polyfunctional aromatic isocyanate and a prepolymer polyol. Example polyfunctional aromatic isocyanates may include a toluene diisocyanate (TDI) compound such as 2,4-TDI, 2,6-TDI, and mixtures thereof; a methylenediphenyl diisocyanate (MDI) compound such as 2,2'-MDI, 2,4'-MDI, and 4,4'-MDI (which is also referred to in the art as 4,4'-diphenylmethane diisocyanate), and mixtures thereof, a naphthalene-1,5-diisocyanate, a tolidine diisocyanate, a para-phenylene diisocyanate, a xylylene diisocyanate, and mixtures thereof. The prepolymer polyol may include substantially any suitable diol, polyol, polyol-diol, as well as copolymers and mixtures thereof. For example, the prepolymer polyol may be selected from the group comprising, consisting of, or consisting essentially of polytetramethylene ether glycol (PTMEG), polypropylene ether glycol (PPG), ethylene oxide capped PTMEG or PPG, polycaprolactone, ester-based polyols, such as ethylene or butylene adipates, copolymers thereof and mixtures thereof. It will be understood that suitable polyols such as PTMEG and PPG may be mixed with low molecular weight polyols, including ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, 1,2-butanediol, 1,3-butanediol, 2-methyl-1, 3-propanediol, 1,4-butanediol, neopentyl glycol, 1,5-pentanediol, 3-methyl-1,5-pentanediol, 1,6-hexanediol, diethylene glycol, dipropylene glycol, tripropylene glycol and mixtures thereof.

[0019] The urethane prepolymers are often characterized by the weight percent of unreacted isocyanate groups (NCO) present in the prepolymer. Weight percent NCO can be used to determining mixing ratios of components for producing polyurethane materials. In preferred embodiments, the polyfunctional aromatic diisocyanate includes a TDI, an MDI, or a mixture thereof and the prepolymer polyol includes PTMEG, PPG, or a mixture thereof. In such embodiments, isocyanate-terminated urethane prepolymer may have a weight percent NCO in a range from about 6.0 to about 20.0 weight percent, for example, from about 7.0 to about 12.0 weight percent.

[0020] In certain embodiments a commercially available isocyanate-terminated urethane prepolymer may be advantageously employed. Suitable commercially available prepolymers include, for example, DESMODUR® Prepolymers (manufactured by Covestro), Andur® prepolymers (supplied by Anderson Development Company), Adiprene® prepolymers (manufactured by Chemtura), and Imuthane® prepolymers (manufactured by COIM USA, Inc.). Suitable prepolymers may include, for example, PET-70D, PHP-70D, PET-75D, PHP-75D, PPT-75D, PHP-80D, LFG-740D, LF-650D, LF-700D, LF-750D, LF-751D, LF-753D, 60DPLF, 70DP, 70DPLF, 7DPLM, 7201DPLF, 73DPLF, 7-5DPLF, 1-75DP, 2-72DP,

75DGP-2, 7500DP, 75DPLF, 7500DP, 7501DP, 80DPLF, 81DP, 82DGP, IP 89, LU-T60D, LU-T70D, LU-T75D, MAX T-80, MD15120.

[0021] Those of ordinary skill in the art will readily appreciate that commercially available prepolymers are commonly categorized using a hardness scale (which generally correlates with a hardness of the corresponding polyurethane reaction product). For example, Imuthane® PET-70D and PHP-70D, Adiprene® LF700D, and Andur® 70DP and 70DPLF may be referred to as 70D prepolymers indicating a corresponding hardness of 70 on the Shore D hardness scale. Likewise, Imuthane® PET-75D, PHP-75D, and PPT-75D, Adiprene® LF750D, LF751D, and LF753D, Andur® 75DGP-2, 75DPLF, 7500DP, and 7501DP and DESMODUR® LU-T75D may be referred to as 75D prepolymers indicating a corresponding hardness of 75 on the Shore D hardness scale. And Imuthane® PHP-80D and Andur® 80DPLF may be referred to as 80D prepolymers indicating a corresponding hardness of 80 on the Shore D hardness scale.

[0022] In preferred embodiments, a hard prepolymer is employed. By hard it is meant that the prepolymer may be categorized as having a Shore D hardness value greater than or equal to about 70 (e.g., greater than or equal to about 75). Suitable hard prepolymers may have a Shore D hardness in a range from about 70 to about 85 (e.g., from about 75 to about 85 or from about 75 to about 80). Hard prepolymers may include, for example, 70D, 75D, and 80D prepolymers (e.g., 75D and 80D prepolymers), such as those listed in the preceding paragraphs, however, the disclosed embodiments are of course not limited in this regard. Suitable prepolymers may also include a mixture of two or more commercially available prepolymers, for example, including a mixture of a 70D prepolymer and a 75D prepolymer, a mixture of a 75D prepolymer and an 80D prepolymer, or a mixture of a 70D prepolymer and an 80D prepolymer.

[0023] As stated above, the inventive pads include a polishing layer fabricated by combining at least one urethane prepolymer (e.g., including at least one hard prepolymer) and a curative to form the thermosetting polyurethane. The disclosed polishing pad embodiments employ first and second curatives (e.g., a mixed or blended curative composition including first and second curatives) including a first polyamine curative and a second cyclohexanedimethanol (CHDM) curative.

[0024] The polyamine curative may include substantially any suitable polyamine, for example including diamines and other multifunctional amines. The polyamine curative may be a low molecular weight polyamine curative. By low molecular weight it is meant that the

and casting techniques. Molded polyurethane pads may be particularly suitable for planarizing semiconductor substrates. Such pads may be individually manufactured, for example, via dividing the raw materials into two batches. The first batch of raw materials may include the isocyanate-terminated prepolymer and certain optional additives including lubricants and porosity forming agents, such as microspheres or gas. The second batch of raw materials may include the curative mixture (the polyamine and CHDM curatives) and certain other optional additives such as ultraviolet stabilizers. The two batches may be individually prepared and then blended together at a predetermined blend ratio and temperature. The mixture may then be poured into a mold where it is maintained at an elevated temperature, for example, between about 60 degrees C and about 160 degrees C. The mold may optionally be deployed in a closed chamber and exposed to vacuum or pressure to expel air trapped in the poured blend. After a predetermined time (e.g., about 10 to about 30 minutes), the pad may be removed from the mold and then cured approximately 6 to 12 hours at a temperature in a range from about 30 degrees C to about 100 degrees C.

[0040] It will be understood that this disclosure may include numerous embodiments. These embodiments include, but are not limited to, the following embodiments.

[0041] A first embodiment may comprise a chemical-mechanical polishing pad comprising a thermosetting polyurethane polishing layer, the thermosetting polishing layer comprising an isocyanate-terminated urethane prepolymer; a polyamine curative; and a cyclohexanedimethanol curative; wherein the polyamine curative and the cyclohexanedimethanol curative are in a molar ratio of polyamine curative to cyclohexanedimethanol curative in a range from about 20:1 to about 1:1.

[0042] A second embodiment may include the first embodiment, wherein the prepolymer is a reaction product of a toluene diisocyanate (TDI) compound or a methylenediphenyl diisocyanate (MDI) compound and polytetramethylene ether glycol (PTMEG) or polypropylene ether glycol.

[0043] A third embodiment may include the first or second embodiment, wherein the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof.

[0044] A fourth embodiment may include any one of the first through third embodiments wherein the polyamine curative is an aromatic diamine curative selected from the group consisting of aniline diamine compounds, toluene diamine compounds, aminobenzoate compounds, and mixtures thereof.

[0054] A fourteenth embodiment may include any one of the first through thirteenth embodiments, wherein the thermosetting polyurethane polishing layer is adhered to a sub-pad.

[0055] A fifteenth embodiment may comprise a thermosetting polyurethane polymer polishing layer, the thermosetting polishing layer comprising: an isocyanate-terminated urethane prepolymer and a curative mixture comprising a polyamine curative and a cyclohexanedimethanol curative, wherein the curative mixture comprises from about 5 to about 50 mole percent of the cyclohexanedimethanol curative.

[0056] A sixteenth embodiment may include the fifteenth embodiment wherein the prepolymer is a reaction product of a toluene diisocyanate (TDI) compound or a methylenediphenyl diisocyanate (MDI) compound and polytetramethylene ether glycol (PTMEG) or polypropylene ether glycol.

[0057] A seventeenth embodiment may include any one of the fifteenth through sixteenth embodiments, wherein the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof.

[0058] An eighteenth embodiment may include any one of the fifteenth through seventeenth embodiments, wherein the polyamine curative is an aromatic diamine curative selected from the group consisting of aniline diamine compounds, toluene diamine compounds, aminobenzoate compounds, and mixtures thereof.

[0059] A nineteenth embodiment may include the eighteenth embodiment wherein the aromatic diamine curative is selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof.

[0060] A twentieth embodiment may include any one of the fifteenth through nineteenth embodiments, wherein the curative mixture comprises from about 10 to about 40 weight percent of the cyclohexanedimethanol curative.

[0061] A twenty-first embodiment may include any one of the fifteenth through twentieth embodiments, wherein the curative mixture consists of the polyamine curative and the cyclohexanedimethanol curative.

[0062] A twenty-second embodiment may include any one of the fifteenth through twenty-first embodiments, wherein the thermosetting polyurethane polishing layer comprises surface asperities and wherein the surface asperities have a ratio of a storage modulus at 25 degrees C to a storage modulus at 75 degrees C in a range from about 3 to about 20.

[0071] A thirty-first embodiment may include the thirtieth embodiment and may further comprise: (d) machining the polishing pad to remove a mold skin and to obtain a polishing pad having a desired thickness.

[0072] A thirty-second embodiment may include the thirty-first embodiment and may further comprise: (e) adhering the polishing pad to a sub-pad to obtain a multi-layer polishing pad.

[0073] A thirty-third embodiment may include any one of the thirtieth through the thirty-second embodiments wherein: (i) the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof; (ii) the polyamine curative is an aromatic diamine curative selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof; and (iii) the molar ratio of polyamine curative to cyclohexanedimethanol curative is in a range from about 10:1 to about 1.5:1.

[0074] A thirty-fourth embodiment may include a method of chemical mechanical polishing a semiconductor substrate, the method comprising: (a) contacting the substrate with a polishing pad and a polishing composition, wherein the polishing pad may be selected from any one of the first through the twenty-ninth embodiments, (b) moving the polishing pad relative to the substrate; and (c) abrading the substrate to remove a portion of a layer from the substrate and thereby polish the substrate.

[0075] A thirty-fifth embodiment may include the thirty-fourth embodiment, wherein: (i) the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof; (ii) the polyamine curative is an aromatic diamine curative selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof; and (iii) the molar ratio of polyamine curative to cyclohexanedimethanol curative is in a range from about 10:1 to about 1.5:1.

[0076] The following examples further illustrate the invention but, of course, should not be construed as in any way limiting its scope.

EXAMPLE 1

[0077] A number of non-porous polishing pad coupons were prepared for evaluating the effect of CHDM on mechanical properties (as described in more detail below in Examples 2-4). The coupons were prepared by mixing prepolymer, diamine curative, and an optional diol

EXAMPLE 6

[0095] Polishing pads 5B and 5C (from Example 5) were evaluated in a CMP experiment in which blanket silicon oxide (TEOS) wafers were polished. The pads were evaluated using a Reflexion® CMP tool (available from Applied Materials) using commercial two-part slurry ACS940/ACC260 available from KC Tech. The wafers were polished at a downforce of 3.5 psi, a platen speed of 50 rpm, a head speed of 47 rpm and slurry flow rates of 140 ml/min for the ACS940 and 160ml/min for the ACC260. The polishing pads were conditioned *ex-situ* between each wafer using a Saesol® LPX-DS2 conditioner for 12 seconds with a downforce of 5 pounds. A total of 40 TEOS wafers were polished. Each wafer was polishing for one minute and the total TEOS removal converted to a polishing rate in units of Å/min. The polished wafers were also evaluated for scratches using a KLA-Tencor™ Surfscan® SP2 Defect and Surface Quality Inspection System, with a 2 mm wafer edge exclusion and a 110 nm cut-off. Table 6 discloses the average polishing rate achieved on each of the pads as well as the average and maximum number of defects observed for each pad.

Table 6

Pad	TEOS Rate (Å/min)	Defects (Ave)	Defects (Max)
5B	743	595	1462
5C	1250	224	609

[0096] As is readily apparent from the polishing data set forth in Table 6, pad 5C including the CHDM, exhibits superior TEOS removal rate and significantly reduced defects (scratches).

EXAMPLE 7

[0097] Pads 5A and 5C (from Example 5) were evaluated in a shallow trench isolation (STI) CMP experiment. The pads were evaluated using a Reflexion® CMP tool using slurry D7805A/B (available from Cabot Microelectronics Corporation) in which one part of the A pack was first combined with 6 parts deionized water and then further combined with 3 parts of the B pack. Blanket silicon oxide wafers as well as Silyb STI pattern wafers were polished at a downforce of 2.0 psi, a platen speed of 93 rpm, and a head speed of 87 rpm, and a slurry

[00114] Common CMP apparatuses include an in situ polishing endpoint detection system, many of which are known in the art. Techniques for inspecting and monitoring the polishing process by analyzing light or other radiation reflected from a surface of the workpiece are well known in the art and commonly used in commercial CMP operations. Example methods and systems are described in U.S. Patent 5,196,353, U.S. Patent 5,433,651, U.S. Patent 5,609,511, U.S. Patent 5,643,046, U.S. Patent 5,658,183, U.S. Patent 5,730,642, U.S. Patent 5,838,447, U.S. Patent 5,872,633, U.S. Patent 5,893,796, U.S. Patent 5,949,927, and U.S. Patent 5,964,643. As such the inventive polishing pads may optionally include one or more transparent windows or apertures formed therein to facilitate such endpoint detection.

[00115] The inventive polishing pads may be used alone or optionally may be used as a polishing layer in a multi-layer stacked polishing pad. For example, the disclosed polishing pads may be used in combination with substantially any suitable subpad. Example subpads include polyurethane foam subpads (e.g., PORON® foam subpads from Rogers Corporation), impregnated felt subpads, microporous polyurethane subpads, or sintered urethane subpads. The subpad may be either softer or harder than the disclosed polishing pads and may therefore be more or less compressible and have a lower or higher Shore D hardness value than the disclosed polishing pads. The subpad may optionally include grooves, channels, hollow sections, windows, apertures, and the like. When the disclosed pads are used with a subpad, an intermediate backing layer such as a polyethyleneterephthalate film may be deployed between the polishing pad and the subpad. The disclosed embodiments are not limited to the use of a subpad or the properties of a subpad when used.

[00116] The disclosed polishing pads may be suitable for use in polishing many types of workpieces (e.g., substrates or wafers) and workpiece materials. For example, the disclosed pads may be used to polish workpieces including memory storage devices, semiconductor substrates, and glass substrates. Suitable workpieces for polishing with the polishing pads include memory or rigid disks, magnetic heads, MEMS devices, semiconductor wafers, field emission displays, and other microelectronic substrates, especially microelectronic substrates comprising insulating layers (e.g., silicon dioxide, silicon nitride, or low dielectric materials) and/or metal-containing layers (e.g., copper, tantalum, tungsten, aluminum, nickel, titanium, platinum, ruthenium, rhodium, iridium or other noble metals). The disclosed embodiments are not limited in regards to the workpiece to be polished.

[00117] Although polishing pads employing polyamine curative and CHDM curative and certain advantages thereof have been described in detail, it should be understood that various

CLAIMS

1. A chemical-mechanical polishing pad comprising a thermosetting polyurethane polishing layer, the thermosetting polishing layer comprising:

an isocyanate-terminated urethane prepolymer;

a polyamine curative; and

a cyclohexanedimethanol curative;

wherein the polyamine curative and the cyclohexanedimethanol curative are in a molar ratio of polyamine curative to cyclohexanedimethanol curative in a range from about 20:1 to about 1:1.

2. The polishing pad of claim 1, wherein the prepolymer is a reaction product of a toluene diisocyanate (TDI) compound or a methylenediphenyl diisocyanate (MDI) compound and polytetramethylene ether glycol (PTMEG) or polypropylene ether glycol.

3. The polishing pad of claim 1, wherein the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof.

4. The polishing pad of claim 1, wherein the polyamine curative is an aromatic diamine curative selected from the group consisting of aniline diamine compounds, toluene diamine compounds, aminobenzoate compounds, and mixtures thereof.

5. The polishing pad of claim 4, wherein the aromatic diamine curative is selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof.

6. The polishing pad of claim 1, wherein the molar ratio of polyamine curative to cyclohexanedimethanol curative is in a range from about 10:1 to about 1.5:1.

7. The polishing pad of claim 1, wherein the thermosetting polyurethane polishing layer comprises surface asperities and wherein the surface asperities have a ratio of a storage modulus at 25 degrees C to a storage modulus at 75 degrees C in a range from about 3 to about 20.

8. The polishing pad of claim 7, wherein:

the isocyanate-terminated urethane prepolymer includes a 75D prepolymer; and

the surface asperities have a storage modulus (E') at 25 degrees C greater than about 500 MPa and a Shore D hardness at 25 degrees C greater than about 60.

9. The polishing pad of claim 8, wherein the surface asperities have a tensile toughness at 25 degrees C greater than about 100 MPa.

10. The polishing pad of claim 7, wherein:

the isocyanate-terminated urethane prepolymer includes an 80D prepolymer; and

the surface asperities have a storage modulus (E') at 25 degrees C greater than about 1000 MPa and a Shore D hardness at 25 degrees C greater than about 70.

11. The polishing pad of claim 10, wherein the surface asperities have a tensile toughness at 25 degrees C greater than about 50 MPa.

12. The polishing pad of claim 1, wherein the thermosetting polyurethane polishing layer further comprises a sufficient quantity of hollow microspheres such that the thermosetting polyurethane polishing layer has a porosity in a range from about 10 to about 50 percent.

13. The polishing pad of claim 1, wherein:

the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof;

the polyamine curative is an aromatic diamine curative selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof; and

the molar ratio of polyamine curative to cyclohexanedimethanol curative is in a range from about 10:1 to about 1.5:1.

14. The polishing pad of claim 1, wherein the thermosetting polyurethane polishing layer is adhered to a sub-pad.

15. A chemical-mechanical polishing pad comprising a thermosetting polyurethane polymer polishing layer, the thermosetting polishing layer comprising:

an isocyanate-terminated urethane prepolymer; and

a curative mixture comprising a polyamine curative and a cyclohexanedimethanol curative, wherein the curative mixture comprises from about 5 to about 50 mole percent of the cyclohexanedimethanol curative.

16. The polishing pad of claim 15, wherein the prepolymer is a reaction product of a toluene diisocyanate (TDI) compound or a methylenediphenyl diisocyanate (MDI) compound and polytetramethylene ether glycol (PTMEG) or polypropylene ether glycol.

17. The polishing pad of claim 15, wherein the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof.

18. The polishing pad of claim 15, wherein the polyamine curative is an aromatic diamine curative selected from the group consisting of aniline diamine compounds, toluene diamine compounds, aminobenzoate compounds, and mixtures thereof.

19. The polishing pad of claim 18, wherein the aromatic diamine curative is selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof.

20. The polishing pad of claim 15, wherein the curative mixture comprises from about 10 to about 40 weight percent of the cyclohexanedimethanol curative.

21. The polishing pad of claim 15, wherein the curative mixture consists of the polyamine curative and the cyclohexanedimethanol curative.

22. The polishing pad of claim 15, wherein the thermosetting polyurethane polishing layer comprises surface asperities and wherein the surface asperities have a ratio of

a storage modulus at 25 degrees C to a storage modulus at 75 degrees C in a range from about 3 to about 20.

23. The polishing pad of claim 22, wherein:

the isocyanate-terminated urethane prepolymer includes a 75D prepolymer; and

the surface asperities have a storage modulus (E') at 25 degrees C greater than about 500 MPa and a Shore D hardness at 25 degrees C greater than about 60.

24. The polishing pad of claim 23, wherein the surface asperities have a tensile toughness at 25 degrees C greater than about 100 MPa.

25. The polishing pad of claim 22, wherein:

the isocyanate-terminated urethane prepolymer includes an 80D prepolymer; and

the surface asperities have a storage modulus (E') at 25 degrees C greater than about 1000 MPa and a Shore D hardness at 25 degrees C greater than about 70.

26. The polishing pad of claim 25, wherein the surface asperities have a tensile toughness at 25 degrees C greater than about 50 MPa.

27. The polishing pad of claim 15, wherein the thermosetting polyurethane polishing layer further comprises a sufficient quantity of hollow microspheres such that the thermosetting polyurethane polishing layer has a porosity in a range from about 10 to about 50 percent.

28. The polishing pad of claim 15, wherein:

the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof;

the polyamine curative is an aromatic diamine curative selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof; and

the curative mixture comprises from about 10 to about 40 weight percent of the cyclohexanedimethanol curative.

29. The polishing pad of claim 15, wherein the thermosetting polyurethane polishing layer is adhered to a sub-pad.

30. A method for fabricating a thermosetting polishing pad, the method comprising:

(a) admixing (i) an isocyanate-terminated urethane prepolymer, (ii) a polyamine curative; and (iii) a cyclohexanedimethanol curative, wherein the diamine curative and the cyclohexanedimethanol curative are in a molar ratio of diamine curative to cyclohexanedimethanol curative in a range from about 20:1 to about 1:1 to obtain a mixture;

(b) heating the mixture in a mold to obtain a pre-cured pad; and

(c) curing the pre-cured pad to obtain a polishing pad.

31. The method of claim 30, further comprising:

(d) machining the polishing pad to remove a mold skin and to obtain a polishing pad having a desired thickness.

32. The method of claim 31, further comprising:

(e) adhering the polishing pad to a sub-pad to obtain a multi-layer polishing pad.

33. The method of claim 30, wherein:

the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof;

the polyamine curative is an aromatic diamine curative selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof; and

the molar ratio of polyamine curative to cyclohexanedimethanol curative is in a range from about 10:1 to about 1.5:1.

34. A method of chemical mechanical polishing a semiconductor substrate, the method comprising:

(a) contacting the substrate with a polishing pad and a polishing composition, the polishing pad having a thermosetting polishing layer comprising (i) an isocyanate-terminated urethane prepolymer, (ii) a polyamine curative; and (iii) a cyclohexanedimethanol curative, wherein the diamine curative and the

cyclohexanedimethanol curative are in a molar ratio of polyamine curative to cyclohexanedimethanol curative in a range from about 20:1 to about 1:1;

(b) moving the polishing pad relative to the substrate; and

(c) abrading the substrate to remove a portion of a layer from the substrate and thereby polish the substrate.

35. The method of claim 34, wherein:

the prepolymer is an aromatic prepolymer selected from the group consisting of 75D prepolymers, 80D prepolymers, and mixtures thereof;

the polyamine curative is an aromatic diamine curative selected from the group consisting of 4,4-methylenebis(2chloroaniline), dimethylthiotoluenediamine, and mixtures thereof; and

the molar ratio of polyamine curative to cyclohexanedimethanol curative is in a range from about 10:1 to about 1.5:1.