a lid in accordance with one embodiment of the invention may be of the
10 order of about 0.3 to about 0.4mm (about 300 to about 400 μ m).

The second layer is suitably an upper layer of the lid. The first layer is suitably a lower layer of the lid which, in the absence of additional plastic layers, is in direct contact with any heat from a substance contained in the container. The upper layer of the lid containing the thermochromic material may be suitably substantially thinner than the
15 lower layer. For example, the upper layer of the lid may be about 15% to about 50%, about 20% to about 40% or about 25% to about 30% of the total lid thickness. In one embodiment the upper layer of the lid may range in thickness from about 120 μ m to about 160 μ m and the lower or bottom layer of the lid may range from about 180 μ m to about 240 μ m.

20 The portion of thermochromic substance and coloured pigment in each layer may be substantially all of the lid or one or more smaller portion(s) of the lid. The portion of the upper layer need not necessarily be the same size as the portion of the lower layer, however at least one of the portions of the upper layer must sufficiently cover a portion of the lower layer so as to reveal that portion at the predetermined temperature.

25 The lid is formed from a plastics material. In one embodiment the lid is suitably made from high impact polystyrene (HIPS). The lid may be in the form of a co-extruded outer and inner layer. The portion(s) having the translucent properties may be only in the outer layer. The inner layer may comprise regrind of a lid of the present invention or a regrind of a different lid.

30 In various embodiments additional plastic layers may also be present.

With respect to regrind, manufacturing of lids typically generate excess material referred to as "webbing". Webbing is recycled in a process called regrind. Regrind is used because thermochromic materials are expensive and adding a portion of the regrind may lower the cost of manufacturing the lid. Typically regrind is added to the first or
35 lower layer (which may be the bottom or base layer adjacent the contents of the container)

of the lid. Regrind is typically not added to the upper layer as the regrind may discolour the thermochromic pigment. For example with HIPS which typically includes a white pigment, the regrind may cause the HIPS to become grey with loss of sheen. The discolouration of the regrind pigment may also create a denser colour affect on the colour of the lid at a temperature other than the predetermined temperature and allow a reduction in the add rate of the thermochromic material in the upper or second layer. However, in certain embodiments a small percentage of regrind may be added to the upper layer so as to provide an opportunity to use excess regrind stockpiles (which may occur) and/or to add depth to the colour of the lid at a temperature not being the predetermined temperature.

By inclusion of regrind in the first layer, the first layer may thereby contain thermochromic substance together with a coloured pigment from the regrind. Where a different lid is used as regrind, it may be desirable to use one having a thermochromic material having a reduced particle size such as BW Grade or PS Conc. available from Matsui International, although the invention is not limited to such regrinds and regrinds having no thermochromic material or containing standard thermochromic materials of conventional particle size may be used.

Typically the coloured pigment of the first layer is chosen so that the first layer is opaque at both the predetermined temperature and a temperature other than the predetermined temperature so as to provide a dense colour. The coloured pigment may be any standard pigment dye other than a white pigment, although the first layer may additionally contain a white pigment. Suitably the coloured pigment is added in an add-on rate of about 2 to about 3wt%. The pigment may be chosen to be the colour of the desired colour at the predetermined temperature. For example, the first layer may contain a red pigment so that the colour of the lid at the predetermined temperature is red. Standard colour may also be added to the first layer via regrind, and consequently the total add on rate of the standard pigment may be in the range of about 1 to about 4wt%. The amount of pigment that is added may differ depending on the desired colour. For example less pigment may be added when the pigment is black than when the pigment is blue.

A standard pigment dye is suitably chosen for the first layer as when the thermochromic material becomes substantially translucent at the predetermined temperature, the standard pigment dye in this layer is observable as a distinct colour. When HIPS is used in the second layer, due to the nature of the HIPS also being mostly translucent, at the predetermined temperature the standard pigment dye of the bottom

layer is observable and if this pigment is red, the lid will be a distinct red colour at the predetermined temperature. The red in the bottom layer may thereby prevent the bottom layer from becoming translucent at the predetermined temperature. Further by inclusion of the standard pigment, a denser colour may be provided to the lid at a temperature other than the predetermined temperature.

The thermochromic material in the upper layer may be used in the absence of any other coloured pigments aside from any underlying colour contained within the thermochromic material itself. Materials having thermochromic properties, including but not limited to thermochromic pigments, are known. The thermochromic material is chosen such that it is only visible when the temperature is other than the predetermined temperature. For example, in one embodiment, the thermochromic material in the second layer is visible when the lid is at a temperature other than the predetermined temperature but becomes substantially translucent at the predetermined temperature. The translucent colour change may be gradual from near the predetermined temperature and complete by the predetermined temperature. In this regard the effect of heating or cooling may not result in total translucency. Rather the colour may change in the upper layer from a dark solid colour to a different much paler colour which by light refraction mixes with the standard, non-colour changing pigment in the bottom layer, the colour of the standard pigment completely dominating the thermochromic material at the predetermined temperature. Whilst it would appear that the upper layer has become totally translucent it may in fact be a pale see-through colour (for example for a lid changing from a dark brown to red, the layer including the thermochromic material may be a very pale pinky/red colour).

The material having thermochromic properties may be a thermochromic pigment, resin or the like. The thermochromic material may be chosen such that it has a reduced particle size in comparison with conventional thermochromic materials. The present inventors have found that thermochromic materials having a reduced particle size are desirable for use in the thin plastic layers of the lid.

Thermochromic pigments are available from several sources, for example, those denoted F4, G7 or J8 sold under the trademark CHROMICOLOR by Matsui International Co., Inc. of Gardena, CA, United States of America. The thermochromic material may be included in the second plastic layer in add rates of less than about 12wt%, for example less than about 10wt% or less than 5wt%.

The thermochromic material may be included in the second plastic layer in an amount of about 6wt% to about 10wt%. Lower add on rates may be beneficial in terms of

costs of manufacture and the high cost of the raw materials. Use of above about 12wt% of the thermochromic material results in a lid which is less economically viable and the structural integrity of the lid may be compromised such that it tears easily as a result of its brittleness and is more susceptible to pitting during production.

5 Whilst standard thermochromic materials can be used, in one embodiment the thermochromic material is a concentrate such as Matsui Chromocolor BW Grade available from Matsui International Inc., Gardena, CA, USA. This product has a reduced particle size relative to conventional thermochromic materials and has been the subject of migration and food safety testing and approved by FDA and other Food Safety Bodies in
10 August 2004 for use in a food contact situation. Other thermochromic materials may be standard thermochromic materials altered to reduce their particle size by the thermochromic material manufacturer, for example Matsui PS Conc and other microencapsulated masterbatches. In one embodiment the thermochromic material used in the second (upper) layer is suitably fresh or virgin material and not material from
15 regrind.

 In one embodiment the thermochromic substance and the coloured pigment are chosen so that, in combination, the layers present one observable colour at a temperature other than the predetermined temperature. Colour mixing may occur in the first layer as a result of any regrind present containing thermochromic material which mixes with the
20 coloured pigment and also as a result of the slight effect of the opaqueness of the HIPS when used. It is the combination of this colour mixing in the first layer and light refraction through the layers which results in the overall observable colour of the lid. The colour of the first layer contributes to the colour of the lid at a temperature other than the predetermined temperature because of the translucent nature of the layer containing the
25 thermochromic material.

 In one embodiment the extent of the colour change may be affected by the coverage of any dark colour (which may be the pigment colour contained in the thermochromic material) which differs from a second distinguishable colour (which is the colour of the coloured pigment in the first layer) at the predetermined temperature and different from
30 the observable colour at the temperature other than the predetermined temperature. This affect may occur when the first (lower) layer also includes a thermochromic material in combination with the standard pigment, as the presence of the thermochromic material may lead to a discolouration/alteration of the final colour of the first layer which discolouration is observable through the second (upper layer) due to the thinness of the
35 second layer i.e., the colour of the lower layer can be seen through the top layer. This

discolouration may be further compounded by the fact that standard dyes are much stronger than thermochromic dyes. For example when a blue thermochromic is placed in an upper layer of the lid with a standard red pigment in the lower layer, the result is a lid which has the desired colour at the predetermined temperature (red) but the discolouration of the observable colour at for example, ambient temperature results in the ambient colour being only slightly darker than the hot colour eg., a reddy-purple colour and there is practically no colour contrast between the hot and ambient states. Accordingly, the colour of the thermochromic additives and coloured pigment in each layer may suitably be selected so that a colour or combination of colours which results is an observable colour at the temperature other than the predetermined temperature and which colour is distinguishable from the colour of the lid at the predetermined temperature.

As an example, the observable colour of the lid at a temperature other than the predetermined temperature such as at ambient temperature may be dark brown/black and the colour at the predetermined temperature may be bright red. This may be achieved using a mixture of green thermochromic and turquoise thermochromic in the second (upper) layer which, by means of light refraction, can show an observable dark brown/black colour at the temperature other than the predetermined temperature when a standard red dye is used (together with any thermochromic from regrind but in the absence of any white pigment) in the first or lower layer. On heating or cooling, the lid will present the bright red colour at the predetermined temperature.

As another example the observable colour of the lid at a temperature other than the predetermined temperature may be black and the colour at the predetermined temperature may be green. This may be achieved by using a mixture of black thermochromic and gold/orange thermochromic in the second or upper layer which, by means of light refraction, can show an observable dark black cold colour at the temperature other than the predetermined temperature such as at ambient temperature when a mixture of standard green and white dyes are used (together with any thermochromic from regrind) in the first or lower layer. On heating or cooling, the lid will present a green colour at the predetermined temperature.

As another example the observable colour of the lid at a temperature other than the predetermined temperature such as at ambient temperature may be red and colour of the lid at the predetermined temperature may be yellow. This may be achieved by using pink thermochromic in the second or upper layer which, by means of light refraction, can show an observable dark red cold colour at the temperature other than the predetermined

temperature when a mixture of standard yellow and white dyes are used (together with any thermochromic from regrind) in the first or lower layer.

In use, with the addition of heat or cooling to the predetermined temperature, the colour of the second (upper) layer containing the thermochromic material may disappear and the colour of the pigment added to at least one portion of the first (bottom) layer may become visible. The portion which becomes visible may form words, symbols or patterns against the remainder of the lid when the contents are at the predetermined temperature.

The thermochromic material may be capable of returning to its original colour in response to the temperature of the regions falling below the predetermined temperature.

In one embodiment different portions of the lid may contain different thermochromic materials. For example the lid may include at least two regions having different thermochromic properties which are each capable of changing upon reaching differing predetermined temperatures in response to heat transfer from or to the contents of the container. In another embodiment three, four or more regions may be provided. The thermochromic material(s) used may also be quasi-reversible and allow two or more colour changes. For example a thermochromic pigment may be blue at one temperature (such as ambient temperature), red at a different temperature (such as a temperature of about 45°C) and yellow at another temperature (such as a temperature of about 60°C).

It is therefore clear from the above that it is possible to use two or more colours and more than two layers, and where more than two layers are used, with the addition of different or the same thermochromic materials in each layer having varying or similar colour changing temperatures. It is possible to select a particular combination of colour(s) to indicate most desired temperatures. One possible use of the lid is one with a safe cold colour (such as blue), a colour which indicates that the beverage is at the right temperature to drink (such as orange), and a third colour (such as red) which indicates that the beverage is too hot.

The predetermined temperature may be a predetermined non-ambient temperature such as a predetermined heated non-ambient temperature or a predetermined cooled non-ambient temperature. The temperature other than the predetermined temperature may be ambient temperature. In one embodiment the ambient temperature is about 20°C to about 30°C. The predetermined heated non-ambient temperature may be above about 25°C, for example about 30°C, about 35 °C, about 40°C, about 45°C, about 50°C, about 55°C, about 60°C, or about 65°C. In alternative embodiments the temperature may be about 45°C, about 50°C, about 55°C, or about 60°C. The predetermined cooled non-ambient

temperature may be below about 25°C, for example about 20°C, about 15°C, about 10°C, about 5°C, about 0°C, about -5°C, about -10°C, or about -15°C.

There is also disclosed herein a lid for a container, the lid comprising a layer comprising at least one portion having at least one thermochromic substance which is adapted to change colour and/or become substantially translucent upon reaching a predetermined temperature(s) in response to heat transfer from or to contents of the container, the layer being provided in at least one portion with a coloured pigment, which portion is observable at said predetermined temperature(s) and non-observable at a temperature other than the predetermined temperature(s), the colour of said pigment being the same or substantially the same colour as that of said thermochromic substance at a temperature other than the predetermined temperature(s) or which portion becomes non-observable at said predetermined temperature(s) and observable at a temperature other than the predetermined temperature(s), the colour of said pigment being the same or substantially the same colour as that of said thermochromic substance at the predetermined temperature(s).

In this embodiment, the lid may be one in accordance with the first aspect of the invention and the layer may be coated on the second plastic layer or may be located between the first and second plastic layers.

In this embodiment, a logo, symbol or writing (such as branding or advertising) may be made to appear on the top of a lid which at ambient temperature appears to have no logo, symbol or writing visible on it. The logo, symbol or writing may be coated by stamping or impregnating the pigment onto the top of the lid using a standard regular non-changing ink after the lid is made using a colour substantially identical or similar to that of the lid at ambient temperature i.e., the colour may be chosen to be substantially identical to or similar to the thermochromic material. In this embodiment, the logo, symbol or writing may be stamped onto the lid as a standard dye (i.e., one that does not change colour on top of the lid in a colour that matches the colour of the thermochromic at a temperature below the predetermined temperature (such as at ambient temperature) and thus is not visible below the predetermined temperature but when the lid changes colour the logo, symbol or writing stays the same colour and is thereby revealed.

Alternatively or additionally the logo, symbol or writing may be formed from a thermochromic material such as a quasi-reversible or non-reversible thermochromic. More than one logo, symbol or writing may be present and the logo, symbol or writing may be revealed at different temperatures. In one embodiment, when the lid is at a temperature other than the predetermined temperature, a user cannot see anything on the

top of the lid, however once the lid is put on the cup and heated or cooled to the predetermined temperature, the thermochromic material changes colour and becomes clear, revealing the logo, symbol or writing to the user.

In one embodiment when using a quasi-reversible thermochromic material in the lid capable of two colour changes (for example blue to yellow to red), stamping a logo, symbol or writing on the top of the lid (or a layer of the lid) with normal ink that matches the colour at a temperature below the predetermined temperature i.e. the ambient cold colour (such as blue), the logo, symbol or writing will be visible at both the red stage and the yellow stage but not the blue stage. Alternatively by stamping the logo, symbol or writing in a standard dye that is yellow, then the logo, symbol or writing will be visible at the blue stage and the red stage, but not the yellow stage. Similarly using a standard red dye will result in visibility during the blue and yellow stage but no visibility of the logo, symbol or writing during the red stage. In another embodiment, by stamping a logo, symbol or writing that is made from a thermochromic material that is capable of becoming substantially translucent on the application of heat, then when using a quasireversible material in the lid as above, it is possible that when the logo, symbol or writing is stamped in a blue thermochromic with only one translucent colour change the change occurring during the red stage, then the logo, symbol or writing will not be visible during the blue stage, will be visible during the yellow stage but will not be visible during the red stage. This offers branding and marketing options as well as enabling logos, symbols or writing to indicate to consumers that the beverage is at the right temperature to drink or is too hot. Another scenario is stamping the lid or a layer of the lid with two (or more) different types of coloured pigments one or both being a thermochromic material(s) capable of becoming substantially translucent at various predetermined temperatures. This allows different logos to appear/disappear at various temperatures.

Where more than two layers are used for example in a multi-layer lid, logos, symbols or writing can be provided in any or between any layers in any desired variation of logo, symbol or writing or combination of colours. In this embodiment it is possible for the logo, symbol or writing to be in the form of a picture.

There is also disclosed herein a process for preparing a lid for a container, the process comprising co-extruding a first plastic layer, a second plastic layer and optionally one or more additional plastic layers, the first layer including in at least one portion a coloured pigment, the second layer including at least one portion including at least one thermochromic substance which is adapted to become substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of

the container to reveal the at least one of the portions having the coloured pigment of the first layer.

In one embodiment the lid is thermoformed, with thermochromic pigments added to molten plastic material such as HIPS before forming. In one embodiment, a process for
5 producing the thermochromic regions of the lids involves co-extruding two or more layers of HIPS from separate drums. The inner layer (ie., that adjacent to or closest to the contents of the cup in use) of HIPS may be produced conventionally to which is added a coloured pigment (other than the normal base pigment of white or grey tone) which does not change colour under heat or cooling and which provides a depth of colour to the lid.
10 The inner layer may be formed from scrap and may include a thermochromic material. The outer layer (i.e., that remote from the contents of the cup in use) may be produced from HIPS to which is added a thermochromic pigment in the absence of any white pigment.

In one embodiment the lid is formed from a plastics material in which portions are
15 impregnated or blended where appropriate with the material having thermochromic properties or with a standard dye and where appropriate thermochromic from regrind. In various embodiments no water may be present in the thermochromic material prior or during addition.

Referring to the drawings, Figure 1 shows a beverage container lid 2 of the present
20 invention which includes a sidewall 2A, corresponding top wall 2B, a rim or lip 3 for engaging beverage cup 67. Edge 4 flares outwardly and independent from contact with cup 67. Beverage container lid 2 also includes a steam release hole 1.

Figure 2 shows the lid of Figure 1 including a cut out cross section 5 showing an inner layer 7 and an outer layer 6.

Figure 3 shows the cross-section 5 of Figure 2 in more detail. It can be seen that
25 Figure 3 represents a magnified representation of cut out cross section 5 of a beverage container lid 2A. Figure 3 includes a top surface 11, a layer 14 which corresponds to outer layer 6 of Figure 2, a bottom layer 15 which corresponds to inner layer 7 of Figure 2, and bottom surface 13. Region 12 denotes a bonding area between top layer 14 and bottom
30 layer 15(a combination of heat and applied pressure allows the layers to bond and meld together on contact on exit from a drum). At ambient temperature the outer surface 11 displays an observable colour combination of layers 14 and 15 in an unmolested state. For this purpose the top layer 14 includes virgin High Impact Polystyrene (HIPS) and at least one thermochromic material and the bottom layer 5 includes virgin HIPS, at least one
35 standard dye pigment and regrind in the form of recycled material of a like lid. In one

embodiment the standard dye pigment is added in an amount sufficient to provide an opaque covering of bottom layer 15. In one embodiment top layer 14 represents a layer between 15-35% of the entire thickness of the lid 2. In one embodiment the thermochromic material is a standard thermochromic material suitable for use with HIPs. In another embodiment the thermochromic material is a concentrate of a standard thermochromic material having its particle size reduced as mentioned hereinbefore. Suitably layer 14 contains at least about 10wt% thermochromic material with the remaining material being the virgin HIP.

In use, the lid 2 of the invention is placed on container 67 containing a hot or cold beverage and subjected to thermal communication from the contents of the container 67 thereby activating the thermochromic material. The thermochromic material present in top layer 14 is activated and becomes substantially translucent at a pre-determined non-ambient temperature to thereby reveal the underlying colour present in the bottom layer 15.

In one embodiment layer 14 may also contains regrind material.

Figure 4 shows another cross section 10 of a lid 2 however in this embodiment the standard dye pigment is insufficient to provide an opaque coverage of the bottom layer 15. In this regard typically less than 1wt% is insufficient and 1 to 3wt% may be insufficient however sufficiency is dependent on the strength and brand of pigment used. Where HIPS is used and a white pigment is not contained therein, a standard dye contained within the thermochromic capsule and acting as a secondary colour was insufficient to provide coverage. In use hot liquid 22 from beverage cup 67 generates steam 23 causing the activation of the thermochromic material however because of the insufficient coverage, the bottom layer 15 itself becomes translucent and condensation 20 is able to be seen through the lid 2 on the surface 13 of the bottom layer 15.

Figure 5 shows a lid 2 however in this embodiment pitting 31 occurs on the lid surface. Layer 14 includes a standard thermochromic additive suitable for HIP environments. The enlarged particle size of the thermochromic additive inherent in the standard material and overcrowding of the thermochromic particles causes an explosion of the crowded particles because the particles are unable to retain their natural configuration resulting in pitting 30 visible on the outer surface 11 of the lid 2. Figure 6 shows a cross-section of the lid 10 showing this pitting in detail. The pitting also leads to a loss of rubber content causing brittleness.

Figures 7, 7A and 7B show a lid 2 having a patterns or logos 62 or 64 on their surface. The patterns or logos 63 are selected to be a colour combination of upper layer 14

and lower layer 15 in the cold ambient state and is not observable. When thermochromic additive is subjected to heat or cooling and becomes translucent, the visible outer substrate 60 colour becomes the colour of the standard pigment contained in lower layer 15 but the logo 62 remains the colour combination of both layers in the cold ambient state and becomes observable as the remaining colour changes to the secondary underlying colour. The logo may be in the form of a standard non-changing pigment stamped on the lid or it may be a quasi-reversible or non-reversible thermochromic material.

The invention will now be described by reference to the following examples:

In the following examples all add rates assume that the top layer of the beverage lid has a thickness being approximately 40% of the thickness of the lid, and the bottom layer being approximately 60% of thickness of lid. These thicknesses can vary and when they do so add rates may vary.

EXAMPLE 1:

To achieve a dark brown to bright red lid.

25. Top Layer:

Chromicolor PS Conc BW Grade Green Type #45	about 10%
Chromicolor PS Conc BW Grade Turquoise Blue Type #45	about 5%
Virgin HIPS	about 85%

Bottom Layer:

Pigment Red 247	about 1.0%
Pigment Red 242	about 0.1%
Balance (regrind from top layer and virgin hips)	about 98.9%

2)

Top Layer:

Chromicolor PS Conc BW Grade Green Type #45	about 15%
Virgin HIPS	about 85%

Bottom Layer:

Pigment Red 247	about 1.0%
Pigment Red 242	about 0.1%
Balance (regrind from top layer and virgin hips)	about 98.9%

EXAMPLE 2:

To achieve a Red to bright Yellow lid:

1)

Top Layer:

	Chromicolor PS Conc BW Grade Pink Type #45	about 15%
	Virgin HIPS	about 85%
	Bottom Layer:	
	Pigment White 6	about 0.06%
5	Pigment Yellow 138	about 0.055%
	Balance (regrind from top layer and virgin hips)	about 99.885%
	2)	
	Top Layer:	
	Chromicolor PS Conc BW Grade Pink Type #45	about 15%
10	Virgin HIPS	about 85%
	Bottom Layer:	
	Pigment White 6	about 0.03%
	Pigment Yellow 138	about 0.0275%
	Balance (regrind from top layer and virgin hips)	about 99.9425%
15	EXAMPLE 3:	
	To achieve a Charcoal to Green:	
	1)	
	Top Layer:	
	Chromicolor PS Conc BW Grade Fast Black Type #45	about 11%
20	Chromicolor PS Conc BW Grade Gold Orange Type #45	about 4%
	Virgin HIPS	about 85%
	Bottom Layer:	
	Pigment White 6	about 0.105%
	Pigment Green 7	about 0.0275%
25	Balance (regrind from top layer and virgin hips)	about 99.8675%
	2)	
	Top Layer:	
	Chromicolor PS Conc BW Grade Fast Black Type #45	about 11%
	Chromicolor PS Conc BW Grade Gold Orange Type #45	about 4%
30	Virgin HIPS	about 85%
	Bottom Layer:	
	Pigment White 6	about 0.05%
	Pigment Green 7	about 0.0015%
	Pigment Yellow 138	about 0.0125%
35	Balance (regrind from top layer and virgin hips)	about 99.936%

Lids according to the embodiments described above may have one or more advantages. For example, the lids may be used in the case of hot beverages to include a warning that there are hot and potentially hazardous contents contained therein. The lids may also provide an improved indication of temperature to persons with minimal
s eyesight, numbness of the hands and/or fingers and to persons in darkened locations.

Although the invention has been described with reference to specific examples, it will be appreciated to those skilled in the art that the invention may be embodied in many other forms.

The claims defining the invention are as follows:

1. A lid for a container, the lid comprising a first plastic layer and a second plastic layer disposed on top of the first layer and optionally one or more additional plastic layers, the first layer including at least one portion comprising at least one coloured pigment, the second layer including at least one portion comprising at least one thermochromic substance which is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container so as to reveal at least one of the portions comprising the coloured pigment of the first layer, at least the first and second plastic layers being co-extruded.
2. A lid for a container, the lid comprising a first HIPS layer and a second HIPS layer disposed on top of the first layer, the first layer comprising at least one portion having at least one coloured pigment, the second layer including at least one portion having at least one thermochromic substance in an amount up to 12wt% of the layer and having a reduced particle size, which thermochromic substance is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container so as to reveal at least one of the portions comprising the coloured pigment of the first layer, the second layer having a thickness substantially less than the thickness of the first layer.
3. A lid according to claim 1 or 2 including one or more additional plastic layer(s).
4. A lid according to claim 3 wherein the additional plastic layer(s) include one or more of coloured pigment(s), thermochromic substance(s) or regrind.
5. A lid according to any one of claims 1 to 4 for a hot or cold cup or container.
6. A lid according to any one of claims 1 to 5 wherein each layer of the lid ranges from about 100µm thickness, with the total thickness of the lid for a two layer lid in the range 200µm to about 800µm.
7. A lid according to any one of claims 1 to 6 wherein the second layer is an upper layer of the lid and the first layer is a lower layer of the lid and additional plastic layers are positioned below the first layer.
8. A lid according to any one of claims 1 to 7 wherein the second layer is an upper layer of the lid and the first layer is a lower layer of the lid and an additional plastic layer(s) includes a thermochromic material and is positioned above the second layer.
9. A lid according to claim 7 or 8 wherein the upper layer of the lid is about 15% to about 50% of the total lid thickness.

10. A lid according to any one of claims 1 to 9 wherein the portion of thermochromic substance and coloured pigment in each layer is substantially all of the lid or one or more small portion(s) of the lid provided that at least one of the portions of the second layer must sufficiently cover a portion of the first layer so as to reveal that portion at the predetermined temperature.

11. A lid according to any one of claims 1 to 10 wherein the first layer includes regrind of the lid or regrind of a different lid.

12. A lid according to any one of claims 1 to 11 wherein the thermochromic substance has a reduced particle size and is selected from the group consisting of Matsui Chromicolor BW Grade or PS Conc.

13. A lid according to any one of claims 1 to 12 wherein the coloured pigment of the first layer is such that the first layer is opaque at both the predetermined temperature and a temperature other than the predetermined temperature.

14. A lid according to any one of claims 1 to 13 wherein the coloured pigment is a standard pigment dye other than a white pigment or is a standard pigment dye combined with a white pigment.

15. A lid according to any one of claims 1 to 14 wherein the coloured pigment is added in an add-on rate of about 1 to about 4wt%.

16. A lid according to any one of claims 1 to 15 wherein the thermochromic substance is included in an amount of about 6wt% to about 10wt%.

17. A lid according to any one of claims 1 to 16, wherein the colour of the thermochromic substance and the coloured pigment in each layer is selected so that a colour or combination of colours which results in an observable colour at the temperature other than the predetermined temperature and which colour is distinguishable from the colour of the lid at the predetermined temperature.

18. A lid according to any one of claims 1 to 17, wherein the portion which is revealed forms a word, symbol, logo, picture or pattern.

19. A lid according to any one of claims 1 to 18, wherein the colour change of the thermochromic substance is reversible, quasi-reversible or non-reversible.

20. A lid according to any one of claims 1 to 19, wherein there is more than one predetermined temperature.

21. A lid according to any one of claims 1 to 20, wherein the predetermined temperature is a predetermined non-ambient temperature selected from a predetermined heated non-ambient temperature above about 25°C or a predetermined cooled non-ambient temperature below about 25°C.

22. A lid for a container according to any one of claims 1 to 21, wherein the lid is a coffee cup lid and the thermochromic substance is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from the contents of the container.

5 23. A lid for a container, the lid comprising a layer comprising at least one portion having at least one reversible or quasi-reversible thermochromic substance which is adapted to change colour and/or become substantially translucent upon reaching a predetermined temperature(s) in response to heat transfer from or to contents of the container, the layer being provided in at least one portion with at least one coloured
10 pigment, which portion is observable at said predetermined temperature(s) and non-observable at a temperature other than the predetermined temperature(s), the colour of said pigment being the same or substantially the same colour as that of said thermochromic substance at a temperature other than the predetermined temperature(s) or
15 which portion becomes non-observable at said predetermined temperature(s) and observable at a temperature other than the predetermined temperature(s), the colour of said pigment being the same or substantially the same colour as that of said thermochromic substance at the predetermined temperature(s).

24. A lid according to claim 23 wherein the observable portion forms a word, symbol, a logo, pattern or picture.

20 25. A lid according to any one of claims 1 to 22 including the layer from the lid according to claim 23 or 24 between the first and second plastic layers or on or above the second plastic layer.

26. A process for preparing a lid for a container comprising:
co-extruding a first plastic layer and a second plastic layer, and optionally one or
25 more additional plastic layers, the first layer comprising in at least one portion at least one coloured pigment, the second layer comprising at least one portion comprising at least one thermochromic substance which is adapted to become substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container to reveal at least one of the portions having the coloured pigment of the first
30 layer.

27. A lid according to any one of claims 1 to 25 wherein regrind is added to one or more layers of the lid.

28. A lid for a container, the lid comprising a first plastic layer and a second plastic layer disposed on top of the first layer and optionally one or more additional
35 plastic layers, the first layer including at least one portion comprising at least one

coloured pigment, the second layer including at least one portion comprising at least one thermochromic substance which is capable of becoming substantially translucent upon reaching a predetermined temperature in response to heat transfer from or to contents of the container so as to reveal at least one of the portions comprising the coloured pigment
5 of the first layer, wherein one or more of the layers of the lid include regrind.