

GENERATION OF MIXED DIISOCYANATES BY PHOSGENATION OF SOY BASED METHYL AMINO ESTERS

CROSS-REFERENCE TO RELATED APPLICATIONS

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This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/377,727 filed on August 27, 2010, which is incorporated herein by reference.

INCORPORATION BY REFERENCE

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Any foregoing applications and all documents cited therein or during their prosecution (“application cited documents”) and all documents cited or referenced in the application cited documents, and all documents cited or referenced herein (“herein cited documents”), and all documents cited or referenced in herein cited documents, together with any
15 manufacturer’s instructions, descriptions, product specifications, and product sheets for any products mentioned herein or in any document incorporated by reference herein, are hereby incorporated herein by reference, and may be employed in the practice of the invention.

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Citation or identification of any document in this application is not an admission that such document is available as prior art to the present invention.

FIELD OF THE INVENTION

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The invention relates to compositions comprising diisocyanates derived from their corresponding diamino alkyl esters and methods of making and using the same. In one embodiment, the invention relates to the compositions comprising mixtures of diisocyanates prepared from soy protein for use as wood binders.

BACKGROUND OF THE INVENTION

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For many years, fiberboards have been manufactured from wood or agricultural substrates using thermosetting binders. Formaldehyde-based binders, such as urea formaldehyde and

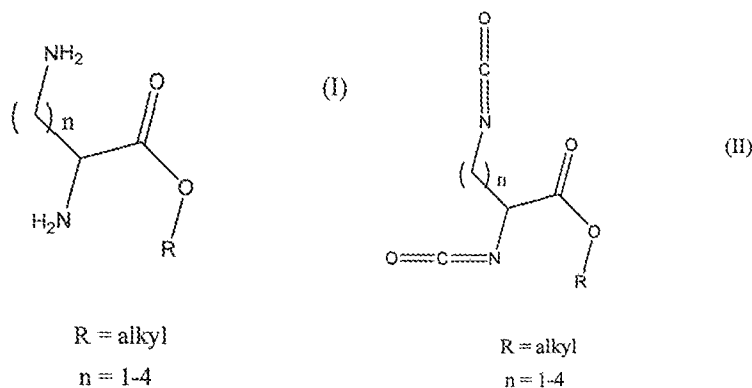
melamine formaldehyde have traditionally dominated the fiberboard industry during that time. Wood composites made with an adhesive binder containing a formaldehyde-based resin have generally been limited to applications where exterior durability is not required. Unfortunately, one of the drawbacks of using formaldehyde-based resins as a component of wood composite adhesive binders is that such resins may release a small amount of formaldehyde.

Isocyanate-based binders, particularly diphenylmethane diisocyanate (MDI) binders, however, offer some significant advantages over formaldehyde-based binders, including superior physical and moisture-resistance properties and the elimination of formaldehyde emission hazards. Although isocyanate binder technology for fiberboard manufacture has been available for many years, isocyanates have not gained widespread commercial acceptance, primarily because of cost. MDI-based isocyanates tend to be more expensive per pound than formaldehyde-based binders, but are used at a lower dose rate, partially offsetting the cost disadvantage.

As such, there is a continuing need for identifying new adhesive binder compositions suitable for making wood and other composites, which have an improved physical properties and are safe to use.

SUMMARY OF THE INVENTION

The present invention relates to an improved composition comprising a blend of diisocyanates of Formula (II) derived from their corresponding diamino alkyl esters of Formula (I), obtained from soy protein source, wherein R is an alkyl and n is 1-4, and methods of making and using such compositions as construction material resin binders.



In one embodiment, the invention relates to a composition comprising a mixture of diisocyanates.

- 5 Another embodiment of the present invention is directed to a method of making diisocyanates by treating the soy-based diamino alkyl esters with phosgene.

In another embodiment, the present invention relates to the use of a composition comprising diisocyanates prepared from soy-based material as wood resin binders.

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It is further noted that the invention does not intend to encompass within the scope of the invention any previously disclosed product, process of making the product or method of using the product, which meets the written description and enablement requirements of the USPTO (35 U.S.C. 112, first paragraph) or the EPO (Article 83 of the EPC), such that

15 applicant(s) reserve the right and hereby disclose a disclaimer of any previously described product, method of making the product or process of using the product.

It is noted that in this disclosure and particularly in the claims and/or paragraphs, terms such as “comprises”, “comprised”, “comprising” and the like can have the meaning attributed to it in U.S. Patent law; e.g., they can mean “includes”, “included”, “including”, and the like;

20 and that terms such as “consisting essentially of” and “consists essentially of” have the meaning ascribed to them in U.S. Patent law, e.g., they allow for elements not explicitly recited, but exclude elements that are found in the prior art or that affect a basic or novel characteristic of the invention.

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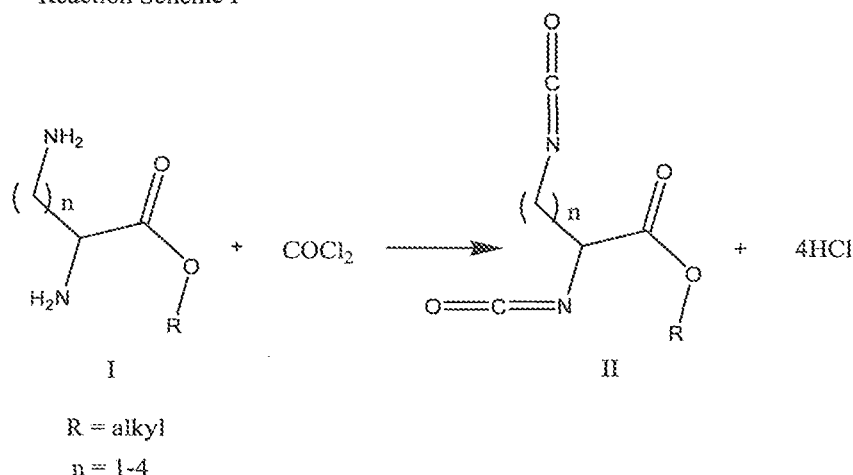
These and other embodiments are disclosed or are apparent from and encompassed by, the following Detailed Description.

DETAILED DESCRIPTION OF THE INVENTION

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The present invention relates to a novel diisocyanate-based composition, and particularly an amino acid derived diisocyanate-based composition, wherein the amino acid derived diisocyanates of Formula (II) are prepared by phosgenation of diamino alkyl esters of Formula (I) obtained from soy protein as shown in Reaction Scheme I below. Such compositions can be used for binding various materials, such as, for example, wood, foam, plastic, etc., used in construction, automotive, and other industries.

Reaction Scheme I



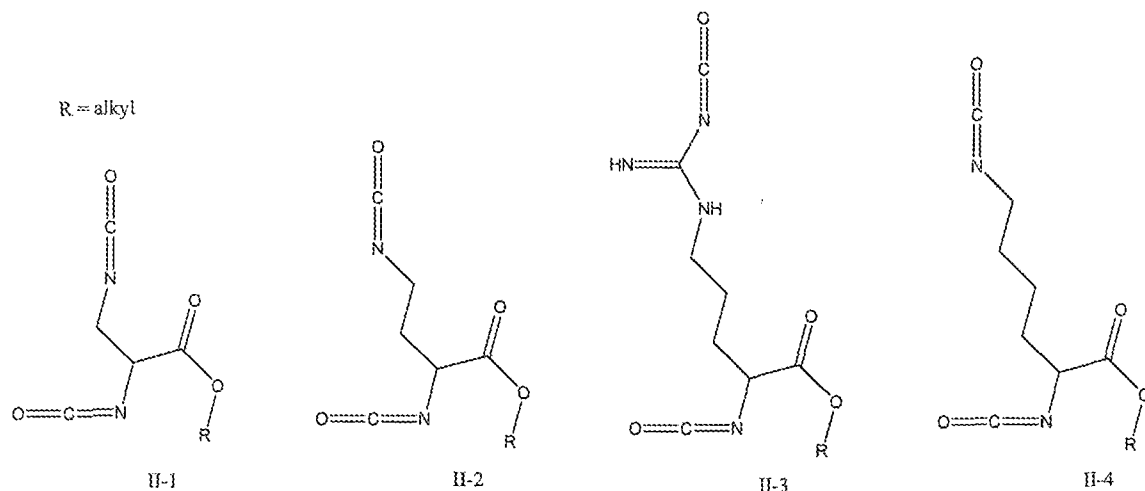
Alkyl as referred herein is a straight or branched chain saturated hydrocarbon having one to six carbons, preferably one to three carbons, and which can be further substituted.

The carbon chain between the two amino groups in Formulas (I), having one to four carbons (n = 1-4), can be further substituted at any position of the chain.

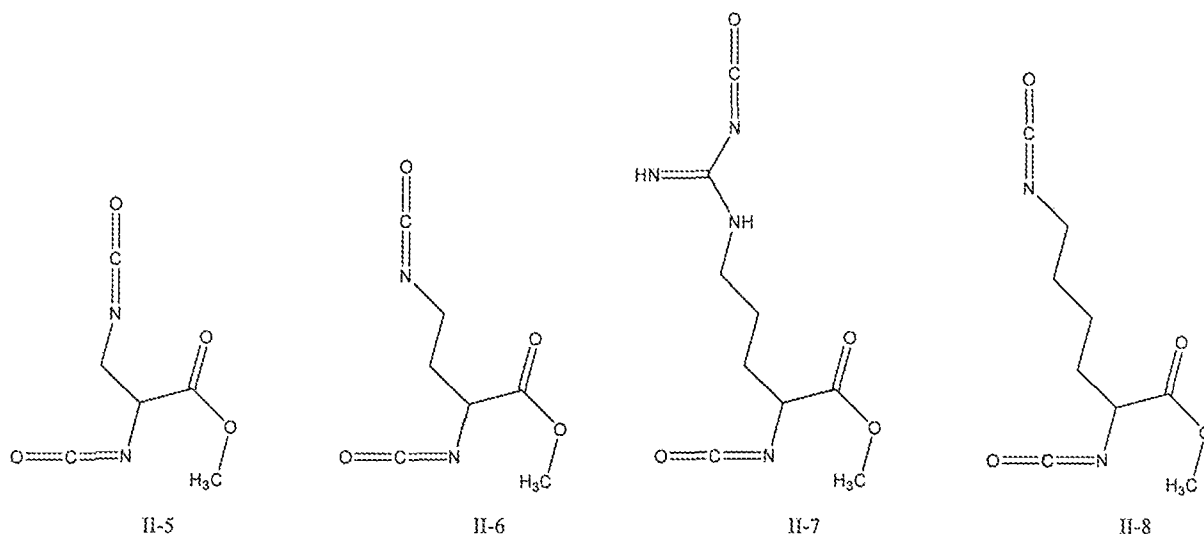
One of the embodiments of the present invention is directed to a composition comprising at least two, at least three, or at least four diisocyanates.

Another embodiment of the present invention is directed to a composition comprising at least two diisocyanates selected from the group consisting of alkyl 2,3-diisocyanatopropanoate (Formula II-1), alkyl 2,4-diisocyanatobutanoate (Formula II-2),

alkyl 5-(3-formylguanidino)-2-isocyanatopentanoate (Formula II-3), and alkyl 2,6-diisocyanatohexanoate (Formula II-4) as shown below:



Another embodiment of the present invention is directed to a composition comprising at least two diisocyanates selected from the group consisting of methyl 2,3-diisocyanatopropanoate (II-5), methyl 2,4-diisocyanatobutanoate (II-6), methyl 5-(3-formylguanidino)-2-isocyanatopentanoate (II-7), and methyl-2,6-diisocyanatohexanoate (II-8) as shown below.



The diisocyanates of the present invention include, but are not limited to the derivatives of lysine, asparagine, arginine, and glutamine.

The composition of the present invention, if used as an adhesive binder composition, may also contain a variety of other known additives such as, for example, silica to enhance fire

resistance, wax to enhance water resistance, antifoamers, lubricants, plasticizers, softening agents, pigments, biocides, fillers, and the like.

According to the present invention, a mixture of diisocyanates can be prepared by reacting diamino alkyl esters of the corresponding amino acid derivatives with di- or triphosgene as shown in Reaction Scheme I. The alkyl esters can be obtained from soy protein or other naturally occurring protein source, such as corn, rice bran, oil seeds and the like. The diamino alkyl esters can be also obtained from other inexpensive sources of proteins, such as, for example algae, various grains and oil seeds, corn, sorghum, and the like.

The mixtures of amino methyl esters suitable for such modification can be obtained, for example, from the process of making biodiesel, as described in U.S. Patent Application No. 12/243,933, which is incorporated herein by reference in its entirety. The water/glycerin fraction produced with the biofuel also contains diamino alkyl esters. About 50% of these alkyl esters are separated as they would only make monofunctional isocyanates, which can be further utilized after being converted to the corresponding amino acids or amino alcohols. The separation of mono- and difunctionalized alkyl esters (or methyl esters) for use in the present invention can be achieved through ion exchange, or chromatographic separation. This process can be done in a batch or a continuous mode typically at ambient temperature and pressure. The target diamino alkyl esters comprising lysine, asparagine, arginine, and glutamine residues are about 50% of the soy protein by mass.

Upon separation from monofunctionalized isocyanates, various mixtures of diamino alkyl esters of Formula (I) are treated with an excess of phosgene (di or tri) to give diisocyanate derivatives of Formula (II) and 4 moles of HCl as exemplified in Reaction Scheme I. This process can be carried out at temperatures of about 50 to about 200° F and at pressures ranging from about 1 to about 10 bar.

Without being bound by any theory, the diisocyanates of the improved diisocyanate-based adhesive composition of the present invention can polymerize with molecules in wood fibers and other materials containing "active" hydrogens to produce corresponding polyurethane based molecules, which provide an improved toughness, durability and safety profile to wood composites or other materials.

One of the embodiments of the present invention relates to compositions comprising a mixture of at least two diisocyanates for use as resin binders in wood products, which include but are not limited to particle boards, such as for example, oriented strand boards (OSB) and medium density fiberboards (MDF).

Diisocyanate resin binders of the present invention can be also used in the manufacturing of other materials and products, which include, but are not limited to flexible foam seating materials, rigid foam insulation panels, microcellular foam seals, microcellular foam gaskets, durable elastomeric wheels, durable elastomeric tires, automotive suspension bushings, electrical potting compounds, adhesives, sealants, synthetic fibers, seals, gaskets, carpet underlay, and hard plastic parts.

Another embodiment of the present invention is directed to a manufactured material or product comprising a polyurethane derived from a mixture of at least two polymerized diisocyanates, wherein the material or product is a wood-based composite panel, an oriented strand board (OSB), a medium-density fiberboard (MDF), a plywood panel, a flexible foam seating material, a rigid foam insulation panel, a microcellular foam seal, a microcellular foam gasket, a durable elastomeric wheel, a durable elastomeric tire, an automotive suspension bushing, an electrical potting compound, an adhesive, a sealant, a fiber, seal, a gasket, a carpet underlay, or a hard plastic part. Particular wood-based composites of the present invention include oriented strand boards (OSB), medium density fiberboards (MDF) and plywood panels.

Having thus described in detail various embodiments of the present invention, it is to be understood that the invention defined by the above paragraphs is not to be limited to particular details set forth in the above description as many apparent variations thereof are possible without departing from the spirit or scope of the present invention.

WHAT IS CLAIMED IS:

1. A composition comprising at least two diisocyanates.
- 5 2. The composition of claim 1, wherein the composition comprises at least four diisocyanates.
3. The composition of claim 1, wherein the diisocyanates are selected from the group consisting of alkyl 2,6-diisocyanatohexanoate, alkyl 2,3-diisocyanatopropanoate, alkyl 5-(3-
10 formylguanidino)-2-isocyanatopentanoate, and alkyl 2,4-diisocyanatobutanoate
4. The composition of claim 1, wherein the diisocyanates are selected from the group consisting of methyl 2,6-diisocyanatohexanoate, methyl 2,3-diisocyanatopropanoate, methyl
15 5-(3-formylguanidino)-2-isocyanatopentanoate, and methyl 2,4-diisocyanatobutanoate.
5. The composition of claim 1, further comprising at least one additive selected from the group consisting of silica, wax, antifoamer, lubricant, plasticizer, softening agent, pigment, biocide, and filler.
- 20 6. A method of preparing a mixture of at least two diisocyanates comprising reacting a mixture of diamino alkyl esters with di- or triphosphage.
7. A manufactured material or product comprising a polyurethane, wherein the material or product is a wood-based composite panel, an oriented strand board (OSB), a medium-
25 density fiberboard (MDF), a plywood panel, a flexible foam seating material, a rigid foam insulation panel, a microcellular foam seal, a microcellular foam gasket, a durable elastomeric wheel, a durable elastomeric tire, an automotive suspension bushing, an electrical potting compound, an adhesive, a sealant, a fiber, seal, a gasket, a carpet underlay, or a hard plastic part and the polyurethane comprises at least two polymerized
30 diisocyanates.
8. The manufactured product according to claim 7, wherein the product is an OSB, MDF, or a plywood panel.

9. An oriented strand board (OSB), a medium density fiberboard (MDF) or a plywood panel comprising a polyurethane which comprises at least two polymerized diisocyanates.