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(54) **POLYMERIC STRUCTURAL PANEL**

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(57) **ABSTRACT**

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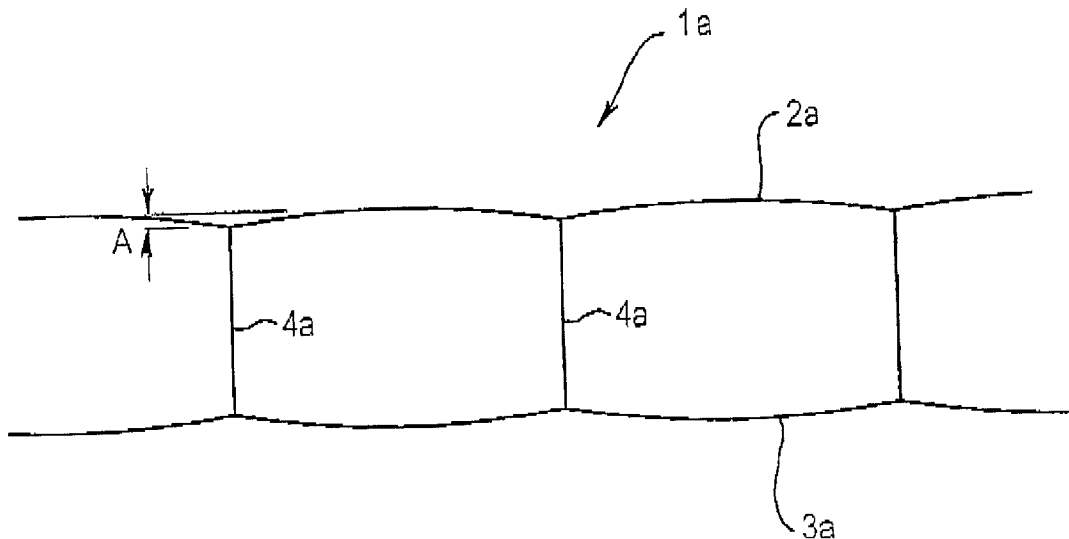
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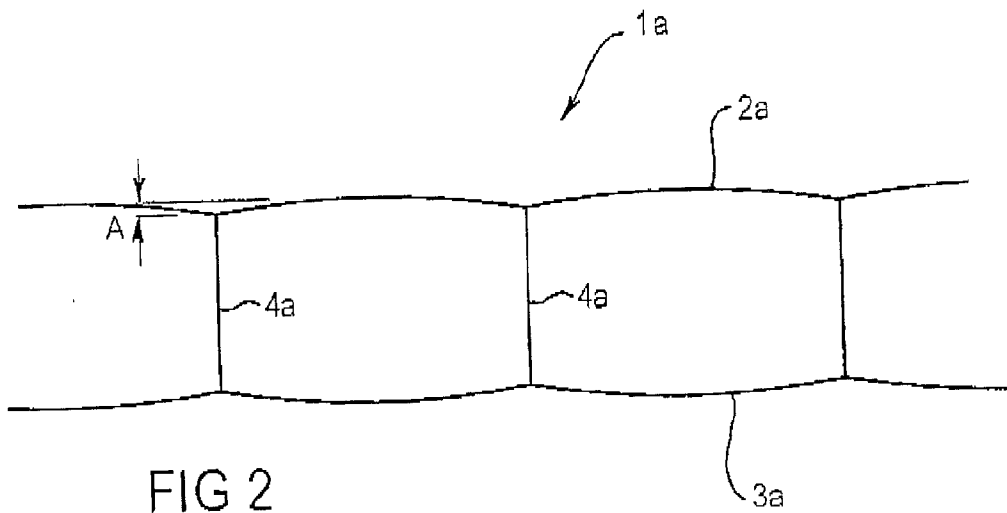
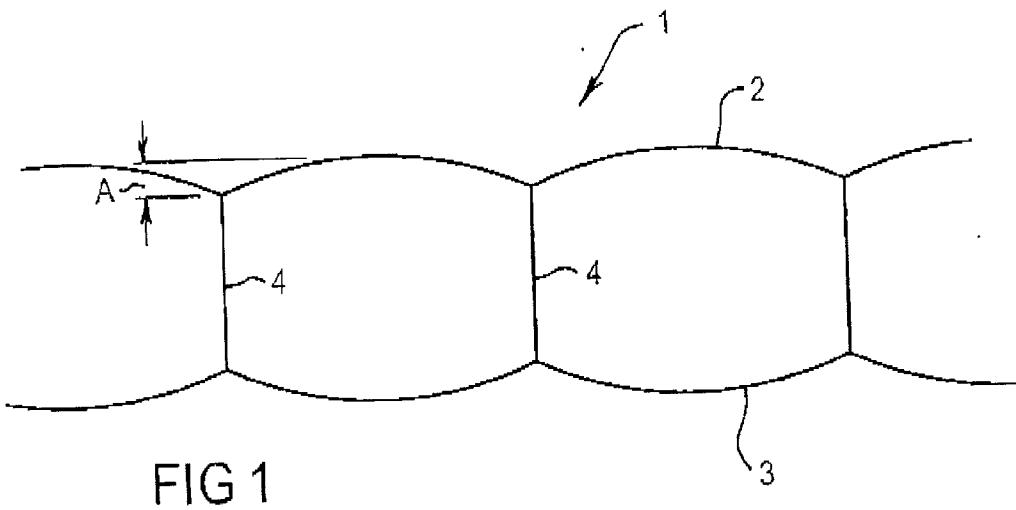
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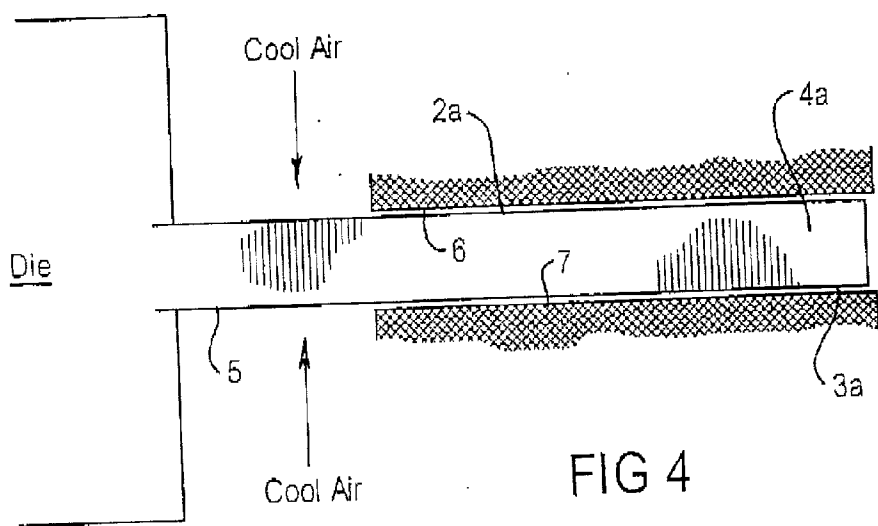
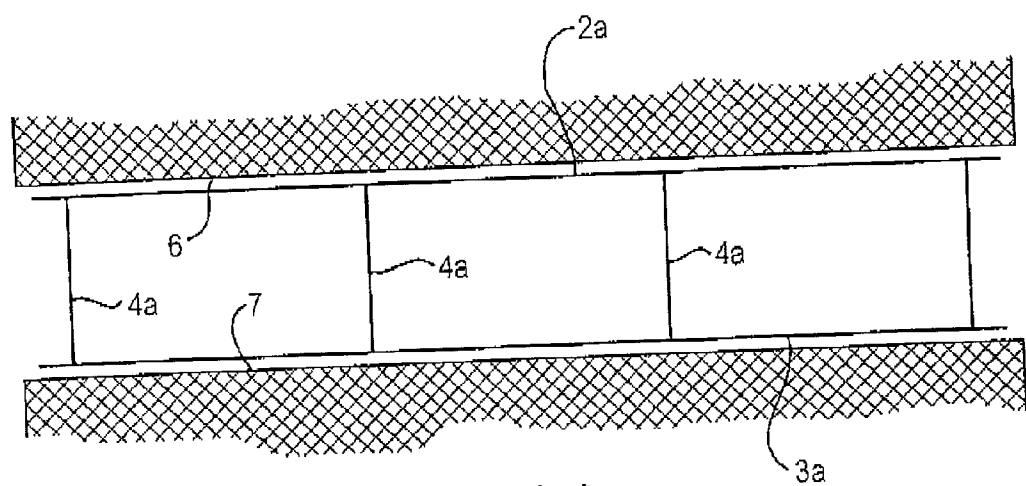
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A polymeric twin wall board which includes a first substantially planar sheet forming the upper side of the board, a second substantially planar sheet forming the underside of the board and a plurality of spaced longitudinally extending webs connecting the first substantially planar sheet to the second substantially planar sheet wherein the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than about 1% of the average distance between adjacent longitudinally extending webs.







POLYMERIC STRUCTURAL PANEL

[0001] This invention concerns a lightweight polymeric structural panel. It particularly concerns an improved twin wall board of the type which incorporates two substantially planar sheets spaced apart from each other and connected by a plurality of transverse webs.

[0002] Polymeric twin wall panels have been manufactured and used for many years. Such panels have broad application for packaging, signage, building and for other similar purposes. These products have found favour as alternatives to twin wall cardboard products as they are more durable, are not susceptible to water damage and are generally stronger than cardboard products of similar weight. Notwithstanding the advantages of polymeric twin wall products in terms of physical performance there are limitations in using these boards as signs or as packaging due to difficulties in achieving high print quality on the polymeric surface. This has restricted the use of these products in some circumstances.

[0003] It is an object of the present invention to provide a polymeric twin wall product which is better suited to receiving and displaying printed words and graphics than existing polymeric twin wall products.

[0004] The applicants have ascertained that one factor relevant to the suitability of polymeric panels for receiving and displaying printed material at high resolution is the level of the intended print surface at the junctures between the respective transverse webs compared with the portions of the print surface intermediate adjacent transverse webs. This is particularly so where the distance between adjacent transverse webs is small.

[0005] In accordance with a first aspect of the present invention there is provided a polymeric twin wall board which includes a first substantially planar sheet forming the upper side of the board, a second substantially planar sheet forming the under side of the board and a plurality of spaced longitudinally extending webs connecting the first substantially planar sheet to the second substantially planar sheet wherein the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than about 1% of the average distance between adjacent longitudinally extending webs. Most desirably the difference is no more than about 0.5%. Preferably the longitudinally extending webs are equally spaced and the difference in levels is no more than 1% of the distance between adjacent longitudinally extending webs.

[0006] Ordinarily, it is also desirable that the difference between the level of the outer surface of the second substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the second substantially planar sheet intermediate any of the adjacent webs is no more than about 1% of the average distance between adjacent longitudinally extending webs. Again, most desirably the difference is no more than about 0.5%. This avoids the board having alternative sides which are differently suited for receiving printed material.

[0007] Preferably, the twin wall board of the invention includes longitudinally extending webs which are separated

by a distance of between 2.0 to 5.0 mm. In boards made to these preferred dimensions it is preferred that the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than 0.020 mm. Most preferably it is no more than 0.010 mm. Desirably, the profile of the second substantially planar sheet is the same. The thickness of the webs and the first and second planar sheets can vary depending on the strength requirements of the intended board. However, generally these walls of the board are of about equal thickness and between 0.1 to 0.3 mm.

[0008] The polymeric material utilized for the manufacture of the boards of the invention can be of any type as known in the art. Preferably, the boards are made from a modified or unmodified polyolefin. Most preferably, the boards are manufactured from a homopolymer or co-polymer of polypropylene or a high density polyethylene material. It is desirable that the polymeric material have good thermal conductivity. Preferably the thermal conductivity of the material utilised is greater than 0.20 W/m.K. Most preferably the polymeric material utilised has a thermal conductivity of between 0.25 to 0.35 W/m.K.

[0009] Whatever polymeric material is used it is most desirable that its crystalline freezing point is higher than that of a standard polypropylene (i.e. above about 112° C.). Most preferably the crystalline freezing point of the polymeric material is more than 120° C. and less than 150° C. The applicant has found that production of boards of the present invention is assisted by utilising a material having a higher crystalline freezing point than materials conventionally used for manufacturing twin wall board. This is because the polymeric product once extruded can be more readily cooled to a temperature at which it will be resistant to non-uniform shrinkage. The crystalline freezing point of the polymer is best measured using a differential scanning calorimeter.

[0010] In accordance with a further aspect of the present invention there is provided a process for the manufacture of a polymeric twin wall board which includes extruding a molten polymeric material through a die configured to produce a board having opposed first and second substantially planar sheets separated by a plurality of transverse longitudinally extending webs and delivering the said extruded material into a cavity bounded by upper and lower platens where the extruded material is cooled to form a solidified board, wherein a sufficiently high vacuum is applied to at least one side of the extruded polymeric material whilst in the cavity so that the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs in the solidified board is no more than about 1% of the distance between adjacent longitudinally extending webs. Preferably the vacuum applied is such that this difference is no more than about 0.5%. Furthermore it is preferred that the vacuum be applied to both sides of the extruded polymeric material.

[0011] In accordance with a further aspect of the present invention there is provided a process for the manufacture of

a polymeric twin wall board which includes the steps detailed above but where the distance between adjacent webs is between 2.0 to 5.0 mm and the vacuum applied to at least one side of the extruded polymeric material is sufficiently high so that the difference between the level of the top surface of the substantially planar sheet adjacent to its juncture with any of the longitudinal extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extended webs in the solidified board is no more than 0.020 mm. Preferably the vacuum applied is sufficiently high to prevent the difference being more than 0.010 mm. Most desirably the vacuum is applied to both sides of the extruded polymeric material.

[0012] In accordance with either aspect of the present invention it is preferred that the platens be substantially flat and that they be cooled so that the temperature of the surface of the platen is 7° C. or lower. Most desirably the operating temperature of the surface of the platen is between 2.0 to 6.0° C.

[0013] As indicated above it is desirable in accordance with the process of the present invention that one utilise a polymeric material which, once extruded, can be more readily cooled to a temperature at which it will be resistant to non-uniform shrinkage. Accordingly, it is preferred that the polymeric material have a crystalline freezing point which is higher than that of a standard polypropylene. Most preferably the freezing point of the polymeric material is more than 120° C. and less than 150° C. Most preferably the freezing point of the polymeric material is more than 125° C.

[0014] The polymeric material preferably utilised in the processes of the invention is also of the type as indicated above in relation to the products of the invention—i.e. it is preferred that the polymeric material used be either a modified or unmodified polyolefin and it is desirable that the thermal conductivity of the material is greater than 0.200 W/m.K. Most desirably the polymeric material has a thermal conductivity of between 0.25 to 0.35 W/m.K.

[0015] When utilising a polymeric material of the type and having the characteristics indicated above the applicants have found that the platen vacuum settings should be set so that the vacuum applied is at least -150 mbar. Most desirably the vacuum is set at between -175 mBar and -300 mBar.

[0016] Whilst different methods might be used to cool the platens the applicants find that if the platens incorporate channels for delivering cooled water through or adjacent to the platen this is a practical way of cooling the platen to the desired temperature.

[0017] The molten polymeric material in its hollow profile form is therefore, in the preferred processes of the invention, drawn hard against the platens by the applied vacuum with enough force to ensure that the molten plastic substantially takes the flat structure of the platens. It is most desirable that the polymeric material have most, if not all, of the characteristics indicated above as being preferred. The high crystalline freezing point of the raw material will allow the polymer to solidify more quickly than a standard polymer thus allowing the sheet to hold the shape of the platens before any significant shrinkage can occur.

[0018] The preferred thermal conductivity properties of the raw polymeric material also assist this process as the use of a material which has better thermal conductivity enables a greater rate of heat transfer from the body of the extrudate and particularly in the planar sheets to the platens. This enables one to solidify the whole profile earlier than would be possible with a standard polypropylene. The heat transfer is also more effective when the temperature of the surface of the platens is reduced to the levels indicated above as preferred.

[0019] Any one of these changes enhances the process but to obtain the maximum benefits of the invention it is desirable that all of the features are incorporated so as to maximize the rate of heat transfer from the extrudate. It is most desirable that the higher vacuum applied be constant and that the extrudate be held in place while the solidifying process takes place. In preferred embodiments the process includes transferring the solidified product into a cavity between a further pair of platens where the vacuum applied is lower (in the order of -30 to -50 mBar) where the product can reach equilibrium before being finished by cutting and packing.

[0020] An example of the twin wall board of the invention and its process of manufacture is hereinafter described with reference to the following drawings in which:

[0021] FIG. 1 is a schematic cross section through a standard twin wall board;

[0022] FIG. 2 is a schematic cross section through a twin wall board product of the invention;

[0023] FIG. 3 is a schematic representation of a molten polymer extruded in accordance with the method of the invention in its hollow profile form located between respective upper and lower platens; and

[0024] FIG. 4 is a schematic representation of a die head adjacent upper and lower platens showing the extrusion of the polymeric material and its delivery between upper and lower platens for the formation of a twin wall board of the invention.

[0025] With reference to FIG. 1 there is shown the cross section through a standard twin wall board. The cross section is shown in an exaggerated form to emphasise the corrugations that one finds in standard product. The twin wall board 1 includes a first or upper surface 2, a second or lower surface 3 and a plurality of transverse longitudinally extending webs 4. Webs 4 extend along the full length of the product and join the upper surface 2 to lower surface 3. In FIG. 1 the letter "A" denotes the amplitude of the "sink". In conventional products the sink is in the order of 0.05 mm.

[0026] FIG. 2 illustrates a product made in accordance with the invention. It will be noted that the upper surface 2a is substantially planar as is lower surface 3a. The amplitude of the sink is less than 1% of the distance between adjacent longitudinally extending webs 4a which are equally spaced. In the product depicted the distance between longitudinally extending webs 4a is 3.2 mm and the sink amplitude is therefore less than 0.032 mm. Most preferably it is less than 0.010 mm (i.e. less than about 0.3%).

[0027] The product shown in FIG. 2 is preferably made from a modified polypropylene with a DSC crystalline freezing point of 125° C. or greater. It preferably has a

thermal conductivity of 0.30 W/m.K or greater and the wall thicknesses of substantially planar sheets **2a** and **3a** are about 0.2 mm with the longitudinally extending webs **4a** being in the order of 0.15 to 0.20 mm in thickness.

[0028] FIG. 3 shows a molten polymeric extrudate **5** in its hollow profile form positioned between platens **6** and **7**. The molten polymeric form **5** is produced using standard technology known in the art. It requires the melting of polymeric material and its extrusion through a die which is configured to produce the hollow profile form as depicted in FIG. 3 with first substantially planar sheet **2a** and second substantially planar sheet **3a** separated by transverse webs **4a**. The modified polypropylene material preferred in the practice of the invention is preferably extruded at temperatures ranging between 190 to 230° C.

[0029] The platens **6** and **7** are cooled by delivering chilled water through conduits which run along or through the respective platens. The platens are metallic and the chilled water is found to be effective in lowering the temperature of the surface of the platens between which the extruded material **5** is positioned. When chilling the platens with water it is desirable that the water be delivered at a temperature which is below 5.5° C. but above 2° C. If the temperature of the water is much below 2° C. it will start to freeze and this will create difficulties in operation. If liquids other than water are used lower temperatures of course can be achieved with benefits for the method of the invention. The lower the temperature of the platens the greater will be the rate of heat transfer from the body of the extrudate **5** to the platens **6** and **7**.

[0030] The vacuum applied to the extrudate through platens **6** and **7** is preferably about

[0031] -175 mBar. It is applied to both the upper planar sheet **2a** and the lower planar sheet **3a**. Extrudate **5** is held between the platens for sufficient time for the polymeric material to solidify and thus allow the formed twin wall board to hold the smooth and flat shape of the platens.

[0032] In FIG. 4 one can see extrudate **5** leaving the die head and being delivered between platens **6** and **7**. Optionally air-blades can be used to direct cool air against the surface of the extrudate **5** in the location indicated in FIG. 4. By directing cool air towards the extrudate as it leaves the die it is possible to accelerate the cooling process.

[0033] Once the polymeric material has solidified it is desirable that the formed board is conveyed or delivered into a cavity between a further set of platens (not shown in the drawings) where a reduced vacuum is applied for sufficient time for the material to reach substantial equilibrium. The formed board is thereafter finished by conventional means and packed for delivery to end users.

[0034] The applicants have found that twin wall board produced in accordance with the invention provides a quality surface suitable for receiving detailed graphics by means of conventional printing techniques.

[0035] It will be appreciated to those skilled in the art that the various modifications to the products and processes hereinbefore described can be made without departing from the spirit and ambit of the present invention as defined in the following claims.

The claims defining the invention are as follows:

1. A polymeric twin wall board which includes a first substantially planar sheet forming the upper side of the board, a second substantially planar sheet forming the underside of the board and a plurality of spaced longitudinally extending webs connecting the first substantially planar sheet to the second substantially planar sheet wherein the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than about 0.1% of the average distance between adjacent longitudinally extending webs.

2. A polymeric twin wall board as claimed in claim 1 wherein the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than about 0.5% of the average distance between adjacent longitudinally extending webs.

3. A polymeric twin wall board as claimed in either one of claims 1 or 2 wherein the longitudinally extending webs are equally spaced.

4. A polymeric twin wall board as claimed in any one of claims 1 to 3 wherein the difference between the level of the outer surface of the second substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the second substantially planar sheet intermediate any of the adjacent webs is no more than about 1% of the average distance between adjacent longitudinally extending webs.

5. A polymeric twin wall board as claimed in claim 4 wherein the difference between the level of the outer surface of the second substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the second substantially planar sheet intermediate any of the adjacent webs is no more than about 0.5% of the average distance between adjacent longitudinally extending webs.

6. A polymeric twin wall board as claimed in any one of the previous claims which includes longitudinally extending webs which are separated by a distance of between 2.0 to 5.0 mm.

7. A polymeric twin wall board as claimed in claim 6 wherein the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than 0.020 mm.

8. A polymeric twin wall board as claimed in claim 7 wherein the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs is no more than 0.010 mm.

9. A polymeric twin wall board as claimed in any one of claims 1 to 8 wherein the first and second substantially planar sheets are of equal thickness and the thickness is between 0.1 to 0.3 mm.

10. A polymeric twin wall board as claimed in any one of the previous claims made from a homopolymer or copolymer of polypropylene.

11. A polymeric twin wall board as claimed in any one of the previous claims wherein the thermal conductivity of the polymer used for the manufacture of the board is greater than 0.20 W/m.K.

12. A polymeric twin wall board as claimed in claim 11 wherein the thermal conductivity of the polymeric material is between 0.25 to 0.35 W/m.K.

13. A polymeric twin wall board as claimed in any one of the previous claims wherein the polymeric material from which the board is made has a crystalline freezing point above 112° C.

14. A polymeric twin wall board as claimed in claim 13 wherein the crystalline freezing point of the polymeric material is more than 120° C. and less than 150° C.

15. A process for the manufacture of a polymeric twin wall board which includes, extruding a molten polymeric material through a die configured to produce a board having opposed first and second substantially planar sheets separated by a plurality of transverse longitudinally extending webs, and delivering the said extruded material into a cavity bounded by upper and lower platens where the extruded material is cooled to form a solidified board, wherein a sufficiently high vacuum is applied to at least one side of the extruded polymeric material whilst in the cavity so that the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extended webs in the solidified board is no more than about 1% of the distance between adjacent longitudinally extending webs.

16. A process for the manufacture of a polymeric twin wall board as claimed in claim 15 wherein the vacuum applied to at least one side of the extruded polymeric material whilst in the cavity is sufficiently high so that the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs in the solidified board is no more than about 0.5% of the distance between adjacent longitudinally extending webs.

17. A process as claimed in either one of claims 15 or 16 wherein a vacuum is applied to both sides of the extruded polymeric material.

18. A process for the manufacture of a polymeric twin wall board which includes, extruding a molten polymeric material through a die configured to produce a board having opposed first and second substantially planar sheets separated by a plurality of transverse longitudinally extending webs where the distance between adjacent webs is between 2.0 to 5.0 mm and delivering the said extruded material into a cavity bounded by upper and lower platens where the extruded material is cooled to form a solidified board, wherein a sufficiently high vacuum is applied to at least one side of the extruded polymeric material whilst in the cavity so that the difference between the level of the top surface of the first substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs in the solidified board is no more than about 0.020 mm.

19. A process for the manufacture of a polymeric twin wall board as claimed in claim 18 wherein the difference between the level of the top surface of the substantially planar sheet adjacent to its juncture with any of the longitudinally extending webs and the level of the top surface of the first substantially planar sheet intermediate any of the adjacent longitudinally extending webs in the solidified board is no more than 0.010 mm.

20. A process for the manufacture of a polymeric twin wall board as claimed in any one of claims 15 to 19 wherein the upper and lower platens are substantially flat and are cooled so that the temperature of the surface of the platens is 7° C. or lower at the time of delivering the said extruded material into the cavity bounded by the said platens.

21. A process for the manufacture of a polymeric twin wall board as claimed in claim 20 wherein the temperature of the surface of both platens is between 2.0 to 6.0° C. at the time of delivering the said extruded material into the cavity bounded by the said platens.

22. A process for the manufacture of a polymeric twin wall board as claimed in any one of claims 15 to 21 wherein the polymeric material used has a crystalline freezing point which is more than 120° C. and less than 150° C.

23. A process for the manufacture of a polymeric twin wall board as claimed in claim 22 wherein the crystalline freezing point of the polymeric material is more than 125° C.

24. A process for the manufacture of a polymeric twin wall board as claimed in any one of claims 15 to 23 wherein the polymeric material has a thermal conductivity greater than 0.20 W/m.K.

25. A process for the manufacture of a polymeric twin wall board as claimed in claim 24 wherein the polymeric material has a thermal conductivity of between 0.25 to 0.35 W/m.K.

26. A process for the manufacture of a polymeric twin wall board as claimed in any one of claims 15 to 21 wherein said polymeric material is a modified or unmodified polyolefin having a thermal conductivity of greater than 0.20 W/m.K and a crystalline freezing point more than 120° C. and less than 150° C., wherein the vacuum applied to at least one side of the extruded polymeric material is at least -150 mBar.

27. A process for the manufacture of a polymeric twin wall board as claimed in claim 26 wherein the vacuum applied to at least one side of the extruded polymeric material whilst in the cavity is between -175 mBar and -300 mBar.

28. A process for the manufacture of a polymeric twin wall board as claimed in any one of the previous claims wherein the vacuum applied is constant and the extrudate is held in place while the solidifying process takes place.

29. A process for the manufacture of a polymeric twin wall board as claimed in any one of claims 15 to 28 further including the step of transferring the solidified product into a cavity between a further pair of platens where a vacuum in the order of -30 to -50 mBar is applied.

30. A polymeric twin wall board substantially as hereinbefore described with reference to what is shown in any one of the drawings.

31. A process for the manufacture of a polymeric twin wall board as hereinbefore described with reference to what is shown in any one of the drawings.

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