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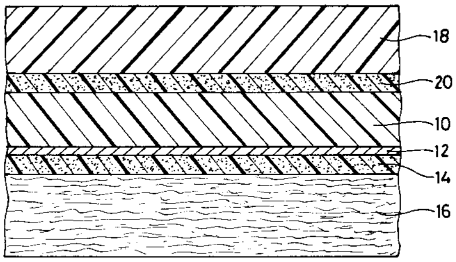
(54) A layered low temperature susceptor.

(57) A layered susceptor material comprising an active microwave absorbing substructure consisting of an inert plastic film substrate layer (10), and an active metal layer (12) deposited on said substrate layer (10), the thickness of said metal layer (12) being selected such that said metal layer has a microwave absorbency of between 10% and 50%. The material comprises furthermore a stock material layer (16) supporting said active microwave substructure and adhered by means of a layer of adhesive (14) to said substructure. The inert plastic film substrate layer (10) is made of a plastic material with a melting point below 200 ° C and further that the substrate layer material is in an oriented state. The material may comprise a further layer (18) of a material with a melting point above the melting point of said substrate layer (10) adhered by means of an adhesive layer (20) to said active microwave absorbing substructure opposite the surface to which the stock material layer (16) is adhered.

Fig-2



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The invention relates to a layered susceptor material comprising an active microwave absorbing substructure consisting of

- an inert plastic film substrate layer, and
- an active metal layer deposited on said substrate layer, the thickness of said metal layer being selected such that said metal layer has a microwave absorbency of between 10% and 50%, and comprising

a stock material layer supporting said active microwave substructure and adhered by means of a layer of adhesive to said substructure.

A similar susceptor, but described as having a far lower electrical sheet resistance of the metal layer, is for instance the subject of US patent 4.641.005. In the context of this description a susceptor can be defined as a material which absorbs microwave energy in order to rapidly heat up and provide a hot surface to aid cooking.

In general in such susceptors a polyester film, e.g. a polyethylene therephtalate film, is used as substrate layer, which film after being metallised is adhered to a paper or paper-board layer functioning as said stock material layer. Susceptors of this type are generally accepted as browning aids for a wide range of microwaveable food products. These susceptors are for instance used as active packaging to generate surface crisping and browning of many pastry products, which would otherwise not be successfully reheatable in the microwave oven. Another major area of use has been in pop-corn bags of the self-inflating type described for instance in US patent 4.571.337 where a susceptor increases the popping efficiency and reduces cooking time.

Current concerns over the use of susceptors have risen on two fronts, both inter-related. Where the susceptor surface is not in intimate contact with a food product to provide an effective heat sink for the heat generated by the susceptor, then the susceptor can self-heat to temperatures well in excess of 200°C. These high temperatures to which the packaging materials and components are not normally screened, can cause release of volatiles from the polyester film surface, and degradation products from the polyester film surface, in close proximity to the food. The paper or paperboard substrate can also brown and char, emitting undesirable (possibly harmful) fumes and smells.

A second problem, also arising from the high temperatures generated by the susceptor board, is the cracking or crazing of the polyester film. This is often invisible to the naked eye, although on some products it is immediately obvious with the paper or paperboard layer becoming exposed as the polyester metallised film shrinks. Examination of the surface of used susceptor materials with a scanning electron microscope shows that the laminating adhesive and the underlying paper or paperboard can become exposed by this cracking process.

The food product, originally isolated from direct exposure to the laminating adhesive and paper base, becomes exposed at the cracks to the hot adhesive and paper, and to any volatiles emitted by these hot (>200°C) surfaces.

It is believed that the temperature limit of conventional susceptors is determined by the melting point of the polyester film, namely 265°C. Above this temperature, it no longer provides a solid base for the microwave absorbing metal layer. The thermal stresses cause the metal layer to become discontinuous and a much weaker microwave absorber. (Without this automatic self cut-off property, temperatures would rise even further till the susceptor ignited).

The objectives of the invention are two-fold: to construct a susceptor with similar heating abilities to existing products, but having a maximum temperature peak lower than the 200+ degrees Celsius of current products; and to construct a susceptor which retains an unbroken barrier surface in contact with the food during heating and use.

In agreement with said object the layered susceptor material described in the first paragraph is according to the invention characterized in that said inert plastic film substrate layer is made of a plastic material with a melting point below 200°C and further that the substrate layer material is in an oriented state.

Preferably the layered susceptor material comprises a further layer of a material with a melting point above the melting point of said substrate layer adhered to said active microwave absorbing substructure opposite the surface to which the stock material is adhered. Said further layer functions as cover layer which, because of the higher melting point temperature will be stable under all circumstances and, during use of the susceptor, isolates the food product from the layers of said substructure.

The invention will now be described in more detail with reference to the drawings.

Figure 1 illustrates a cross-sectional view through a layered susceptor material according to the invention.

Figure 2 illustrates a cross-sectional view through a preferred embodiment of a layered susceptor material according to the invention.

Figure 3 illustrates another embodiment of the layered susceptor material according to the invention.

Figure 1 illustrates a cross-sectional view through a layered susceptor material comprising a substrate layer 10 and a metal layer 12 which is deposited on the substrate layer 10. The substrate layer is a thin inert plasic film which forms the material to be vacuum coated with the metal layer 12. Said two layers form together a substructure which can be manufactured as separate product. A stock material layer 16 is adhered to said substructure by a layer of adhesive 14. In the illustrated embodiment, the stock layer is adhered to the metal layer 12. According to the invention the substrate layer 10 is made of a plastic material having a melting point below 200°C and is preferably made of biaxially oriented polypropylene film of a grade suitable for food packaging applications and suitable for metallising. Within the context of this description the term melting point not only represents the temperature at which a polymer changes from solid phase to liquid phase, but also indicates the softening point or temperature range at which non crystalline plastics change from solid state to viscous state.

Preferrably the substrate layer is a biaxially oriented film made of polypropylene. The thickness of the film 10 is preferably between 5 and 50 μ.

The metal layer 12 can be any metal or alloy which is stable and corrosion resistant as a thin film, but is preferably aluminium or stainless steel, which are metals already widely accepted in food packaging and food preparation.

The metal layer is applied to the substrate layer by means of a suitable vacuum deposition process such as thermal evaporation or sputtering. In such processes, the substrate film is transported, at a controllable speed, over the vapour source allowing the vapour condense on the substrate to build up the desired thickness of fractions of one micron.

The final metal coating has preferably a sheet resistance in the range of 50 to 500 ohms per square. The optical density for an aluminium metallised film should preferably be in the range of 0,18 to 0,28 such that the metal layer has a microwave absorbency of between 10% and 50%. The correct thickness can be achieved by those skilled in the art by controlling the metal evaporation or sputtering rate and by control of the film speed over the metal vapour source.

Preferably the stock material layer 16 consists of paper or paperboard. The metallised film is laminated to this paper or paperboard using an adhesive approved for food packaging use, whereby the metallised surface of the substrate film is in contact with the adhesive 14.

A cross-sectional view through a further developed embodiment of a layered susceptor material according to the invention is illustrated in figure 2. Those layers, which are also present in the embodiment illustrated in figure 1, are indicated by the same reference numbers. The difference between figure 1 and figure 2 is the fact that a further plastic film 18 is adhered by means of an adhesive layer 20 to the top of the metallised substrate film 10. The further plastic layer has a melting point temperature above the melting point temperature of the (polypropylene) substrate film and consists preferably of polyester. The purpose of this further layer is to provide a protective barrier between the actual food product and the microwave absorbing substructure. Because the substructure comprising the layers 10, 12 has a self cut-off property at temperatures of about 170°, determined by the melting point of the polypropylene film, there is no danger that the polyester film 18 will start releasing volatiles or degradation products because of overheating of said layer. On the other hand any volatiles or degradation products which might be released by the polypropylene film 10 are effectively blocked from the food product by the further layer of polyester.

Figure 3 illustrates a cross-sectional view through another embodiment of the susceptor material according to the invention which only differs from the embodiment illustrated in figure 2 by the orientation of the substructure comprising the polypropylene film 10 and the metallised layer 12. It will be clear from figure 3 that the paper or paperboard stock material layer 16 is in this embodiment not adhered to the metal layer 12 but adhered to the polypropylene layer 10. Thereafter the further plastic layer 18 consisting of polyester is adhered by means of the adhesive layer 20 to the metal layer 12. Also this embodiment has the self cut-off property at a rather low temperature determined by the melting point of the polypropylene film (170°C).

The following three examples demonstrate the invention. More specifically the browning properties, the need for an oriented base film and the need for a temperature resistent food contact layer are demonstrated.

Example 1

A roll of cast, i.e. unoriented, polypropylene film (Karl Dickel "Safran" PP 350 MET) was metallised by vacuum evaporation of aluminium to produce a coating having an optical density of 0.2. The metallised film was laminated, using a water-based adhesive (Duraflex 56) applied to a dry coating weight of 3 g/m^2 to the metallised side, to a 240 g/m^2 paperboard.

Pieces of this laminated board, cut to 11x18 cm (approx. 200 cm^2) were tested as susceptor for browning pieces of fresh pizza dough weighing 190 g.

Two pieces of dough were each placed on a 200 cm^2 susceptor board in a 600 W microwave oven, and cooked at full, i.e. continuous, power for

5 minutes. As intended and expected, rapid heating of the board occurred, but surprisingly, heating continued unregulated well beyond the melting point of polypopylene. Burning of the board in "hot spots" occurred. The oven filled with smoke from the burnt board, polypropylene, and pastry.

This demonstrated the strong microwave absorbing properties of the susceptor but the absence of a necessary cut-off in absorption properties at the melting point of the plastic film.

Example 2

A roll of biaxially oriented polypropylene film (ICI "Propafilm" MVG) was metallised in the same way as example 1 to an optical density of 0.2, and subsequently laminated to the same board and with the same adhesive as in example 1.

The susceptor board was tested in a microwave oven with pizza dough as in example 1.

After 5 minutes cooking, the pizza dough was observed to be lightly browned on the undersurface in contact with the board. Examination of the surface of the used susceptor revealed a dulling of the surface. When examined under a scanning electron microscope, the surface was seen to have changed from the glossy smooth surface of the original film to a textured surface of a melted and re-solidified polymer. The surface was continuous apart from small "vent holes" a few microns in diameter with occasional larger holes up to 100 μ (0.1 mm) across.

This example demonstrated the browning functioning of the susceptor, the temperature cut-off which prevented burning or overheating of the susceptor and food product, and melting of the susceptor surface, also in contact with the food.

Example 3

To the laminated susceptor board described in example 2 (metallised biaxially oriented polypropylene on paperboard) was further laminated, to the polypropylene surface, a 12 μ film of polyester film (ICI "Melinex S", a biaxially oriented polyethylene terephtalate food packaging film). This is the same type of base film used metallised for conventionally constructed susceptor products.

Rectangles of this board (200 cm^2) were again tested in the 600 W microwave oven with 190 g pieces of pizza dough. After 5 minutes cooking, the pizza dough had developed browning on its undersurface, the board itself remained unburnt, and the polyester film in contact with the food remained continuous, unbroken, and showed no evidence of melting.

Claims

1. A layered susceptor material comprising an active microwave absorbing substructure consisting of

- an inert plastic film substrate layer, and
- an active metal layer deposited on said substrate layer, the thickness of said metal layer being selected such that said metal layer has a microwave absorbency of between 10% and 50%,

and comprising a stock material layer supporting said active microwave substructure and adhered by means of a layer of adhesive to said substructure, characterized in that said inert plastic film substrate layer is made of a plastic material with a melting point below 200°C and further that the substrate layer material is in an oriented state.

2. A layered susceptor material according to claim 1, characterized in that, the layered susceptor material comprises a further layer of a material with a melting point above the melting point of said substrate layer adhered to said active microwave absorbing substructure opposite the surface to which the stock material layer is adhered.

3. A layered susceptor material according to one of the preceding claims, characterized in that the oriented substrate layer is made of biaxially oriented material.

4. A layered susceptor material according to one of the preceding claims, characterized in that the substrate layer is a film made of polypropylene.

5. A layered susceptor material according to one of the preceding claims, characterized in that the metal layer is aluminium with a thickness corresponding to an optical density in the range 0,18 to 0,3.

6. A layered susceptor material according to one of the preceding claims, characterized in that the metal layer has a sheet resistance in the range of 40 to 500 ohms per square.

7. A layered susceptor material according to one of the preceding claims 2 - 6, characterized in that the further layer of a material with a melting point above the melting point of the substrate layer is made of polyethylene terephtalate, polyamide or polycarbonate.

Fig-1

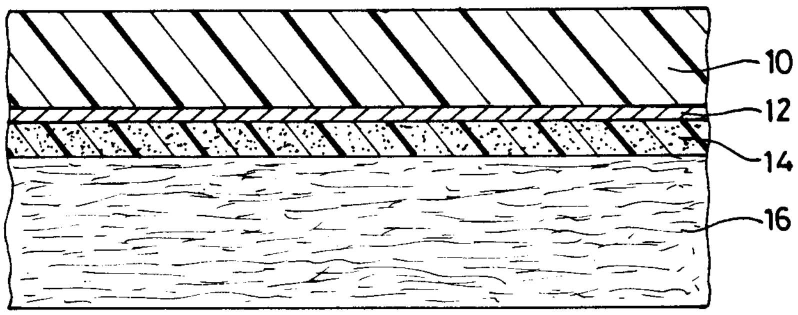


Fig-2

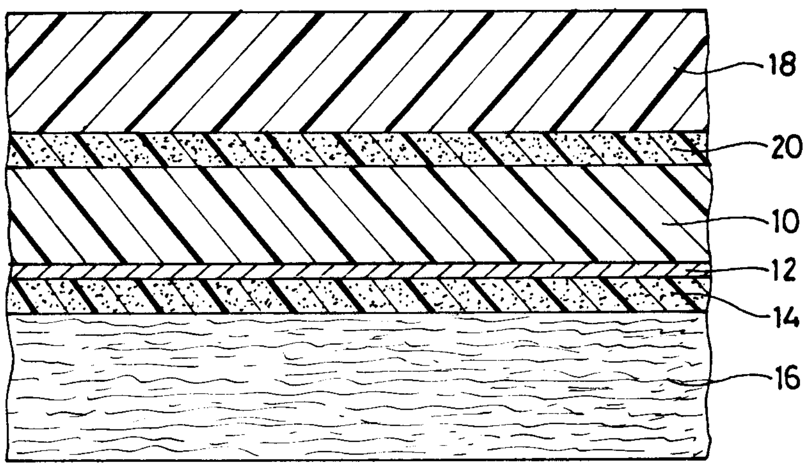
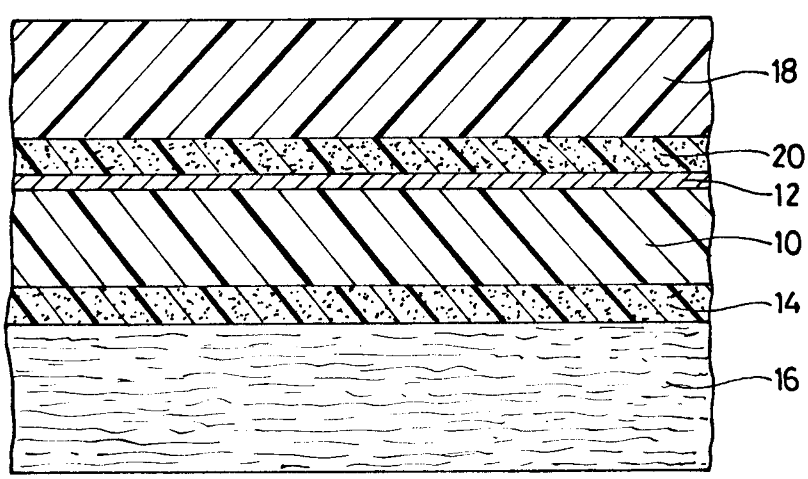


Fig-3



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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 3039

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	GB-A-2 211 380 (INTERNATIONAL PAPER CO.) * page 9, line 13 - page 10, line 16; figure 4 * ---	1-7	H05B6/64 B65D81/34
Y	EP-A-0 187 512 (AJINOMOTO CO. INC.) * claims 1,3,6 * ---	1-7	
Y	EP-A-0 340 037 (E.I. DU PONT DE NEMOURS AND CO.) * page 3, line 19 - line 42; figures 1,2 * * page 4, line 22 - line 31 * ---	2,7	
Y	EP-A-0 371 739 (BECKETT INDUSTRIES INC.) * column 5, line 25 - line 47 * -----	6	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H05B B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 FEBRUARY 1992	PERNICE C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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