

POLISHING PAD

CROSS-REFERENCE TO RELATED APPLICATION

[0001]This application claims priority to Chinese patent application No. 202210978288.4, filed on August 16, 2022 and entitled “Polishing Pad”, the disclosure of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002]The disclosure relates to the technical field of polishing by chemical-mechanical planarization, and specifically to a polishing pad.

BACKGROUND

[0003]In the Chemical-Mechanical Polishing (CMP) technology, a surface of a workpiece to be processed faces down with a certain pressure being applied to a polishing pad, and the material is removed from the surface of the workpiece under the condition of a flowing polishing fluid medium (a mixture of nanoparticles, a chemical oxidant and a liquid medium) by means of the relative motion between the polishing pad and the workpiece, under mechanical grinding of the nanoparticles and chemical corrosion of the oxidant, thereby achieving global planarization of the workpiece surface. As the semiconductor industry evolves following the curve of Moore’s Law, the processing technology is driven to shift towards a higher current density, a higher clock frequency, and more interconnect layers. Due to the reduction in size of a device and the reduction in depth of focus of an optical lithography equipment, it is required that the flatness of the acceptable resolution of the wafer surface reaches the nanometer level. Traditional planarization techniques such as selective deposition, sputtering glass SOG, low-pressure chemical vapor deposition (CVD), plasma-enhanced CVD, bias sputtering, which are based on deposition technologies, and post-sputtering corrosion, thermal reflow, deposition-corrosion-deposition, etc. which are based on structure, can also provide a “smooth” surface, but they

are all local planarization techniques and cannot achieve global planarization. At present, it is widely believed internationally that when the feature size of a device is below 0.35 μm , global planarization must be performed to ensure the accuracy and resolution transferred by the photolithographic image. Currently, CMP technology is internationally recognized as the only technology that can provide global planarization, and the yield of CMP will severely affect the yield of chips.

[0004]With the development of the technology node of the feature size towards deep nanometer, the linewidth of interconnect metals is becoming narrower. DRAM technology is developing from 30-nanometer level to 10-nanometer level. NAND technology is developing from flat to 3D. The number of CMP cycles is also increasing. For example, a 28 nm logic chip requires 12-13 CMP cycles, and the number of CMP cycles doubles to 25-30 cycles after entering the 10 nm process. This puts higher requirements on CMP process consumables. Higher planarization characteristics, lower defect levels, higher efficiency, and lower costs are eternal topics for semiconductor process consumables.

[0005]Affected by the epidemic, semiconductor manufacturers have suspended or reduced production, while the market demand for chips has increased sharply, leading to chip shortages in the past two years. Although advanced process chips such as 5 nm and 3 nm are widely known to the public with products such as smartphones, the largest market share is still in mature processes, namely processes of 28 nm and above, which have wider linewidths and more mature processes. Although the requirements for CMP consumables are relatively low, the cost control is more stringent. For example, mature processes have stricter requirements for the life of CMP polishing pads, usually using each polishing pad to the extreme, thus placing extremely strict demands on the stability, especially the life stability of polishing pads.

[0006]Therefore, it is urgent to develop a CMP polishing pad with a high life stability and more suitable for mature processes.

SUMMARY

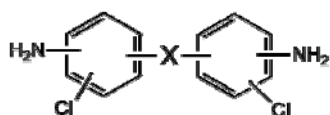
[0007]In view of the problems existing in the related art, an objective of the disclosure is to provide a polishing pad with a high life stability and suitable for mature processes.

[0008] A first aspect of the disclosure provides a polishing pad including a polishing layer. The polishing layer includes a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition. The polyamine composition includes one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos. An average molecular weight of the polyamine composition is between 200 and 400, and an average functionality of the polyamine composition is greater than 2 and not higher than 2.20. Proportions of the diamines and the triamines relative to a total amount of the polyamine composition are 77%-96% : 3%-12%, respectively, in the polyamine composition.

[0009] A second aspect of the disclosure provides a polishing pad including a polishing layer. The polishing layer includes a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition. The polyamine composition includes one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos. An average molecular weight of the polyamine composition is between 200 and 400, and an average functionality of the polyamine composition is greater than 2 and not higher than 2.20. Proportions of the diamines and the tetraamines relative to a total amount of the polyamine composition are 77%-96% : 0.1%-10%, respectively, in the polyamine composition.

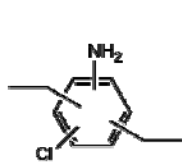
[0010] Further, the polyamines with more than 3 aminos include tetraamines. A proportion of the tetraamines relative to the total amount of the polyamine composition is between 0.1% and 10%.

[0011] Furthermore, the diamines and/or triamines and/or polyamines with more than 3 aminos include a compound represented by Structural Formula 1.

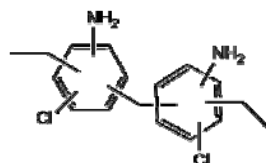


Structural Formula 1.

[0012] In the Structural Formula 1, X represents a carbon atom or one or a combination of more of structural units represented by Structural Formula 2 or Structural Formula 3:



Structural Formula 2



Structural Formula 3.

[0013]Further, the polyamine composition comprises free chloride ions in a content of less than 900 ppm.

[0014]Further, a total average functionality of the polyol composition and the polyamine composition is not higher than 2.2.

[0015]Further, the multifunctional isocyanates include one or a combination of more of aromatic isocyanates or aliphatic isocyanates. The aromatic isocyanates include one or a combination of more of 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 2,2'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 4,4'-diphenylmethane diisocyanate, 1,5-naphthalene diisocyanate, p-phenylene diisocyanate, m-phenylene diisocyanate, p-xylylene diisocyanate, or m-xylylene diisocyanate. The aliphatic isocyanates include one or a combination of more of ethylene diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate, 1,6-hexamethylene diisocyanate, 1,4-cyclohexane diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, isophorone diisocyanate, or norbornane diisocyanate.

[0016]Further, the polyol composition includes one or a combination of more of polytetramethylene ether glycol, polyethylene glycol, polypropylene glycol, ethylene glycol, 1,3-butanediol, 1,4-butanediol, diethylene glycol, neopentyl glycol, 2-methyl-1,3-propanediol, hexanediol, 3-methyl-1,5-pentanediol, or 1,4-cyclohexanedimethanol.

[0017]Further, the polishing layer has a density between 0.4 and 1.1 g/cm³ and a Shore hardness between 15 and 85D.

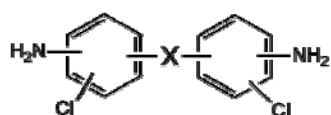
[0018]Further, the polishing pad includes a cushion layer, an adhesive layer, and a back adhesive layer. The polishing pad is arranged to be the polishing layer, the adhesive layer, the cushion layer, and the back adhesive layer in sequence from top to bottom. The adhesive layer is used for bonding the polishing layer to the cushion layer, and the back adhesive layer is used for bonding the polishing pad to the polishing table. The back adhesive layer further includes a release paper or a release film.

[0019] A third aspect of the disclosure provides a polyamine composition including one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos. An average molecular weight of the polyamine composition is between 200 and 400. An average functionality of the polyamine composition is greater than 2 and not higher than 2.20. Proportions of the diamines and the triamines relative to the total amount of the polyamine composition are 77%-96% : 3%-12%, respectively, in the polyamine composition.

[0020] A fourth aspect of the disclosure provides a polyamine composition including one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos. An average molecular weight of the polyamine composition is between 200 and 400. An average functionality of the polyamine composition is greater than 2 and not higher than 2.20. Proportions of the diamines and the tetraamines relative to the total amount of the polyamine composition are 77%-96% : 0.1%-10%, respectively.

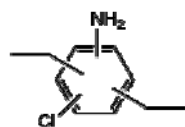
[0021] Further, the polyamines with more than 3 aminos include tetraamines. A proportion of the tetraamines relative to the total amount of the polyamine composition is between 0.1% and 10%.

[0022] Further, the diamines and/or triamines and/or polyamines with more than 3 aminos include a compound represented by Structural Formula 1:

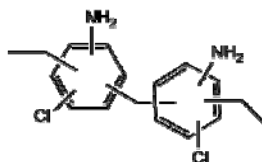


Structural Formula 1.

[0023] In the Structural Formula 1, X represents a carbon atom or one or a combination of more of structural units represented by Structural Formula 2 or Structural Formula 3:



Structural Formula 2



Structural Formula 3.

[0024] Further, the polyamine composition comprises free chloride ions in a content of less than 900 ppm.

[0025] A fifth aspect of the disclosure provides a polishing layer obtained by reacting the polyamine composition of any one above with a multifunctional isocyanate and a polyol

composition.

[0026]A sixth aspect of the disclosure provides a polishing pad including a polishing layer. The polishing layer includes a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition. In a liquid chromatogram obtained by a liquid chromatography analysis of the polyamine composition under following conditions, a ratio of a peak area with a retention time of 7.0-7.8 min to a peak area with a retention time of 10-11 min is between 5 and 30.

[0027]Liquid chromatography analysis conditions:

[0028]Test sample: methanol is added to 0.0204 g of the polyamine composition until a total mass of 20.0026 g is obtained. Methanol is added to 0.2 ml of a solution obtained thereby until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing. Methanol is added to 0.2 ml of the 100 ppm solution until a total volume of 2 ml is obtained, such that a 10 ppm solution is obtained by mixing;

[0029]Chromatography column: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron, made by Aglient;

[0030]Column temperature: 40 °C;

[0031]Mobile phase: A (0.1% formic acid aqueous solution) : B(methanol)=20 : 80;

[0032]Flow rate: 0.5 ml/min;

[0033]Detector: a UV detector with a wavelength of 254 nm;

[0034]Sample injection volume: 10 µl.

[0035]A seventh aspect of the disclosure provides a polishing pad including a polishing layer. The polishing layer includes a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition. In a liquid chromatogram obtained by a liquid chromatography analysis of the polyamine composition under following conditions, a ratio of a peak area with a retention time of 7.0-7.8 min to a peak area with a retention time of 14.2-16 min is between 10 and 400.

[0036]Liquid chromatography analysis conditions:

[0037] Test sample: methanol is added to 0.0204 g of the polyamine composition until a total mass of 20.0026 g is obtained. Methanol is added to 0.2 ml of a solution obtained thereby until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing. Methanol is added to 0.2 ml of the 100 ppm solution until a total volume of 2 ml is obtained, such that a 10 ppm solution is obtained by mixing;

[0038] Chromatography column: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron, made by Aglient;

[0039] Column temperature: 40 °C;

[0040] Mobile phase: A (0.1% formic acid aqueous solution) : B(methanol)=20 : 80;

[0041] Flow rate: 0.5 ml/min;

[0042] Detector: a UV detector with a wavelength of 254 nm;

[0043] Sample injection volume: 10 µl.

[0044] An eighth aspect of the disclosure provides a polishing pad including a polishing layer. The polishing layer includes a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition. In a liquid chromatogram obtained by a liquid chromatography analysis of the polyamine composition under following conditions, a ratio of a peak area with a retention time of 7.0-7.8 min, to a peak area with a retention time of 10-11 min, and to a peak area with a retention time of 14.2-16 min is 360-450 : 15-45 : 1-40.

[0045] Liquid chromatography analysis conditions:

[0046] Test sample: methanol is added to 0.0204 g of the polyamine composition until a total mass of 20.0026 g is obtained. Methanol is added to 0.2 ml of a solution obtained thereby until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing. Methanol is added to 0.2 ml of the 100 ppm solution until a total volume of 2 ml is obtained, such that a 10 ppm solution is obtained by mixing;

[0047] Chromatography column: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron made by Aglient;

[0048]Column temperature: 40 °C;

[0049]Mobile phase: A (0.1% formic acid aqueous solution) : B(methanol)=20 : 80;

[0050]Flow rate: 0.5 ml/min;

[0051]Detector: a UV detector with a wavelength of 254 nm;

[0052]Sample injection volume: 10 µl.

[0053]Beneficial effects

[0054]In the polishing pad provided by the disclosure, a polyurethane with a certain crosslinking degree is provided in polishing layer, and the crosslinking degree may be controlled by a material having multifunctionality. The polishing pad has a higher controllability, lower processing condition requirements, a wider processing window, compared with the conventional micro-crosslinking of excessive free isocyanate groups. The formed polishing layer has a higher life stability, and has a wider range of applicability for diamond trimming discs with different cutting abilities, thereby achieving a more stable service performance. In addition, due to the introduction of a multifunctional raw material, the crosslinking degree and more suitable mechanical properties can be more conveniently adjusted. Accordingly, the formed polishing layer has a more stable removal rate during the polishing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055]In order to more clearly illustrate the technical solutions in the embodiments of the disclosure, a brief introduction will be given below to the accompanying drawings required for the embodiments. It is apparent that the drawings described below are only some embodiments of the disclosure. Other drawings can be obtained based on these drawings for those skilled in the art without creative labor.

[0056]FIG. 1 is a schematic diagram of a polishing process of a polishing pad in an embodiment of the disclosure.

[0057]FIG. 2 is a schematic diagram of a polishing pad provided by an embodiment of the

disclosure.

[0058]FIG. 3-1 is a diagram showing a fitted relationship between the peak area in the LC-MS liquid chromatogram and the concentration for a diamine according to the disclosure.

[0059]FIG. 3-2 is a diagram showing a fitted relationship between the peak area in the LC-MS liquid chromatogram and the concentration for a triamine according to the disclosure.

[0060]FIG. 3-3 is a diagram showing a fitted relationship between the peak area in the LC-MS liquid chromatogram and the concentration for a tetraamine according to the disclosure.

[0061]FIG. 4-1 is a schematic diagram of the peak area in the LC-MS liquid chromatogram for a diamine according to the disclosure.

[0062]FIG. 4-2 is a schematic diagram of the peak area in the LC-MS liquid chromatogram for a triamine according to the disclosure.

[0063]FIG. 4-3 is a schematic diagram of the peak area in the LC-MS liquid chromatogram for a tetraamine according to the disclosure.

[0064]1: Object to be polished; 2: Polishing pad; 3: Polishing table; 4: Holder; 5: Polishing solution; 20: Polishing layer; 21: Adhesive layer; 22: Cushion layer; 23: Back adhesive layer.

DETAILED DESCRIPTION

[0065]Implementations of the disclosure will be described in detail below in combination with the embodiments. However, it is to be understood by a person skilled in the art that the following embodiments are merely used for illustrating the disclosure and should not be considered as a limit to a scope of the disclosure. Those without indicated specific conditions in the embodiments are carried out according to a conventional condition or a condition suggested by a manufacturer. An agent or an instrument without indicated manufacturers thereof may be commercially available or purchased.

[0066]< Method for manufacturing a semiconductor device>

[0067]A semiconductor device is manufactured through a process of polishing the surface of

a semiconductor wafer using a polishing pad. The semiconductor wafer generally refers to a wafer with a wiring metal and an oxide film stacked on top of a silicon wafer. The method for manufacturing a semiconductor device of the disclosure includes a process of polishing the surface of a semiconductor wafer using a polishing pad, in which the polishing device is not particularly limited.

[0068] For example, the polishing treatment is carried out using a polishing device as shown in FIG. 1. The polishing device comprises a polishing table 3 for supporting a polishing pad 2, a backing material for uniformly pressing a holder 4 for supporting an object to be polished (a semiconductor wafer 1) and the wafer, and a supply mechanism for a polishing solution 5. The polishing pad 2 is installed on the polishing table 3, for example, by adhering via a back adhesive layer. The polishing table 3 and the holder 4 are configured such that the polishing pad 2 and the semiconductor wafer 1 supported by them respectively are opposite to each other, and each of the polishing table 3 and the holder 4 has a rotating shaft. In addition, a pressing mechanism for pressing the semiconductor wafer 1 onto the polishing pad 2 is provided at one side of the holder 4. During polishing, the polishing table 3 and the holder 4 are rotated, and the semiconductor wafer 1 is pressed onto the polishing pad 2 while supplying a slurry for polishing. The flow rate of the slurry, the load for polishing, the rotational speed of the polishing table, and the rotational speed of the wafer are not particularly limited and can be adjusted appropriately.

[0069] As a result, the protruding parts of the surface of the semiconductor wafer 1 are removed to obtain a flat surface by polishing. Afterwards, a semiconductor device is made through processes such as scribing, welding, and packaging. The semiconductor device is used in a computing processing apparatus, storage equipment, and the like.

[0070] <Polishing pad>

[0071] The polishing pad in the disclosure, as shown in FIG. 2, includes a polishing layer 20, a cushion layer 22, an adhesive layer 21, and a back adhesive layer 23. The polishing pad in the disclosure is arranged to be the polishing layer 20, the adhesive layer 21, the cushion layer 22, and the back adhesive layer 23 in sequence from top to bottom. The adhesive layer 21 is used for bonding the polishing layer 20 and the cushion layer 22. The back adhesive 23 further includes a release film or a release paper, which can be peeled off in use to achieve bonding between the polishing pad and the polishing table.

[0072]<Polishing layer>

[0073]The polishing layer in the disclosure has a certain degree of cross-linking, and the polishing layer is a closed-cell elastomer formed by a continuous polyurethane with pores of 5-100 μm . The polyurethane includes one or a combination of two of a thermoplastic polyurethane or a thermosetting polyurethane.

[0074]The density of the polishing layer in the disclosure is between 0.4 and 1.1 g/cm^3 , preferably between 0.5 and 1.06 g/cm^3 , and particularly preferably between 0.51 and 1.0 g/cm^3 . The Shore hardness of the polishing layer is between 15 and 85D, preferably between 40 and 70D, and particularly preferably between 52 and 68D.

[0075]Multifunctional isocyanates

[0076]The multifunctional isocyanates in the disclosure include, but are not limited to, one or a combination of more of aromatic isocyanates or aliphatic isocyanates. It is preferred to use 80 mol% or more of aromatic isocyanates, further preferred to use 95 mol% or more of aromatic isocyanates, and particularly preferred to use 100 mol% of aromatic isocyanates.

[0077]Aromatic isocyanates include one or a combination of more of 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 2,2'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 4,4'-diphenylmethane diisocyanate, 1,5-naphthalene diisocyanate, p-phenylene diisocyanate, m-phenylene diisocyanate, p-xylylene diisocyanate, or m-xylylene diisocyanate.

[0078]Aliphatic isocyanates include one or a combination of more of ethylene diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate, 1,6-hexamethylene diisocyanate, 1,4-cyclohexane diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, isophorone diisocyanate, or norbornene diisocyanate.

[0079]In the disclosure, it is preferred to use one or a combination of more of 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, or 4,4'-dicyclohexylmethane diisocyanate, considering the reactivity and the physical properties of the polishing pad.

[0080]Polyol composition

[0081] The polyol composition in the disclosure may include a polyether-based high molecular weight diol, including but not limited to, poly(tetramethylene ether glycol) (PTMEG), polyethylene glycol (PEG), polypropylene glycol (PPG), and one or a combination of more of poly(tetramethylene ether glycol)-polyethylene glycol, poly(tetramethylene ether glycol)-polypropylene glycol, polyethylene glycol-polypropylene glycol, or ethylene glycol, propylene glycol, butanediol, or a high molecular weight polyol formed from homopolymerization or copolymerization of the above three small molecule diols with an initiator having two hydroxyl groups, or a composition of more thereof.

[0082] The polyol composition in the disclosure may include a small molecule diol, including but not limited to, one or a combination of more of ethylene glycol, 1,3-butanediol, 1,4-butanediol, diethylene glycol, neopentyl glycol, 2-methyl-1,3-propanediol, hexanediol, 3-methyl-1,5-pentanediol, or 1,4-cyclohexanedimethanol.

[0083] The polyol composition in the disclosure may include a polyester-based polyol which is obtained from the condensation reaction between a diol or a diol/diphenol and a diacid. The diol includes one or a combination of more of ethylene glycol, 1,3-butanediol, 1,4-butanediol, diethylene glycol, neopentyl glycol, 2-methyl-1,3-propanediol, hexanediol, 3-methyl-1,5-pentanediol, or 1,4-cyclohexanedimethanol. Preferably, the diol includes one or a combination of two of 1,4-butanediol or hexanediol. The diol/diphenol is one or a combination of more of hydroquinone, resorcinol, naphthalenediol, bisphenol A, bisphenol S, p-phenylenedimethanol, m-phenylenedimethanol, o-phenylenedimethanol, 2,5-furandimethanol, p-phenylenedimethanol, or diphenyl ether diphenol. Preferably, the diol/diphenol is one or a combination of two of p-phenylenediphenol or p-phenylenedimethanol. The diacid is one or a combination of more of succinic acid, adipic acid, azelaic acid, or sebacic acid.

[0084] The polyol composition in the disclosure may include polyols obtained by mixing a polyether, a polyester formed with a small molecule polyol with a functionality greater than 2 as an initiator and a diol with a functionality of 2; or polyols obtained by mixing a small molecule polyol with a functionality greater than 2 and a high molecule polyol with a functionality of 2, in which the average functionality of the polyols after mixing is not high than 2.2. The small molecule polyol with a functionality greater than 2 may include, but is not limited to, one or a combination of more of glycerol, pentaerythritol, trimethylolpropane, propylene oxide tetraol, xylitol, sorbitol, or mannitol.

[0085]The average functionality mentioned above is the arithmetic mean of the number of hydroxyl groups in each molecule. The polyols have a number average molecular weight between 500 and 3000. As an alternative example, the polyether polyol may be a single polyether polyol with a number average molecular weight between 500 and 3000, a mixture of two or more polyether polyols with a number average molecular weight between 500 and 3000, or a mixture of a polyether with a number average molecular weight between 500 and 3000 and/or a small molecule polyol, in which the polyether with a number average molecular weight between 500 and 3000 is obtained by mixing a polyether with a number average molecular weight greater than 5000 and small molecule ethylene glycol, butanediol, sorbitol.

[0086]The polyurethane in the disclosure can be manufactured using well-known polyurethane technologies such as a melting method, a solution method, or can also be manufactured by any of the conventional methods such as a prepolymer method, one-time injection method. The prepolymer method includes firstly synthesize an isocyanate-terminated prepolymer from a multifunctional isocyanate and a polyol composition, and then react it with a polyamine composition. The one-time injection method is a one-step reaction of a multifunctional isocyanate, a polyol composition, and a polyamine composition. In the disclosure, it is preferred to use the prepolymer method for the synthesis of the polyurethane.

[0087]The isocyanate-terminated prepolymer above can be obtained by reacting the multifunctional isocyanate above with the polyol composition, or can also be obtained by purchasing commercially available prepolymer products.

[0088]The commercially available isocyanate-terminated prepolymer includes, but is not limited to, any one or a combination of more of series of prepolymers produced by Chemtura: L325, LF800A, LF900A, LF910A, LF930A, LF931A, LF939A, LF950A, LF952A, LF600D, LF601D, LF650D, LF667D, LF700D, LF750D, LF751D, LF752D, LF753D, LFG963A, LFG964A, or LFG740D.

[0089]The isocyanate-terminated prepolymer in the disclosure contains 6.0-9.5 wt% of unreacted isocyanate groups (-NCO). Preferably, the isocyanate-terminated prepolymer in the disclosure contains 8.0-9.5 wt% of unreacted isocyanate groups (-NCO). Particularly preferably, the isocyanate-terminated prepolymer in the disclosure contains 8.5-9.5 wt%

of unreacted isocyanate groups (-NCO).

[0090] Polyamine composition

[0091]The polyamine composition in the disclosure includes one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos. The average molecular weight of the polyamine composition is between 200 and 400, and the average functionality of the polyamine composition is greater than 2 and not higher than 2.20. Preferably, the average functionality of the curing agent composition is not lower than 2.01 and not higher than 2.15. Particularly preferably, the average functionality of the polyamine composition is not lower than 2.01 and not higher than 2.09, taking into account the influence of the polymer microstructure on the properties of the polishing layer.

[0092]The disclosure provides a polyamine composition, in which the proportions of the diamines and the triamines relative to the total amount of the polyamine composition are 77%-96% : 3%-12%, preferably 87%-95% : 4%-11%, and particularly preferably 87%-91% : 6%-10%, respectively. The total amount of the diamines does not exceed 96% because the polishing effect of the polishing pad is not good when it exceeds 96%. On the other hand, the amount of the diamines should not be too low. When it is lower than 77%, the polishing life of the polishing pad will be insufficient.

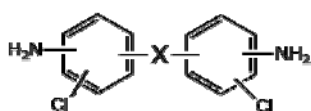
[0093]Herein, the proportion of a single amine compound relative to the total amount of the polyamine composition is in a mass percentage, and the proportions of other amine compounds relative to the total amount of the polyamine composition are all in mass percentages.

[0094]As a preferred embodiment, the polyamine composition further includes a polyamine with more than 3 aminos. The polyamine with more than 3 aminos includes one or a combination of more of common polyamines such as a tetraamine, a pentamine, a hexamine, a heptamine, or an octamine. Considering the influences on the polishing performance and the polishing life, a tetraamine and a pentamine are preferred, with a tetraamine being particularly preferred. As a preferred embodiment, in the polyamine composition including a tetraamine, the proportions of a diamine, a trimine, and a tetraamine relative to the total amount of the polyamine composition are 77%-96%: 3%-12%: 0.1%-10%, respectively. Preferably, the proportions of a diamine, a triamine, and a tetraamine relative to the total amount of the polyamine composition are 87%-95%: 4%-11%: 0.1%-2%, respectively. The

content of the tiramine and the tetraamine should not be too high, as excessive triamine and tetraamine will lead to a reduction in the service life of the polishing pad.

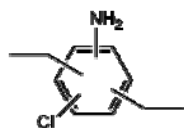
[0095]The disclosure further provides a polyamine composition including a diamine and a tetraamine, in which the proportions of the diamine and the tetraamine relative to the total amount of the polyamine composition are 77%-96% : 0.1%-10%, respectively. The average molecular weight of the polyamine composition is between 200 and 400, and the average functionality of the polyamine composition is greater than 2 and not higher than 2.20. Preferably, the average functionality of the curing agent composition is not lower than 2.01 and not higher than 2.15. Particularly preferably, the average functionality of the polyamine composition is not lower than 2.01 and not higher than 2.09. Preferably, the proportions of the diamine and the tetraamine relative to the total amount of the polyamine composition are 87%-95% : 0.1%-2% respectively in the polyamine composition.

[0096]In the disclosure, given that an aliphatic polyamine will cause problems such as a reduction in the hardness of the cured polishing layer, a reduction in the removal rate, and a too high compression rate, it is preferred not to include aliphatic polyamines in the disclosure. It is further preferred that the diamines and/or triamines and/or polyamines with more than 3 aminos include only aromatic polyamines. It is particularly preferred that the diamines and/or triamines and/or polyamines with more than 3 aminos include a compound represented by Structural Formula 1:

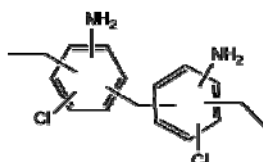


Structural Formula 1.

[0097]In Structural Formula 1, X represents a carbon atom or one or a combination of more of structural units represented by Structural Formula 2 or Structural Formula 3:

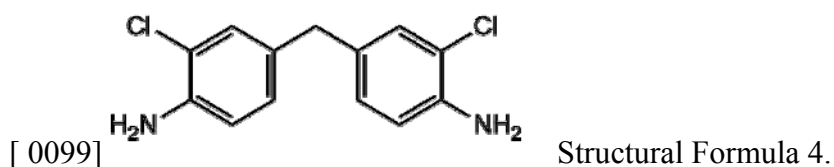


Structural Formula 2

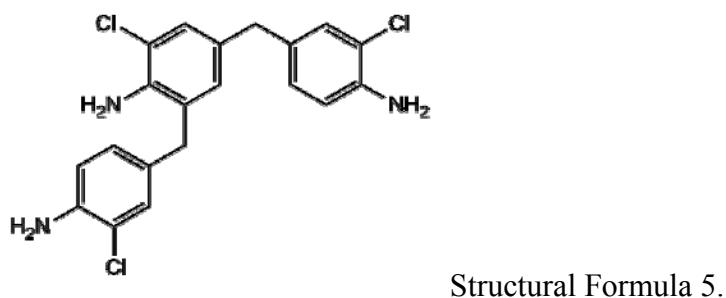


Structural Formula 3.

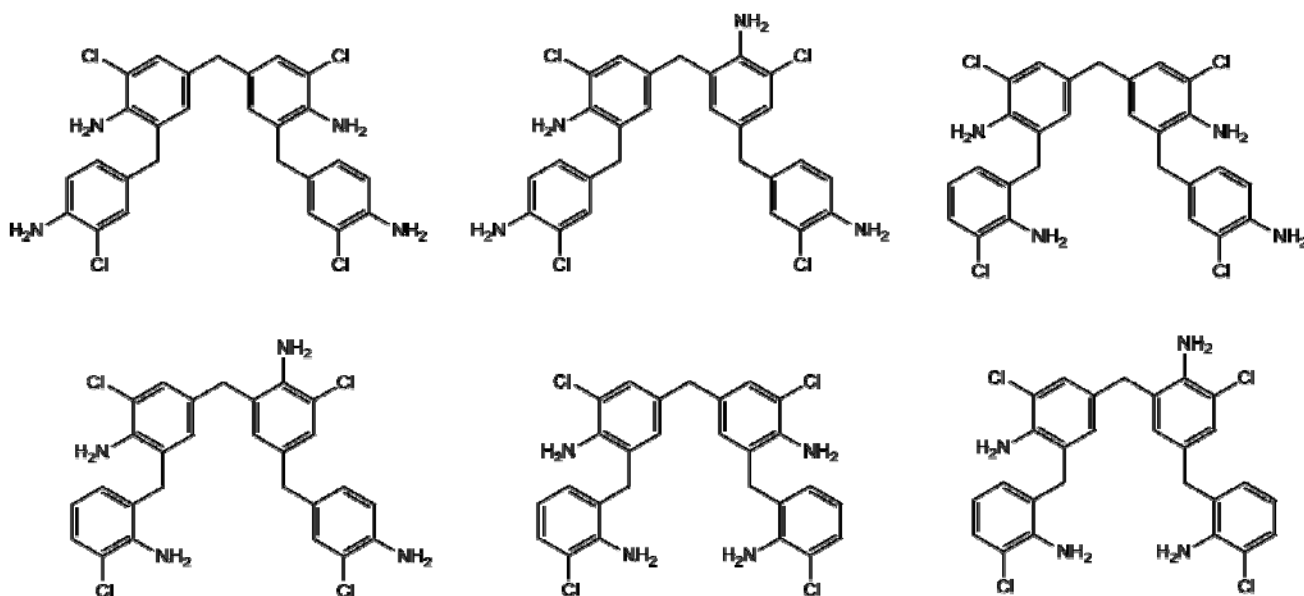
[0098]When X represents a carbon atom, Structural Formula 1 represents a diamine, preferably including the following compound represented by Structural Formula 4:



[00100] When X represents the structure represented by Structural Formula 2, Structural Formula 1 represents a triamine, preferably including the following compound represented by Structural Formula 5:



[00101] When X represents the structure represented by Structural Formula 3, Structural Formula 1 represents a tetraamine, preferably including one or a combination of more of the following compounds represented by Structural Formula 6:



Structural Formula 6

[00102] The polyamine composition above can be obtained by combining a diamine, triamine, tetraamine purchased via commercial channels, or can also be obtained directly by synthesis through conventional synthesis methods in related art or by separating and

combining after synthesis.

[00103] As an example of the synthesis methods, it can be prepared by selecting and using o-chloroaniline to react with formaldehyde. The specific preparation method is as follows.

[00104] 1. At room temperature, a certain amount of deionized water is added to a reaction kettle, and a certain amount of 37% hydrochloric acid is added. A certain amount of o-chloroaniline with a purity of 99% is added under stirring well to form a solution of o-chloroaniline hydrochloride.

[00105] 2. Under the protection of an inert gas and at a temperature controlled below 35 °C, a certain amount of formaldehyde aqueous solution is added dropwise in a constant rate into a reaction kettle. After the dropwise addition is completed, a gradient heating is used to ensure that o-chloroaniline and formaldehyde react fully. As an example, the gradient heating procedure is 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient is 0.5-1h. After the reaction is completed, the temperature is cooled to 50-60 °C.

[00106] 3. Then, the pH is adjusted to greater than 12, and the mixture is left to stand for 12-24h. The lower aqueous solution of inorganic salts is separated, and deionized water at a temperature not lower than 95 °C is then added to the organic phase. The volume of deionized water is 1.5 times of the volume of the organic phase. After fully stirring, the mixture is left to stand. After the aqueous phase is separated, the organic phase is washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed.

[00107] 4. After fully washing, the organic phase is separated. The organic phase is cooled down to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5h to obtain a polyamine composition G1. The yield is calculated.

[00108] Through research, it has been found that by controlling the reaction conditions and raw material ratios, the proportions of various polyamine compounds relative to the total amount of the polyamine composition can be effectively controlled. By controlling the proportions of a diamine, a triamine, a tetraamine relative to the total amount of the polyamine composition within certain ranges, the service life of the polishing layer can be effectively improved.

[00109] Therefore, in order to determine the mass percentages of a diamine, a triamine, a tetraamine relative to the total amount of the polyamine composition in the polishing layer, as an exemplary method, a standard curve method is used for calculation. The standard curve can be determined by LC-MS or HPLC. The polyamine composition G1 prepared by the above-mentioned polyamine composition preparation method may be used as the test sample for the standard curve, or a polyamine composition G2, obtained by subjecting a cured polishing layer to operations such as hydrolysis, post-treatment, and separation and purification, can be used as the test sample for the standard curve.

[00110] The disclosure further provides a method for obtaining a polyamine composition G2 by subjecting a cured polishing layer to hydrolysis, post-treatment, and separation and purification, including the following steps.

[00111] 1. Feeding for hydrolysis reaction: a finely ground polishing layer containing the polyamine composition G2 is added to a reaction kettle for hydrothermal synthesis, and it is stirred in a certain amount of NaOH solution and anhydrous ethanol at 150 °C for 10h.

[00112] 2. Reaction pretreatment: after the reaction time is over, the above liquid is cooled to room temperature. The above liquid is then subjected to rotary evaporation at 40-50 °C.

[00113] 3. Extraction and separation: 30-50 ml of dichloromethane is added to the solution obtained by the rotary evaporation. Then, a separatory funnel is used to separate water and oil, and the organic phase is collected. 30-50 ml of dichloromethane is then added to the aqueous phase again for repeated extraction twice. To all organic phases obtained, an appropriate amount of desiccant is added to remove water. After dichloromethane is completely separated by rotary evaporation, the residue is weighed to obtain the polyamine composition G2.

[00114] The determination of the standard curve in the disclosure: a certain amount of standard sample of each of a diamine, a triamine, and a tetraamine may be dissolved in a solvent to prepare solutions each at a certain concentration. A certain amount of each of the above solutions is taken and diluted to obtain solutions with a certain concentration gradient. Liquid chromatography-mass spectrometry (LC-MS) analysis is then performed on the solutions with a certain concentration gradient to obtain the relationship between the concentration (ppm) and the liquid chromatography peak area, in which a scatter plot is

made with the concentration (ppm) and the liquid chromatography peak area as the horizontal and vertical coordinates respectively. A linear fitting is then performed using a software to obtain the slope, intercept, and R^2 value therein.

[00115] In the disclosure, the mass percentages of a diamine, a triamine, and a tetraamine relative to the total amount of the polyamine composition may be measured by the standard curve method described below.

[00116] Diamine: 0.005 g of a standard sample of a diamine is weighed and added into a 10 ml centrifuge tube, and methanol is added until a total mass of 5.00 g is obtained. 0.1 ml of the prepared solution above is taken, and methanol is added until a total volume of 10 ml is obtained, such that solution A (10 ppm) is obtained by mixing. 0.2 ml of solution A + 1.8 ml of methanol, 0.6 ml of solution A + 1.4 ml of methanol, 1.0 ml of solution A + 1.0 ml of methanol, and 1.4 ml of solution A + 0.6 ml of methanol are taken to prepare solutions of 1, 3, 5, and 7 ppm, respectively, together with the undiluted solution of 10 ppm to form standard sample solutions of a diamine with a concentration gradient.

[00117] Triamine: 0.005 g of a standard sample of a triamine is weighed and added into a 10 ml centrifuge tube, and methanol is added until a total mass of 5.00 g is obtained. 0.1 ml of the prepared solution above is taken, and methanol is added until a total volume of 10 ml is obtained, such that solution B (10 ppm) is obtained by mixing. 0.2 ml of solution B + 1.8 ml of methanol, 0.6 ml of solution B + 1.4 ml of methanol, 1.0 ml of solution B + 1.0 ml of methanol, and 1.4 ml of solution B + 0.6 ml of methanol are taken to prepare solutions of 1, 3, 5, and 7 ppm, respectively, together with the undiluted solution of 10 ppm to form standard sample solutions of a triamine with a concentration gradient.

[00118] Tetraamine: 0.005 g of a standard sample of a tetraamine is weighed and added into a 10 ml centrifuge tube, and methanol is added until a total mass of 5.00 g is obtained. 0.1 ml of the prepared solution above is taken, and methanol is added until a total volume of 10 ml is obtained, such that solution C (10ppm) is obtained by mixing. 0.2 ml of solution C + 1.8 ml of methanol, 0.6 ml of solution C + 1.4 ml of methanol, 1.0 ml of solution C + 1.0 ml of methanol, and 1.4 ml of solution C + 0.6 ml of methanol are taken to prepare solutions of 1, 3, 5, and 7 ppm, respectively, together with the undiluted solution of 10 ppm to form standard sample solutions of a tetraamine with a concentration gradient.

[00119] Liquid chromatography-mass spectrometry (LC-MS) analysis is performed on

the standard sample solutions of a diamine, a triamine and a tetraamine with a concentration gradient mentioned above. As an example of analytical instruments, Aglient 1220 HPLC (chromatography column: Aglient model: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron) and Agilent G6125C MS may be used. The HPLC mobile phase is 0.1% formic acid aqueous solution : methanol=20 : 80, the flow rate is 0.5 ml/min, the chromatography column temperature may be 40 °C, the standard sample injection volume is 10 µl, and a UV detector with a wavelength of 254 nm is used as the detector.

[00120] The retention time of the diamine is between 7.0 and 7.8 min, the retention time of the triamine is between 10 and 11 min, and the retention time of the tetraamine is between 14.2 and 16 min.

[00121] As an example, the standard curves of the diamine, the triamine and the tetraamine are shown in FIG. 3-1, FIG. 3-2, and FIG. 3-3. The standard curve of the diamine shown in FIG. 3-1 is $y_2=48.429x_2-1.2514$, with a goodness of fit $R^2=0.9995$, where y_2 represents the liquid chromatography peak area of the diamine, and x_2 represents the concentration (ppm) of the diamine standard solution. The standard curve of the triamine shown in FIG. 3-2 is $y_3=37.969x_3+0.4591$, with a goodness of fit $R^2=0.9996$, where y_3 represents the liquid chromatography peak area of the triamine, and x_3 represents the concentration (ppm) of the triamine standard solution; The standard curve of the tetraamine shown in FIG. 3-3 is $y_4=37.983x_4+0.6908$, with a goodness of fit $R^2=0.9998$, where y_4 represents the liquid chromatography peak area of the tetraamine, and x_4 represents the concentration (ppm) of the tetraamine standard solution.

[00122] Those skilled in the art know that the methods for measuring the mass percentages of a diamine, a triamine and a tetraamine relative to the total amount of the polyamine composition in the polishing layer by a LC-MS standard curve method described in the specification do not constitute any limitations to the scope of the claims of the disclosure. It is to be noted that any method that can be used to measure the mass percentages of a diamine, a triamine and a tetraamine relative to the total amount of the polyamine composition in the polishing layer claimed in the disclosure is applicable to the scope of protection of the disclosure.

[00123] In the disclosure, the above-mentioned polyamine composition G1 or G2 is prepared to be a test sample for the standard curve at a concentration of 10-100 ppm, and

LC-MS analysis is performed under the same analysis conditions as the standard sample to obtain the results. The liquid chromatography peak areas of the three amine compounds of the test samples for the standard curve are substituted into the standard curves of the diamine, triamine and tetraamine mentioned above to calculate the concentrations (ppm) of the diamine, the triamine and the tetraamine in the test samples. Then, the mass percentages of the diamine, the triamine and the tetraamine relative to the total amount of the polyamine composition can be calculated.

[00124] As an example of a test sample for the standard curve, 0.0204 g of a polyamine composition may be used, to which methanol is added, and a total mass of 20.0026 g is obtained. 0.2 ml of the above solution is taken, and methanol is added until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing. 0.2 ml of the above 100 ppm solution is taken, methanol is added until a total volume of 2 ml is obtained, such that a 10ppm solution is obtained by mixing. The concentration of the test sample for the standard curve may be adjusted according to its actual use in the disclosure.

[00125] In the disclosure, the liquid chromatography peak areas of the diamine, triamine, and tetraamine obtained under the above testing conditions satisfy the following relationship: the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min is between 5 and 30; the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min is between 10 and 400.

[00126] The ratio of the peak area with a retention time of 7.0-7.8 min, to the peak area with a retention time of 10-11 min and to the peak area with a retention time of 14.2-16 min is 360-450 : 15-45 : 1-40.

[00127] Those skilled in the art know that the methods for determining the ratio of the liquid chromatography peak areas of a diamine, a triamine and a tetraamine in the polishing layer by LC-MS described in the specification do not constitute any limitations to the scope of the claims of the disclosure. It is to be noted that any methods that can be used to measure the ratio of the liquid chromatography peak areas of a diamine, a triamine and a tetraamine in the polishing layer claimed in the disclosure is applicable to the scope of protection of the disclosure.

[00128] The disclosure has found that the polishing layer is allowed to have a higher

service life by controlling the total average functionality of the polyamine composition and the polyol within a certain range. Considering the hardness of the polishing layer, the total average functionality of the polyamine composition and the polyol is controlled to be no higher than 2.2 in the disclosure. When the total average functionality of the polyamine composition and the polyol is higher than 2.2, the polishing layer becomes hard and brittle, seriously affecting the service life. Accordingly, when the polyamine composition and the polyol are selected, it should be avoided to select both of them having higher average functionalities. Therefore, it is preferred to use a combination of a polyol with a low average functionality and a polyamine composition with a high average functionality, or to use a combination of a polyol with a low average functionality and a polyamine composition with a low average functionality in the disclosure.

[00129] The polyamine composition in the disclosure contains a certain amount of free chloride ions. If a content of chloride ions is too high, a complex reaction between the chloride ions and metal ions generated by oxidation of the metal to be polished will occur, thereby affecting the stability of the polishing rate. In view of this, the disclosure controls the content of chloride ions to be below 900 ppm. It is preferred to control the content of chloride ions to be below 100 ppm, and particularly preferred to control the content of chloride ions to be below 10 ppm in the disclosure.

[00130] **Other additives**

[00131] In the disclosure, in order to achieve an appropriate density and excellent physical properties of the polishing layer, the polyurethane are usually foamed. Common foaming processes include mechanical foaming or microsphere foaming and the like.

[00132] Exemplarily, in terms of mechanical foaming, using a copolymer of a polyalkylsiloxane and a polyether and silicone without active hydrogen groups as a surfactant, mechanical foaming of a polyurethane may be achieved under mechanical stirring. Exemplarily, surfactants such as L5340 (manufactured by NIHON UNICA), SH-192 (manufactured by Dow Corning Toray Silicone Co., Ltd.) can be used.

[00133] Exemplarily, in terms of microsphere foaming, a hollow microsphere polymer is generally uniformly dispersed in a polyurethane to adjust the properties of the polishing layer. The term “hollow microsphere polymer” in the disclosure refers to an expandable hollow polymer microsphere that is moderately expandable during the curing process due

to the temperature rise caused by the exothermic reaction. By adjusting the distribution pattern (such as the concentration) of a hollow microsphere polymer in the polyurethane polishing layer, combined with the adjustment of the particle size of the hollow microsphere polymer, the polishing properties of the polishing layer can be further adjusted. Preferably, the hollow microsphere polymer being dispersed in the polishing layer can result in a final porosity of the polishing layer of 1-60%, particularly preferably a porosity of 15-45%.

[00134] Preferably, the hollow microsphere polymer includes, but are not limited to, a capsule structure with an outer wall of a polyacrylonitrile and polyacrylonitrile copolymer, which can be microspheres or microbeads purchased from any company of AkzoNobel, Matsumoto Oil and Fat Pharmaceutical Co., Ltd., or Sekisui Chemical Industry Co., Ltd. Particularly preferably, hollow microspheres from AkzoNobel or microsphere F series from Matsumoto are selected in the embodiments of the disclosure.

[00135] In the disclosure, appropriate modifiers can also be added to the polyurethane to achieve a better overall performance improvement. Preferably, these modifiers can modify at least one property of the polishing layer, including but not limited to the group consisting of porosity, rigidity, surface energy, wear resistance, conductivity, and chemical function. Modifying materials include but are not limited to antioxidants, lubricants, pigments, fillers, antistatic agents, etc.

[00136] **Grooves**

[00137] In the disclosure, the polishing layer may be, conventionally as in the related art, provided with grooves for receiving a polishing solution during the polishing process. The grooves can be obtained by processing after the polishing layer is formed. The grooves can ensure the smooth discharge and flow of the polishing solution used during the polishing process. Preferably, the grooves are one or more of concentric circular grooves (such as circular or spiral grooves), curved grooves, grid line grooves, regular polygon grooves (such as hexagons, triangles), or tire tread patterns. Particularly preferably, the grooves are one or more of circular grooves, spiral grooves, X-Y grid grooves, hexagonal grooves, triangular grooves, or fractal grooves. Particularly preferably, the cross sections of the grooves are one or more of a straight sidewall rectangle, a “V” shape, a “U” shape, or a sawtooth shape.

[00138] Exemplarily, the width of the grooves is 0.1-0.6 mm, the depth of the grooves is 0.5-0.9 mm, and the spacing between adjacent grooves is 2-5 mm. A central blank area can be provided or not, with a radius of 60 mm-70 mm for the central blank area.

[00139] <Cushion layer, intermediate adhesive, and back adhesive layer>

[00140] In the disclosure, the polishing pad further includes a cushion layer. In CMP, in order to balance the trade-off between the planarity and the uniformity, a cushion layer is required. The planarity refers to the flatness of the pattern portion when an object to be polished with small bumps and depressions generated during pattern formation is polished, and the uniformity refers to the overall uniformity of the object to be polished. The planarity is improved by means of the polishing layer, and the uniformity is improved by means of the cushion layer. In the polishing pad of the disclosure, it is preferred to use a material softer than the polishing layer for the cushion layer.

[00141] As a cushion layer, examples may include fiber non-woven fabrics such as polyester non-woven fabrics, nylon non-woven fabrics, acrylonitrile-based non-woven fabrics, resin-impregnated non-woven fabrics like polyurethane-impregnated polyester non-woven fabrics, polymer resin foams such as polyurethane foams, polyethylene foams, rubber resins such as butadiene rubbers, isoprene rubbers, and photosensitive resins, etc.

[00142] As a method of bonding the polishing layer to cushion layer, an intermediate adhesive is used. A double-sided tape may be selected and used as the intermediate adhesive. The polishing layer and the cushion layer are placed on either side of the intermediate adhesive for compression.

[00143] The polishing pad of the disclosure further comprises a back adhesive layer. As a back adhesive layer, a double-sided tape may also be selected. As the composition of the back adhesive layer, examples may include rubber-based adhesives, acrylic-based adhesives, etc. Considering the content of metal ions, acrylic-based adhesives have a low content of metal ions, so they are preferred.

[00144] The back adhesive layer of the disclosure further includes a release film or a release paper, which can be peeled off before use to achieve adhesion between the polishing pad and the polishing table.

[00145] <Endpoint detection window>

[00146] The polishing layer in the disclosure can be provided with an endpoint detection window according to actual needs. Exemplarily, at least one endpoint detection area is formed in the polishing layer. During a polishing operation, the endpoint detection area of the polishing layer can perform a high-precision optical endpoint detection, and the detection method may be an optical detection. The endpoint detection area is made from an appropriate material, and thus it has an appropriate light transmittance in order to observe an object being polished (such as a silicon wafer). As a preferred embodiment, the material forming the endpoint detection area has a light transmittance of 20% or more throughout the wavelength range of 300-800 nm. It is further preferred that the high transmittance material has a light transmittance of 60% or more.

[00147] As a preferred embodiment, the material for the endpoint detection area includes, but are not limited to, one or a combination of more of thermosetting resins such as polyurethane resins, polyester resins, phenolic resins, urea resins, melamine resins, epoxy resins, or acrylic resins; thermoplastic resins such as polyurethane resins, polyester resins, polyamide resins, cellulose-based resins, acrylic resins, polycarbonate resins, halogen-containing resins (polyvinyl chloride, polytetrafluoroethylene, polyvinylidene fluoride, etc.), polystyrene and olefin resins (polyethylene, polypropylene, etc.).

[00148] As a preferred embodiment, during a polishing operation, the Shore hardness of the endpoint detection area is 40-75D, and further preferably 55-70D. When the Shore hardness of the endpoint detection area is less than 40D, creep is prone to occur in this area, making it difficult to perform a stable optical endpoint detection. When the Shore hardness exceeds 75D, scratches are prone to occur on the surface of the object to be polished.

[00149] <Polishing treatment>

[00150] The polishing pad involved in the disclosure can be applied to commonly-used semiconductor processes, including but not limited to STI process, Oxide process, W process, Al process, Copper process, and Poly process.

[00151] Polishing treatment: it is carried out using a polishing device as shown in FIG. 1. The polishing device comprises a polishing table 3 for supporting a polishing pad 2, a backing material for uniformly pressing a holder 4 for supporting an object to be polished (a semiconductor wafer 1) and the wafer, and a supply mechanism for a polishing solution 5. The polishing pad 2 is installed on the polishing table 3, for example by adhering via a

back adhesive layer. The polishing table 3 and the holder 4 are configured such that the polishing pad 2 and the semiconductor wafer 1 supported by them respectively are opposite to each other, and each of the polishing table 3 and the holder 4 has a rotating shaft. In addition, a pressing mechanism for pressing the semiconductor wafer 1 onto the polishing pad 2 is provided at one side of the holder 4. During polishing, the polishing table 3 and the holder 4 are rotated, and the semiconductor wafer 1 is pressed onto the polishing pad 2 while supplying a slurry for polishing. The flow rate of the slurry, the load for polishing, the rotational speed of the polishing table, and the rotational speed of the wafer are not particularly limited and can be adjusted appropriately.

[00152] **Examples**

[00153] In order to facilitate the understanding of the disclosure, the following examples are listed. Those skilled in the art should understand that the examples are only intended to assist in the understanding of the disclosure and should not be regarded as specific limitations to the disclosure.

[00154] Definition of symbols in the examples:

[00155] TDI100: 100% 2,4-toluene diisocyanate;

[00156] TDI80: 80% 2,4-toluene diisocyanate, 20% 2,6-toluene diisocyanate;

[00157] HMDI: 4,4'-Dicyclohexylmethane Diisocyanate;

[00158] PTMEG: Polytetramethylene ether glycol;

[00159] MOCA: 4,4'-methylene-bis-(2-chloroaniline);

[00160] M-CDEA: 4,4'-methylene-bis-(3-chloro-2,6-diethylaniline);

[00161] DETDA: 3,5-diethyltoluene diamine;

[00162] D2000: Amino-terminated polyoxypropylene ether;

[00163] T5000: Trifunctional polyetheramine;

[00164] DEG: Diethylene glycol;

[00165] Hollow microsphere polymer: Expancel[®] 551DE40d42, with an average particle

size of 40 μm and a density of 0.042 g/cm^3 ; Expancel[®] 461DE20d70, with an average particle size of 20 μm and a density of 0.07 g/cm^3 .

[00166] The above raw materials are all from commercially available bulk industrial products, for which the manufacturers include BASF, Covestro, Wanhua Chemical, Suzhou Xiangyuan, Chizhou Tianci, Mitsui Chemical, Mitsubishi Chemical, etc.

[00167] Di-A: Diamine;

[00168] Tri-A: Triamine;

[00169] Tetra-A: Tetraamine;

[00170] The above-mentioned Di-A, Tri-A, and Tetra-A are obtained by separating a polyamine composition prepared by any one of Preparation Examples 1-8.

[00171] The methods for measuring physical and chemical parameters, as well as the method for calculating other parameters, are as follows.

[00172] **Shore hardness of the polishing layer**

[00173] It was measured using REX digital Shore D automatic hardness tester and Bareiss digital Shore D automatic hardness tester. The test sample was cut into a 3"× 3" square sample, with a thickness of not less than 5 mm. The measurement point should be at least 9 mm away from any edge of the sample, and the hardness value should be measured at measurement points at least 6 mm apart from each other on a same sample. The maximum value was taken. The sample needed to be tested in a standard environment at 23 ± 2 °C and a humidity of $50\% \pm 10\%$.

[00174] **Density of the polishing layer**

[00175] It was calculated according to the following formula: $S.G = m/v = m/(\pi (d/2)^2 \cdot h)$, where m is the weight of the polishing layer, d is the diameter of the polishing layer, and h is the thickness of the polishing layer.

[00176] **Determination of free chloride ion content**

[00177] A certain amount of the polyamine composition was taken and dissolved, and treated with ultrasonic, and then centrifuged at 3000-10000 r/min for 10 min. The

supernatant was taken, and tested using an anion chromatography.

[00178] **Mass percentages of diamine, triamine, and tetraamine relative to the total amount of the polyamine composition, respectively**

[00179] The polyamine composition was taken to prepare a solution with a concentration of 10 ppm, which was measured using Aglient 1220 HPLC (column: Aglient model: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron) and Agilent G6125C MS. The HPLC mobile phase was 0.1% formic acid aqueous solution : methanol=20 : 80, the flow rate was 0.5 ml/min, the chromatography column temperature may be 40 °C, the standard sample injection volume was 10 µl, and a UV detector with a wavelength of 254nm was used as the detector.

[00180] **Average functionality of the polyamine composition**

[00181] Average functionality of the polyamine composition =

$$\frac{(2*X_2/M_{2Am}+3*X_3/M_{3Am}+4*X_4/M_{4Am})}{(X_2/M_{2Am}+X_3/M_{3Am}+X_4/M_{4Am})} \quad \text{Equation 1}$$

[00182] In Equation 1, X₂, X₃, and X₄ represent the mass percentages of diamine, triamine, and tetraamine relative to the total amount of the polyamine composition, respectively. M_{2Am}, M_{3Am}, and M_{4Am} represent the molecular weights of diamine, triamine, and tetraamine, respectively.

[00183] **Average molecular weight of the polyamine composition**

[00184] Average molecular weight of the polyamine composition =

$$\frac{(X_2+X_3+X_4)}{(X_2/M_{2Am}+X_3/M_{3Am}+X_4/M_{4Am})} \quad \text{Equation 2}$$

[00185] In Equation 2, X₂, X₃, and X₄ represent the mass percentages of diamine, triamine, and tetraamine relative to the total amount of the polyamine composition, respectively. M_{2Am}, M_{3Am}, and M_{4Am} represent the molecular weights of diamine, triamine, and tetraamine, respectively.

[00186] **Total average functionality of the polyamine composition and the polyol composition**

[00187] Total average functionality of the polyamine composition and the polyol composition =

$$\frac{(2 \cdot C_2/M_{2-ol} + 3 \cdot C_3/M_{3-ol} + 4 \cdot C_4/M_{4-ol} + \dots + n \cdot C_n/M_{n-ol} + 2 \cdot m \cdot X_2/M_{2Am} + 3 \cdot m \cdot X_3/M_{3Am} + 4 \cdot m \cdot X_4/M_{4Am})}{(C_2/M_{2-ol} + C_3/M_{3-ol} + C_4/M_{4-ol} + \dots + C_n/M_{n-ol} + m \cdot X_2/M_{2Am} + m \cdot X_3/M_{3Am} + m \cdot X_4/M_{4Am})} \quad \text{Equation 3}$$

[00188] In Equation 3, X_2 , X_3 , and X_4 represent the mass percentages of diamine, triamine, and tetraamine relative to the total amount of the polyamine composition, respectively. m represents the mass of the polyamine composition. C_2 , C_3 , C_4 , and C_n represent the masses of polyols with functionalities of 2, 3, 4, and n . M_{2Am} , M_{3Am} , and M_{4Am} represent the molecular weights of diamine, triamine, and tetraamine, respectively. M_{2-ol} , M_{3-ol} , M_{4-ol} , and M_{n-ol} represent the molecular weights of diol, triol, and tetraol, or polyol, respectively.

[00189] **Evaluation of the Polishing Performance of the Polishing Pad**

[00190] The polishing pads in the Preparation Examples and Comparative Examples were tested on the testing machine to evaluate their polishing performance. The testing conditions were as follows.

[00191] The testing machine was AMAT Refelxion (Modify 5Zone).

[00192] The polishing solution was ANJI U3061A (slurry (g) : DIW (g) : 30% H_2O_2 (g))=1 : 10 : 0.37), with a flow rate of 300 mL/min.

[00193] The trimming disk was Saesol Disk AJ27, 6 lbf, in-situ 100%; Platen/Head Speed=97/91.

[00194] Zone Pressure: RR/Z1/Z2/Z3/Z4/Z5: 5.90/5.10/2.40/2.15/2.10/2.20.

[00195] The wafer used was a Patten wafer: Semitech 754, Cu Blanket wafer Pre Thickness 10-12 KA.

[00196] The changes in removal rate during the polishing were recorded. Data for 0/5hrs/10hrs/15hrs/20hrs were recorded. The changes in non-uniformity of grinding rates (NU) for 0/5hrs/10hrs/15hrs/20hrs were recorded. The average value was calculated. A four probe film thickness gauge (NAPSON Crestest/RG3000) was used.

[00197] **Evaluation of the life of the polishing pad**

[00198] The polishing pads in the Examples and Comparative Examples were subjected to long-term cutting by a trimmer to test their ultimate service life, i.e., the time required

to complete the cutting of grooves with the same parameters (a groove depth of 30 mil, a groove width of 20 mil, a groove spacing of 120 mil, and a radius of the center blank area of 60-70 mm).

[00199] **Defect evaluation**

[00200] After being polished by the polishing pad, defects on the object to be polished were inspected using Surfscan[®] SP2 defect inspection system available from KLA Tencor, and the size of the detected defect is 0.16 μm . $\circ\circ$ indicates almost no defects, $\circ$ indicates very few defects, $\times$ indicates a small amount of defects, $\times\times$ indicates more defects, and $\times\times\times$ indicates a large number of defects.

[00201] Preparation Example 1

[00202] At room temperature, 60 L of deionized water was added to a reaction kettle, 118.25 kg of 37% hydrochloric acid was added, and 128.86 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 41.39 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3 h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2 h, 50-60 °C for 4 h, 70-80 °C for 4 h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 249.6 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 126.56 kg of polyamine composition B1. In the polyamine composition B1, the mass percentage of the Di-A component in the polyamine composition was 90.86%, the mass percentage of the Tri-A component in the polyamine composition

was 6.46%, and the mass percentage of the Tetra-A component in the polyamine composition was 1.09%. The average functionality of the polyamine composition was 2.06. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 18; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 91. The peak area with a retention time of 7.0-7.8 min was 430.2, the peak area with a retention time of 10-11 min was 24.5, and the peak area with a retention time of 14.2-16 min was 4.8.

[00203] Preparation Example 2

[00204] At room temperature, 60 L of deionized water was added to a reaction kettle, 130.08 kg of 37% hydrochloric acid was added, and 141.75 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 47.32 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3 h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2 h, 50-60 °C for 4 h, 70-80 °C for 4 h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 274.56 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12 h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 124.16 kg of polyamine composition B2. In the polyamine composition B2, the mass percentage of the Di-A component in the polyamine composition was 87.21%, the mass percentage of the Tri-A component in the polyamine composition was 9.83%, and the mass percentage of the Tetra-A component in the polyamine composition was 1.92%. The average functionality of the polyamine composition was 2.09. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak

area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 11; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 53. The peak area with a retention time of 7.0-7.8 min was 412.9, the peak area with a retention time of 10-11 min was 37.1, and the peak area with a retention time of 14.2-16 min was 7.8.

[00205] Preparation Example 3

[00206] At room temperature, 60 L of deionized water was added to a reaction kettle, 120.97 kg of 37% hydrochloric acid was added, and 131.83 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 40.26 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 247.10 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 131.12 kg of polyamine composition B3. In the polyamine composition B3, the mass percentage of the Di-A component in the polyamine composition was 94.83%, the mass percentage of the Tri-A component in the polyamine composition was 4.13%, and the mass percentage of the Tetra-A component in the polyamine composition was 0.12%. The average functionality of the polyamine composition was 2.03. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 28; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 395. The peak area with a retention time of

7.0-7.8 min was 449.1, the peak area with a retention time of 10-11 min was 15.8, and the peak area with a retention time of 14.2-16 min was 1.1.

[00207] Preparation Example 4

[00208] At room temperature, 60 L of deionized water was added to a reaction kettle, 120.97 kg of 37% hydrochloric acid was added, and 126.45 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 42.12 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 247.75 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 127.52 kg of polyamine composition B4. In the polyamine composition B4, the mass percentage of the Di-A component in the polyamine composition was 88.31%, the mass percentage of the Tri-A component in the polyamine composition was 8.29%, and the mass percentage of the Tetra-A component in the polyamine composition was 1.86%. The average functionality of the polyamine composition was 2.08. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 13; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 55. The peak area with a retention time of 7.0-7.8 min was 418.1, the peak area with a retention time of 10-11 min was 31.3, and the peak area with a retention time of 14.2-16 min was 7.6.

[00209] Preparation Example 5

[00210] At room temperature, 60 L of deionized water was added to a reaction kettle, 120.97 kg of 37% hydrochloric acid was added, and 127.56 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 42.94 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 247.52 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 125.85 kg of polyamine composition B5. In the polyamine composition B5, the mass percentage of the Di-A component in the polyamine composition was 81.84%, the mass percentage of the Tri-A component in the polyamine composition was 9.95%, and the mass percentage of the Tetra-A component in the polyamine composition was 7.32%. The average functionality of the polyamine composition was 2.15. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 10; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 14. The peak area with a retention time of 7.0-7.8 min was 387.4, the peak area with a retention time of 10-11 min was 37.5, and the peak area with a retention time of 14.2-16 min was 28.0.

[00211] Preparation Example 6

[00212] At room temperature, 60 L of deionized water was added to a reaction kettle,

128.03 kg of 37% hydrochloric acid was added, and 143.75 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 48.91 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 274.56 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 124.16 kg of polyamine composition B6. In the polyamine composition B6, the mass percentage of the Di-A component in the polyamine composition was 77.12%, the mass percentage of the Tri-A component in the polyamine composition was 11.84%, and the mass percentage of the Tetra-A component in the polyamine composition was 9.98%. The average functionality of the polyamine composition was 2.20. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 8; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 10. The peak area with a retention time of 7.0-7.8 min was 365.0, the peak area with a retention time of 10-11 min was 44.5, and the peak area with a retention time of 14.2-16 min was 37.9.

[00213] Preparation Example 7

[00214] At room temperature, 60 L of deionized water was added to a reaction kettle, 129.42 kg of 37% hydrochloric acid was added, and 140.81 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below

35 °C, 48.95 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The gradient heating procedure was 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 274.12 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 128.42 kg of polyamine composition B7. In the polyamine composition B7, the mass percentage of the Di-A component in the polyamine composition was 66.38%, the mass percentage of the Tri-A component in the polyamine composition was 18.94%, and the mass percentage of the Tetra-A component in the polyamine composition was 13.73%. The average functionality of the polyamine composition was 2.30. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 4; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 6. The peak area with a retention time of 7.0-7.8 min was 314.0, the peak area with a retention time of 10-11 min was 71.0, and the peak area with a retention time of 14.2-16 min was 51.8.

[00215] Preparation Example 8

[00216] At room temperature, 60 L of deionized water was added to a reaction kettle, 130.84 kg of 37% hydrochloric acid was added, and 134.82 kg of o-chloroaniline with a purity of 99% was added under stirring well to form a solution of o-chloroaniline hydrochloride. Under the protection of nitrogen and at a temperature controlled below 35 °C, 47.65 kg of 37% formaldehyde aqueous solution was added dropwise in a constant rate into the reaction kettle in 2-3h. After the dropwise addition was completed, a gradient heating was carried out to ensure that o-chloroaniline and formaldehyde react fully. The

gradient heating procedure was 35-40 °C for 2h, 50-60 °C for 4h, 70-80 °C for 4h, and 100 °C for 1h. The heating time for each gradient was 0.5h. The temperature was lowered to 50-60 °C. 275.42 kg of a sodium hydroxide solution with a mass fraction of 25% was added to neutralize to a pH greater than 12, and the mixture was left to stand for 12h. The lower aqueous solution of inorganic salts was separated, and deionized water at a temperature not lower than 95 °C was then added to the organic phase. The volume of deionized water was 1.5 times of the volume of the organic phase. After fully stirring, the mixture was left to stand. The aqueous phase was separated, and the organic phase was washed with water 5 to 8 times repeatedly to ensure that the organic salt is thoroughly removed. After the final washing, the organic phase was separated, cooled to allow the organic phase to crystallize into a solid, and dried at 50-60 °C under vacuuming to 100 Pa for 5 hours to obtain 127.21 kg of polyamine composition B8. In the polyamine composition B8, the mass percentage of the Di-A component in the polyamine composition was 54.54%, the mass percentage of the Tri-A component in the polyamine composition was 24.97%, and the mass percentage of the Tetra-A component in the polyamine composition was 19.49%. The average functionality of the polyamine composition was 2.44. In the liquid chromatography peak area of the polyamine composition, the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 10-11 min was 3; and the ratio of the peak area with a retention time of 7.0-7.8 min to the peak area with a retention time of 14.2-16 min was 4. The peak area with a retention time of 7.0-7.8 min was 257.7, the peak area with a retention time of 10-11 min was 93.4, and the peak area with a retention time of 14.2-16 min was 73.3.

[00217] Example 1

[00218] This Example provides a polishing pad, of which the preparation method is as follows.

[00219] At step 1, 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG were reacted to obtain an isocyanate-terminated prepolymer. The isocyanate-terminated prepolymer was heated to 25-65 °C, and degassed under vacuum (-0.095 MPa) for 2 hours to remove gases and small molecule compounds from the prepolymer. 1.83 parts by mass of hollow microsphere polymer 551DE40d42 with an average particle size of 40 μm was then added. The mixture was stirred to evenly disperse the hollow microsphere polymer in the prepolymer, degassed again under vacuum

(-0.095 MPa) for 2 hours, and set aside for later use.

[00220] At step 2, 27.06 parts by mass of polyamine composition B1 was heated to 115 °C and set aside for later use. The average molecular weight of the polyamine composition is 275.

[00221] At step 3, the prepolymer was mixed with the polyamine composition under high-speed shearing, and then cast into a circular mold to form a casting block with a thickness of 12 cm, which was left to stand at room temperature for 10 min, and then cured in an oven at 100 °C for 16 hours. After the curing was completed, the casting block was left to naturally cool down to room temperature in the oven, and then cut it into thin sheets with a thickness of 80 mil, totaling 60 sheets.

[00222] At step 4, a groove shape that was circular and had a blank (uncut) area in the center was selected and used for the grooves. The groove parameters were a groove depth of 30 mil, a groove width of 20 mil, a groove spacing of 120 mil, and a radius of the center blank area of 60-70 mm. After cutting grooves, the polishing layer was obtained.

[00223] At step 5, a double-sided tape was selected and used as the intermediate adhesive and the back adhesive layer. The polishing layer was bonded to the cushion layer by the intermediate adhesive, and the back adhesive layer was bonded on the other side of the cushion layer (the side where the polishing layer was not bonded) to obtain a polishing pad P1. A polyurethane-impregnated non-woven fabric material (SUBA) was used for the cushion layer.

[00224] Example 2

[00225] This Example provides a polishing pad P2, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 57.25 parts by mass of PTMEG650, and 2.1 parts by mass of DEG. The hollow microsphere polymer was 2.00 parts by mass of 551DE40d42 with an average particle size of 40 μm. The polyamine composition was 26.32 parts by mass of B1, with an average molecular weight of 275.

[00226] Example 3

[00227] This Example provides a polishing pad P3, which was prepared by the same

method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 51.84 parts by mass of PTMEG1400, and 7.51 parts by mass of DEG. The hollow microsphere polymer was 1.92 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.77 parts by mass of B2, with an average molecular weight of 279.

[00228] Example 4

[00229] This Example provides a polishing pad P4, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 53.6 parts by mass of PTMEG1000, and 5.76 parts by mass of DEG. The hollow microsphere polymer was 1.99 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 25.98 parts by mass of B3, with an average molecular weight of 271.

[00230] Example 5

[00231] This Example provides a polishing pad P5, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.84 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.51 parts by mass of B2, with an average molecular weight of 279.

[00232] Example 6

[00233] This Example provides a polishing pad P6, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.83 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.7 parts by mass of B3, with an average molecular weight of 271.

[00234] Example 7

[00235] This Example provides a polishing pad P7, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained

by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.84 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.35 parts by mass of B4, with an average molecular weight of 278.

[00236] Example 8

[00237] This Example provides a polishing pad P8, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.76 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 28.34 parts by mass of B5, with an average molecular weight of 288.

[00238] Example 9

[00239] This Example provides a polishing pad P9, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.69 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 28.98 parts by mass of B6, with an average molecular weight of 294.

[00240] Example 10

[00241] This Example provides a polishing pad P10, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 34.55 parts by mass of TDI100, 1.81 parts by mass of HMDI, and 63.64 parts by mass of PTMEG650. The hollow microsphere polymer was 2.27 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 25.68 parts by mass of B1, with an average molecular weight of 275.

[00242] Example 11

[00243] This Example provides a polishing pad P11, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 30.68 parts by mass of TDI100, 5.42 parts by mass of HMDI, and 63.9 parts

by mass of PTMEG650. The hollow microsphere polymer was 2.87 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 23.82 parts by mass of B4, with an average molecular weight of 278.

[00244] Example 12

[00245] This Example provides a polishing pad P12, which was prepared by the same method as Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 31.99 parts by mass of TDI100, 4.21 parts by mass of HMDI, and 63.8 parts by mass of PTMEG650. The hollow microsphere polymer was 2.65 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 23.97 parts by mass of B3, with an average molecular weight of 271.

[00246] Example 13

[00247] This Example provides a polishing pad, of which the preparation method is as follows.

[00248] At step 1, 20.1 parts by mass of TDI100, 8.3 parts by mass of HMDI, and 71.6 parts by mass of PTMEG1000 were taken, and 4.04 parts by mass of the hollow microsphere polymer 551DE40d42 with an average particle size of 40 μm and 18.05 parts by mass of polyamine composition B1 were added to allow them to react fully under stirring at 115 °C. The average molecular weight of the polyamine composition is 275.

[00249] At step 2, the resultant material from step 1 was mixed under high-speed shearing, then cast into a circular mold to form a casting block with a thickness of 12 cm, which was left to stand at room temperature for 10 min, and then cured in an oven at 100 °C for 16 hours. After the curing was completed, the casting block was left to naturally cool down to room temperature in the oven, and then cut it into thin sheets with a thickness of 80 mil, totaling 60 sheets.

[00250] At step 3, a groove shape that was circular and had a blank (uncut) area in the center was selected and used for the grooves. The groove parameters were a groove depth of 30 mil, a groove width of 20 mil, a groove spacing of 120 mil, and a radius of the center blank area of 60-70 mm. After cutting grooves, the polishing layer was obtained.

[00251] At step 4, a double-sided tape was selected and used as the intermediate adhesive

and the back adhesive layer. The polishing layer was bonded to the cushion layer by the intermediate adhesive, and the back adhesive layer was bonded on the other side of the cushion layer (the side where the polishing layer was not bonded) to obtain a polishing pad P13. A polyurethane-impregnated non-woven fabric material (SUBA) was used as the cushion layer.

[00252] Example 14

[00253] This Example provides a polishing pad P14, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 25.68 parts by mass of TDI100, 5.42 parts by mass of HMDI, 65.3 parts by mass of PTMEG1400, and 3.6 parts by mass of DEG. The hollow microsphere polymer was 3.16 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 20.94 parts by mass of B1, with an average molecular weight of 275.

[00254] Example 15

[00255] This Example provides a polishing pad P15, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 5.92 parts by mass of DEG, and 55.08 parts by mass of PTMEG1000. The hollow microsphere polymer was 1.83 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 25.12 parts by mass of Di-A and 1.79 parts by mass of Tri-A, with an average molecular weight of 273 and an average functionality of 2.04.

[00256] Example 16

[00257] This Example provides a polishing pad P16, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 5.92 parts by mass of DEG, and 55.08 parts by mass of PTMEG1000. The hollow microsphere polymer was 1.83 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 24.77 parts by mass of Di-A and 2.33 parts by mass of Tri-A, with an average molecular weight of 275 and an average functionality of 2.06.

[00258] Example 17

[00259] This Example provides a polishing pad P17, which was prepared by the same method as Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 5.92 parts by mass of DEG, and 55.08 parts by mass of PTMEG1000. The hollow microsphere polymer was 1.84 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition consists of 25.2 parts by mass of Di-A and 2.25 parts by mass of Tetra-A, with an average molecular weight of 279 and an average functionality of 2.08.

[00260] Example 18

[00261] This Example provides a polishing pad P18, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 57.25 parts by mass of PTMEG650, and 2.1 parts by mass of DEG. The hollow microsphere polymer was 2.00 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 24.51 parts by mass of Di-A and 2.19 parts by mass of Tetra-A, with an average molecular weight of 279 and an average functionality of 2.08.

[00262] Example 19

[00263] This Example provides a polishing pad P19, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 51.84 parts by mass of PTMEG1400, and 7.51 parts by mass of DEG. The hollow microsphere polymer was 2.00 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 23.51 parts by mass of Di-A, 2.21 parts by mass of Tri-A, and 0.91 parts by mass of M-CDEA, with an average molecular weight of 278 and an average functionality of 2.06.

[00264] Example 20

[00265] This Example provides a polishing pad P20, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 53.6 parts by mass of PTMEG1000, and 5.76 parts by mass of DEG. The hollow microsphere polymer was 1.98 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine

composition was 20.6 parts by mass of Di-A, 1.84 parts by mass of Tetra-A, and 2.73 parts by mass of DETDA, with an average molecular weight of 263 and an average functionality of 2.07.

[00266] Example 21

[00267] This Example provides a polishing pad P21, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 2.41 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.5 parts by mass of B1, with an average molecular weight of 275.

[00268] Example 22

[00269] This Example provides a polishing pad P22, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 57.25 parts by mass of PTMEG650, and 2.1 parts by mass of DEG. The hollow microsphere polymer was 2.94 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.76 parts by mass of B1, with an average molecular weight of 275.

[00270] Example 23

[00271] This Example provides a polishing pad P23, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 4.04 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.5 parts by mass of B1, with an average molecular weight of 275.

[00272] Example 24

[00273] This Example provides a polishing pad P24, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 4.7 parts by mass of

551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.35 parts by mass of B4, with an average molecular weight of 278.

[00274] Example 25

[00275] This Example provides a polishing pad P25, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 53.6 parts by mass of PTMEG1000, and 5.76 parts by mass of DEG. The hollow microsphere polymer was 6.06 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 25.98 parts by mass of B3, with an average molecular weight of 271.

[00276] Example 26

[00277] This Example provides a polishing pad P26, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 51.84 parts by mass of PTMEG1400, and 7.51 parts by mass of DEG. The hollow microsphere polymer was 9.08 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.77 parts by mass of B2, with an average molecular weight of 279.

[00278] Example 27

[00279] This Example provides a polishing pad P27, which was prepared by the same method as in Example 13, except that the raw materials include 34.55 parts by mass of TDI100, 3.81 parts by mass of HMDI, and 61.64 parts by mass of PPG600. The hollow microsphere polymer was 3.3 parts by mass of 461DE20d70 with an average particle size of 20 μm . The polyamine composition was 26.35 parts by mass of B1, with an average molecular weight of 275.

[00280] Example 28

[00281] This Example provides a polishing pad P28, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 38.5 parts by mass of TDI100, 3 parts by mass of HMDI, 53.4 parts by mass of PPG800, and 5.1 parts by mass of DEG. The hollow microsphere polymer was 2.6 parts by mass of 461DE20d70 with an average particle size of 20 μm . The polyamine

composition was 27.55 parts by mass of B2, with an average molecular weight of 279.

[00282] Example 29

[00283] This Example provides a polishing pad P29, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PPG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 3.16 parts by mass of 461DE20d70 with an average particle size of 20 μm . The polyamine composition was 26.7 parts by mass of B3, with an average molecular weight of 271.

[00284] Example 30

[00285] This Example provides a polishing pad P30, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, 5.33 parts by mass of DEG, and 0.34 parts by mass of glycerol. The hollow microsphere polymer was 1.74 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.06 parts by mass of B1, with an average molecular weight of 275 and a total average functionality of 2.04 for the polyamine composition and the polyol composition.

[00286] Example 31

[00287] This Example provides a polishing pad P31, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 56.05 parts by mass of PTMEG650, 1.89 parts by mass of DEG, and 0.12 parts by mass of xylitol. The hollow microsphere polymer was 1.64 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.68 parts by mass of B3, with an average molecular weight of 271 and a total average functionality of 2.03 for the polyamine composition and the polyol composition.

[00288] Example 32

[00289] This Example provides a polishing pad P32, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained

by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 56.49 parts by mass of PTMEG1400, 6.58 parts by mass of DEG, and 0.47 parts by mass of pentaerythritol. The hollow microsphere polymer was 2.26 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.46 parts by mass of B3, with an average molecular weight of 271 and a total average functionality of 2.05 for the polyamine composition and the polyol composition.

[00290] Example 33

[00291] This Example provides a polishing pad P33, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.93 parts by mass of PTMEG1000, 5.33 parts by mass of DEG, and 0.34 parts by mass of glycerol. The hollow microsphere polymer was 1.68 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.59 parts by mass of B4, with an average molecular weight of 278 and a total average functionality of 2.05 for the polyamine composition and the polyol composition.

[00292] Example 34

[00293] This Example provides a polishing pad P34, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 56.05 parts by mass of PTMEG1400, 6.39 parts by mass of DEG, and 0.65 parts by mass of xylitol. The hollow microsphere polymer was 2.07 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.78 parts by mass of B3, with an average molecular weight of 271 and a total average functionality of 2.08 for the polyamine composition and the polyol composition.

[00294] Example 35

[00295] This Example provides a polishing pad P35, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 56.49 parts by mass of PTMEG1400, 6.21 parts by mass of DEG, and 0.7 parts by mass of pentaerythritol. The hollow microsphere polymer was 1.91 parts by mass of 551DE40d42 with an average

particle size of 40 μm . The polyamine composition was 28.53 parts by mass of B5, with an average molecular weight of 288 and a total average functionality of 2.12 for the polyamine composition and polyol composition.

[00296] Example 36

[00297] This Example provides a polishing pad P36, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.93 parts by mass of PTMEG1000, 5.03 parts by mass of DEG, and 0.51 parts by mass of glycerol. The hollow microsphere polymer was 1.6 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 27.82 parts by mass of B4, with an average molecular weight of 278 and a total average functionality of 2.06 for the polyamine composition and the polyol composition.

[00298] Example 37

[00299] This Example provides a polishing pad P37, which was prepared by the same method as in Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 48.54 parts by mass of PTMEG3000, 9.19 parts by mass of DEG, and 0.93 parts by mass of mannitol. The hollow microsphere polymer was 1.82 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26.75 parts by mass of B2, with an average molecular weight of 279 and a total average functionality of 2.14 for the polyamine composition and the polyol composition.

[00300] Comparative Example 1

[00301] This comparative example provides a polishing pad, which was prepared as follows.

[00302] At Step 1, 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG were reacted to obtain an isocyanate-terminated prepolymer. The isocyanate-terminated prepolymer was heated to 25-65 $^{\circ}\text{C}$, and degassed under vacuum (-0.095 MPa) for 2 hours to remove gases and small molecule compounds from the prepolymer. 1.82 parts by mass of hollow microsphere polymer 551DE40d42 with an average particle size of 40 μm was then added. The mixture was stirred to evenly disperse

the hollow microsphere polymer in the prepolymer, degassed again under vacuum (-0.095 MPa) for 2 hours, and set aside for later use.

[00303] At step 2, 26.3 parts by mass of polyamine composition MOCA was heated to 115 °C and set aside for later use, with an average functionality of 2.0.

[00304] At step 3, the prepolymer was mixed with the polyamine composition under high-speed shearing, and then cast into a circular mold to form a casting block with a thickness of 12 cm, which was left to stand at room temperature for 10 min, and then cured in an oven at 100 °C for 16 hours. After the curing was completed, the casting block was left to naturally cool down to room temperature in the oven, and then cut it into thin sheets with a thickness of 80 mil, totaling 60 sheets.

[00305] At step 4, a groove shape that was circular and had a blank (uncut) area in the center was selected and used for the grooves. The groove parameters were a groove depth of 30 mil, a groove width of 20 mil, a groove spacing of 120 mil, and a radius of the center blank area of 60-70 mm. After cutting grooves, the polishing layer was obtained.

[00306] At step 5, a double-sided tape was selected and used as the intermediate adhesive and the back adhesive layer. The polishing layer was bonded to the cushion layer by the intermediate adhesive, and the back adhesive layer was bonded on the other side of the cushion layer (the side where the polishing layer was not bonded) to obtain a polishing pad PD1. A polyurethane-impregnated non-woven fabric material (SUBA) was used as the cushion layer.

[00307] Comparative Example 2

[00308] This comparative example provides a polishing pad PD2, which was prepared by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 2.17 parts by mass of 551DE40d42 with an average particle size of 40 μm. The polyamine composition was 37.34 parts by mass of M-CDEA, with an average functionality of 2.0.

[00309] Comparative Example 3

[00310] This comparative example provides a polishing pad PD3, which was prepared

by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 2.22 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 17.55 parts by mass of DETDA, with an average functionality of 2.0.

[00311] Comparative Example 4

[00312] This comparative example provides a polishing pad PD4, which was prepared by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.56 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 32.35 parts by mass of B8, with an average molecular weight of 329.

[00313] Comparative Example 5

[00314] This comparative example provides a polishing pad PD5, which was prepared by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 1.62 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 30.45 parts by mass of B7, with an average molecular weight of 309.

[00315] Comparative Example 6

[00316] This comparative example provides a polishing pad PD6, which was prepared by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 2.44 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 23.46 parts by mass of MOCA and 5.92 parts by mass of D2000, with an average molecular weight of 619 and an average functionality of 2.0.

[00317] Comparative Example 7

[00318] This comparative example provides a polishing pad PD7, which was prepared

by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 39.01 parts by mass of TDI100, 55.08 parts by mass of PTMEG1000, and 5.92 parts by mass of DEG. The hollow microsphere polymer was 2.64 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 23.46 parts by mass of MOCA, 4 parts by mass of D2000, and 1 part by mass of T5000, with an average molecular weight of 677 and an average functionality of 2.03.

[00319] Comparative Example 8

[00320] This comparative example provides a polishing pad PD8, which was prepared by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 56.05 parts by mass of PTMEG1000, 4.13 parts by mass of DEG, and 1.94 parts by mass of xylitol. The hollow microsphere polymer was 1.86 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 26 parts by mass of B3, with an average molecular weight of 271 and a total average functionality of 2.21 for the polyamine composition and the polyol composition.

[00321] Comparative Example 9

[00322] This comparative example provides a polishing pad PD9, which was prepared by the same method as in Comparative Example 1, except that the isocyanate-terminated prepolymer was obtained by reacting 32.65 parts by mass of TDI100, 8 parts by mass of HMDI, 28.03 parts by mass of PTMEG1000, 28.03 parts by mass of PTMEG650, 1.88 parts by mass of DEG, and 3.22 parts by mass of mannitol. The hollow microsphere polymer is 0.2 parts by mass of 551DE40d42 with an average particle size of 40 μm . The polyamine composition was 29.99 parts by mass of B7, with an average molecular weight of 309 and a total average functionality of 2.49 for the polyamine composition and the polyol composition.

[00323] The physical properties and performance parameters of the polishing pads of Examples 1-37 and Comparative Examples 1-9 are shown in Table 1.

[00324] Table 1

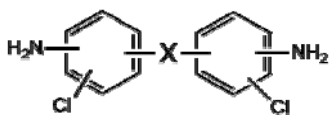
Polishing layers	Physical properties of polishing layers				Polishing pads	Removal rate of polishing pads ($\text{\AA}/\text{m in}$)					Life of polishing pads (h)	NU (%)	defect
	N CO (%)	Density (g/cm^3)	Hardness (D)	Free chloride ion content (ppm)		0h	5hrs	10hrs	15hrs	20hrs			
Ex. 1	9.50	0.81	63.1	92	P1	7900	7868	7835	7801	7770	42.5	6.71	○○
Ex. 2	9.25	0.79	60.5	94	P2	7644	7610	7578	7546	7515	42.4	6.60	○○
Ex. 3	9.25	0.80	61.3	209	P3	7722	7694	7665	7636	7607	40.9	6.66	○○
Ex. 4	9.25	0.79	60.3	65	P4	7616	7580	7544	7508	7470	43.4	6.58	○○
Ex. 5	9.50	0.81	63.4	214	P5	7934	7905	7877	7850	7823	40.8	6.81	○○
Ex. 6	9.50	0.81	62.8	61	P6	7874	7838	7801	7764	7728	43.1	6.68	○○
Ex. 7	9.50	0.81	63.3	186	P7	7919	7889	7859	7830	7799	41.8	6.77	○○
Ex. 8	9.50	0.82	64.4	374	P8	8029	8003	7977	7951	7927	39.4	6.85	○○
Ex. 9	9.50	0.83	65.1	482	P9	8104	8083	8061	8039	8016	37.5	6.88	○○
Ex. 10	9.02	0.76	57.7	91	P10	7634	7602	7569	7535	7504	42.4	6.55	○○
Ex. 11	8.28	0.70	50.2	198	P11	7485	7453	7423	7393	7363	41.7	6.48	○○
Ex. 12	8.53	0.72	52.4	67	P12	7528	7491	7454	7417	7379	43.3	6.51	○○
Ex. 13	6.34	0.60	32.8	99	P13	7136	7105	7073	7041	7008	42.5	6.44	○○
Ex. 14	7.35	0.67	42.7	98	P14	7333	7300	7268	7237	7206	42.7	6.47	○○
Ex. 15	9.50	0.81	62.9	84	P15	7884	7848	7812	7776	7741	42.8	6.68	○○
Ex. 16	9.50	0.81	63.1	168	P16	7904	7873	7841	7809	7777	42.3	6.71	○○
Ex. 17	9.50	0.81	63.3	354	P17	7919	7888	7857	7824	7794	42.7	6.72	○○
Ex. 18	9.25	0.79	60.7	357	P18	7659	7627	7596	7565	7535	42.7	6.66	○○
Ex. 19	9.25	0.79	60.6	847	P19	7647	7615	7581	7549	7516	42.3	6.65	○○
Ex. 20	9.25	0.79	60.7	514	P20	7656	7625	7594	7563	7531	42.9	6.66	○○
Ex. 21	9.50	0.75	60.4	90	P21	7623	7590	7557	7526	7494	42.6	6.56	○○
Ex. 22	9.25	0.70	56.5	95	P22	7545	7513	7480	7448	7416	42.3	6.48	○○
Ex. 23	9.50	0.62	54.6	91	P23	7507	7474	7442	7410	7377	42.0	6.45	○○
Ex. 24	9.50	0.58	52.9	186	P24	7474	7442	7412	7380	7351	41.4	6.43	○○
Ex. 25	9.25	0.51	47.7	68	P25	7368	7332	7295	7259	7222	43.1	6.41	○○
Ex. 26	9.25	0.41	43.8	201	P26	7290	7262	7233	7202	7175	40.7	6.39	○○
Ex. 27	9.25	0.80	61.0	91	P27	7636	7602	7570	7537	7505	42.1	6.66	○○
Ex. 28	9.52	0.85	65.3	201	P28	7722	7693	7663	7634	7604	40.4	6.74	○
Ex. 29	9.50	0.81	62.8	65	P29	7672	7635	7598	7562	7523	43.2	6.78	○○
Ex. 30	9.53	0.82	64.1	99	P30	8005	7972	7940	7909	7878	45.1	6.83	○○
Ex. 31	9.62	0.83	64.8	64	P31	8073	8037	7999	7963	7927	46.1	6.85	○
Ex. 32	9.04	0.77	58.5	66	P32	7439	7403	7367	7332	7295	45.8	6.50	○○
Ex. 33	9.53	0.83	64.9	188	P33	8077	8045	8015	7984	7955	44.7	6.85	○
Ex. 34	9.19	0.79	60.7	61	P34	7657	7621	7586	7550	7514	45.6	6.61	○○
Ex. 35	9.19	0.81	63.1	371	P35	7899	7875	7849	7825	7800	45.4	6.69	○○
Ex. 36	9.62	0.84	66.0	182	P36	8191	8162	8133	8105	8074	44.7	6.89	○
Ex. 37	9.31	0.81	63.5	211	P37	7945	7917	7890	7863	7837	43.9	6.79	○
C.Ex. 1	9.50	0.81	62.2	58	PD1	7004	6955	6905	6856	6805	39.2	9.14	×
C.Ex. 2	9.50	0.79	60.3	932	PD2	6787	6735	6681	6627	6574	39.4	9.21	×
C.Ex. 3	9.50	0.75	56.5	114	PD3	6697	6644	6590	6536	6482	38.1	9.35	×
C.Ex. 4	9.50	0.85	66.9	967	PD4	7884	7868	7850	7832	7814	35.1	9.61	×
C.Ex. 5	9.50	0.84	65.9	871	PD5	7779	7759	7739	7718	7697	36.4	9.51	×
C.Ex. 6	9.50	0.75	56.5	104	PD6	6871	6821	6771	6721	6670	39.1	10.48	×
C.Ex. 7	9.50	0.73	54.6	115	PD7	6964	6913	6861	6808	6757	39.4	10.44	×
C.Ex. 8	9.01	0.81	61.7	71	PD8	7234	7184	7134	7083	7033	38.5	12.71	×
C.Ex. 9	9.19	1.06	78.2	877	PD9	7651	7634	7615	7594	7576	37.4	12.25	×

[00325] For the Examples including the polyamine composition, the polishing pads have high removal rates, and the removal rate of the polishing pads decays less over time. The NU values are low, with almost no defects or very few defects, and the life is significantly improved compared to the Comparative Examples.

[00326] It is noted that, those skilled in the art to which the disclosure pertains can make changes and modifications to the above embodiments, based on the explanations and elaborations described above. Therefore, the disclosure is not limited to the specific embodiments disclosed and described above, and the equivalent modifications and changes to the disclosure shall also fall within the scope of protection of the claims of the disclosure. In addition, some specific terms are used in this specification, but these terms are only used for description in a convenient way and do not constitute any limitations to the disclosure.

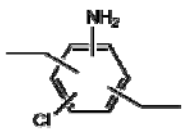
CLAIMS

1. A polishing pad, comprising a polishing layer, wherein the polishing layer comprises a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition, wherein the polyamine composition comprises one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos, an average molecular weight of the polyamine composition is between 200 and 400, and an average functionality of the polyamine composition is greater than 2 and not higher than 2.20, and wherein proportions of the diamines and the triamines relative to a total amount of the polyamine composition are 77%-96% : 3%-12%, respectively, in the polyamine composition.
2. A polishing pad, comprising a polishing layer, wherein the polishing layer comprises a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition, wherein the polyamine composition comprises one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos, an average molecular weight of the polyamine composition is between 200 and 400, and an average functionality of the polyamine composition is greater than 2 and not higher than 2.20, and wherein proportions of the diamines and tetraamines relative to a total amount of the polyamine composition are 77%-96% : 0.1%-10%, respectively, in the polyamine composition.
3. The polishing pad of claim 1, wherein the polyamines with more than 3 aminos comprise tetraamines, wherein a proportion of the tetraamines relative to the total amount of the polyamine composition is between 0.1% and 10%.
4. The polishing pad of any one of claims 1 to 3, wherein the diamines and/or triamines and/or polyamines with more than 3 aminos comprise a compound represented by Structural Formula 1:

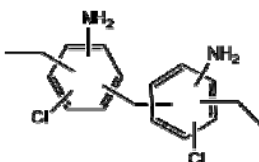


Structural Formula 1

in the Structural Formula 1, X represents a carbon atom or one or a combination of more of structural units represented by Structural Formula 2 or Structural Formula 3:



Structural Formula 2



Structural Formula 3.

5. The polishing pad of any one of claims 1 to 3, wherein the polyamine composition comprises free chloride ions in a content of less than 900 ppm.

6. The polishing pad of any one of claims 1 to 3, wherein a total average functionality of the polyol composition and the polyamine composition is not higher than 2.2.

7. The polishing pad of claim 6, wherein the multifunctional isocyanate comprises one or a combination of more of aromatic isocyanates or aliphatic isocyanates, wherein the aromatic isocyanates comprise one or a combination of more of 2,4-toluene diisocyanate, 2,6-toluene diisocyanate, 2,2'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 4,4'-diphenylmethane diisocyanate, 1,5-naphthalene diisocyanate, p-phenylene diisocyanate, m-phenylene diisocyanate, p-xylylene diisocyanate, or m-xylylene diisocyanate, and the aliphatic isocyanates comprise one or a combination of more of ethylene diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate, 1,6-hexamethylene diisocyanate, 1,4-cyclohexane diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, isophorone diisocyanate, or norbornane diisocyanate.

8. The polishing pad of claim 6, wherein the polyol composition comprises one or a combination of more of polytetramethylene ether glycol, polyethylene glycol, polypropylene glycol,

ethylene glycol, 1,3-butanediol, 1,4-butanediol, diethylene glycol, neopentyl glycol, 2-methyl-1,3-propanediol, hexanediol, 3-methyl-1,5-pentanediol, or 1,4-cyclohexanedimethanol.

9. The polishing pad of any one of claims 1 to 3, wherein the polishing layer has a density between 0.4 g/cm^3 and 1.1 g/cm^3 and a Shore hardness between 15D and 85D.

10. The polishing pad of any one of claims 1 to 3, wherein the polishing pad comprises a cushion layer, an adhesive layer, and a back adhesive layer, and the polishing pad is arranged to be the polishing layer, the adhesive layer, the cushion layer, and the back adhesive layer in sequence from top to bottom, wherein the adhesive layer is used for bonding the polishing layer to the cushion layer, the back adhesive layer is used for bonding the polishing pad to the polishing table, and the back adhesive layer further comprises a release paper or a release film.

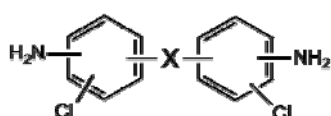
11. A polyamine composition, comprising one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos, wherein an average molecular weight of the polyamine composition is between 200 and 400, an average functionality of the polyamine composition is greater than 2 and not higher than 2.20, and wherein proportions of the diamines and the triamines relative to a total amount of the polyamine composition is 77%-96% : 3%-12%, respectively, in the polyamine composition.

12. A polyamine composition, comprising one and/or more of diamines and/or triamines and/or polyamines with more than 3 aminos, wherein an average molecular weight of the polyamine composition is between 200 and 400, an average functionality of the polyamine composition is greater than 2 and not higher than 2.20, and proportions of the diamines and tetraamines relative to a total amount of the polyamine composition is 77%-96% : 0.1%-10%, respectively, in the polyamine composition.

13. The polyamine composition of claim 11, wherein the polyamines with more than 3 aminos

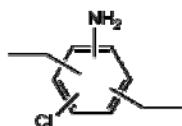
comprise tetraamines, wherein a proportion of the tetraamines relative to the total amount of the polyamine composition is between 0.1% and 10%.

14. The polyamine composition of any one of claims 11 to 13, wherein the diamines and/or triamines and/or polyamines with more than 3 aminos comprise a compound represented by Structural Formula 1:

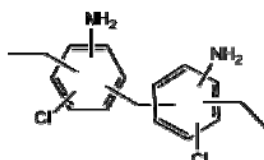


Structural Formula 1

in the Structural Formula 1, X represents a carbon atom or one or a combination of more of structural units represented by Structural Formula 2 or Structural Formula 3:



Structural Formula 2



Structural Formula 3.

15. The polyamine composition of any one of claims 11 to 13, wherein the polyamine composition comprises free chloride ions in a content of less than 900 ppm.

16. A polishing layer, obtained by reacting the polyamine composition of any one of claims 11 to 13 with a multifunctional isocyanate and a polyol composition.

17. A polishing pad, comprising a polishing layer, wherein the polishing layer comprises a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition, and wherein in a liquid chromatogram obtained by a liquid chromatography analysis of the polyamine composition under following conditions, a ratio of a peak area with a retention time of 7.0-7.8 min to a peak area with a retention time of 10-11 min is between 5 and 30:

liquid chromatography analysis conditions:

test sample: to 0.0204 g of the polyamine composition, methanol is added until a total mass of 20.0026 g is obtained; to 0.2 ml of a solution obtained thereby, methanol is added until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing; to 0.2 ml of the 100 ppm solution, methanol is added until a total volume of 2 ml is obtained, such that a 10 ppm solution is obtained by mixing;

chromatography column: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron, made by Agilent;

column temperature: 40 °C;

mobile phase: A (0.1% formic acid aqueous solution) : B(methanol)=20 : 80;

flow rate: 0.5 ml/min;

detector: a UV detector with a wavelength of 254 nm;

sample injection volume: 10 µl.

18. A polishing pad, comprising a polishing layer, wherein the polishing layer comprises a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition, wherein in a liquid chromatogram obtained by a liquid chromatography analysis of the polyamine composition under following conditions, a ratio of a peak area with a retention time of 7.0-7.8 min to a peak area with a retention time of 14.2-16 min is between 10 and 400:

liquid chromatography analysis conditions:

test sample: to 0.0204 g of the polyamine composition, methanol is added until a total mass of 20.0026 g is obtained; to 0.2 ml of a solution obtained thereby, methanol is added until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing; to 0.2 ml of the 100 ppm solution, methanol is added until a total volume of 2 ml is obtained, such that a 10 ppm solution is obtained by mixing;

chromatography column: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron, made

by Aglient;

column temperature: 40 °C;

mobile phase: A (0.1% formic acid aqueous solution) : B(methanol)=20 : 80;

flow rate: 0.5 ml/min;

detector: a UV detector with a wavelength of 254 nm;

sample injection volume: 10 µl.

19. A polishing pad, comprising a polishing layer, wherein the polishing layer comprises a polyurethane obtained by reacting a multifunctional isocyanate, a polyol composition, and a polyamine composition, wherein in a liquid chromatogram obtained by a liquid chromatography analysis of the polyamine composition under following conditions, a ratio of a peak area with a retention time of 7.0-7.8 min, to a peak area with a retention time of 10-11 min and to a peak area with a retention time of 14.2-16 min is 360-450 : 15-45 : 1-40;

liquid chromatography analysis conditions:

test sample: to 0.0204 g of the polyamine composition, methanol is added until a total mass of 20.0026 g is obtained; to 0.2 ml of a solution obtained thereby, methanol is added until a total volume of 2 ml is obtained, such that a 100 ppm solution is obtained by mixing; to 0.2 ml of the 100 ppm solution, methanol is added until a total volume of 2 ml is obtained, such that a 10 ppm solution is obtained by mixing;

chromatography column: ZORBAX Eclipse XDB-C18, 4.6*250 mm, 5-Micron, made by Aglient;

column temperature: 40 °C;

mobile phase: A (0.1% formic acid aqueous solution) : B(methanol)=20 : 80;

flow rate: 0.5 ml/min;

detector: a UV detector with a wavelength of 254 nm;

sample injection volume: 10 μ l.