

DESCRIPTION

TITLE OF THE INVENTION

POLISHING BODY AND RELATED MANUFACTURING METHOD

TECHNICAL FIELD

[0001] The present invention relates to a polishing body preferably used for polishing a chamfer or a surface of a semiconductor wafer, for instance, with a CMP method or the like, and a manufacturing method thereof.

BACKGROUND ART

[0002] In general, when a semiconductor element such as an LSI or the like is manufactured, a manufacturing method in which a large number of chips are formed on a thin disc-like semiconductor wafer and the wafer is cut in respective chip sizes on final step is adopted. Recently, manufacturing technologies on, for instance, VLSI have achieved improvement accompanied by a resultant dramatic advance in integration and an advancement in multi-layered wiring. Thus, steps of forming respective layers need to include performing planarization throughout a whole semiconductor wafer (global planarization). As one of techniques to realize the planarization throughout whole semiconductor wafer, a CMP (Chemical Mechanical Polishing) method has been employed. In the CMP method, a semiconductor wafer is pressed against a polishing pad such as an unwoven cloth or a foamed pad, etc., attached to a polishing platen, and is forcibly rotated. Slurry (a concentrated suspension with fine powder dispersed in a liquid such as, for instance, an alkaline aqueous solution) containing fine polishing particles, i.e., liberated grinding particles is supplied thereto. Then, polishing is performed. With such a CMP method, polishing work can be accomplished with high precision at increased efficiency due to a synergistic effect of chemical polishing, relying on a liquid component, and mechanical polishing relying on liberated grinding particles.

[0003] In the CMP method described above, polishing work has been conducted with steadily supplying slurry to the polishing pad, consequently, consumption of a large amount of slurry containing relatively expensive polishing particles has been needed. Since used slurry needs treatment as industrial waste, negligible disposal cost increases and such disposal has been unfavorable in view of environmental standpoint. Further, the most expensive factor affecting polishing work with the CMP method is the polishing particles contained in slurry while all of the polishing particles contained in slurry are necessarily

uninvolved in polishing work and a large number of the polishing particles are discarded in a noneconomic result. Therefore, the CMP method has a problem of bad economy.

[0004] With a view to addressing such defect, on the contrary, a polishing body of a fixed polishing-particle type has been developed to perform polishing work with the CMP method without using slurry. For instance, Patent Publication 1 discloses such a polishing pad (polishing body). Matrix resin such as, for instance, poly(vinyl fluoride) or the like, is dissolved into a solvent with which a large number of polishing particles such as silica or the like are mixed. Then, a disc-like compact is formed by cast molding. In this case, the matrix resin whose critical surface tension ranges from 1.6×10^{-2} to 4.0×10^{-2} (N/m) is used. This allows the polishing particles to be easily retained within net-like interconnected pores formed of the matrix resin, resulting in sufficient polishing efficiency and polishing performance without using slurry and providing a dramatic increase in the percentage of the polishing particles to contribute to the polishing of the semiconductor wafer. In view of a feature that the polishing particles are held under a relatively loose state, the polishing pad is also referred to as an LHA (Loosely Held Abrasive) pad.

[0005]

[Patent Publication 1] Patent No. 4266579

[0006] Meanwhile, in manufacturing the polishing pad (LHA pad) used for the CMP method of the related art mentioned above, the fluidic raw material in which the polishing particles are mixed with the matrix resin dissolved into the solvent is formed in a sheet-like configuration. Thereafter, at aging step and/or drying step, the solvent is removed from the fluidic raw material so that the sheet-like configuration is hardened, thereby a sheet-shaped compact body with a predetermined thickness is obtained.

[0007] However, depending on the method of manufacturing the polishing pad (LHA pad), it was difficult to manufacture the polishing pad having cavities (pores) larger in size than the interconnected pores during step of removing the solvent. The polishing pad may be conceivably applied with a production method in which, for instance, air bubbles are formed in the fluidic raw material and then, the fluidic raw material is hardened. Due to a certain amount of time for the fluidic raw material to be hardened after it is formed in the sheet-like configuration or high viscosity of the fluidic raw material, the air bubbles are distributed unevenly. Thus, it was difficult to allow the large-size cavities to be uniformly dispersed in the polishing body. Therefore, in Patent Publication 1 above, the polishing body had relatively high hardness and was difficult to have sufficient compressive deformation like that of a foamed pad used for a usual CMP method. As a result, it was possible that a semiconductor wafer surface had non-polished areas after the completion of polishing work.

SUMMARY OF THE INVENTION

[0008] The present invention has been completed with the above views in mind and has an object to provide a polishing body (LHA pad), used for polishing work in a CMP method, which exhibits an appropriate compressive elasticity against a polishing work due to the presence of pores that are internally formed, and a manufacturing method of the polishing body.

[0009] As a result of continuing dedicated studies and researches conducted by the present inventor to develop such a polishing body and manufacturing method thereof, it turns out that the polishing body can be internally formed with large-size pores capable of exhibiting sufficient compressive elasticity. This is accomplished by mixing water-soluble particles, insoluble to a solvent but soluble to water, into the fluidic raw material, removing the solvent, with the water-soluble particles remained intact to cause the matrix resin to be hardened, and then removing the water-soluble particles. The present invention has been completed on the ground of such an inspiration.

[0010] The object indicated above can be achieved according to a first mode of the invention, which provides (a) a polishing body formed in a circular disc, having a matrix resin and multiple polishing particles, for use in polishing work in a CMP method: (b) the matrix resin including a plurality of interconnected pores containing the polishing particles respectively, and a plurality of large-size pores isolated from each other by the interconnected pores and the matrix resin with a cross sectional area of the large-size pore in one cross section greater than that of the interconnected pore.

[0011] The object indicated above can be achieved according to a second mode of the invention, which provides the polishing body according to the first mode, wherein the large-size pores have an average pore diameter ranging from 0.05 to 0.2 (mm) and the polishing particles have a volumetric fraction ranging from 1 to 49 (%) with respect to the polishing body.

[0012] The object indicated above can be achieved according to a third mode of the invention, which provides the polishing body according to the first or second mode, wherein the polishing body has an ASKER C hardness ranging from 60 to 95 with a thickness of 4.5 (mm).

[0013] The object indicated above can be achieved according to a fourth mode of the invention, which provides the polishing body according to any one of the first to third modes, wherein the matrix resin has a critical surface tension ranging from 1.6×10^{-2} to 4.0

$\times 10^{-2}$ (N/m).

[0014] The object indicated above can be achieved according to a fifth mode of the invention, which provides the polishing body according to any one of the first to fourth modes, wherein the polishing particles have a weight fraction ranging from 2 to 90 (%) with respect to the polishing body.

[0015] The object indicated above can be achieved according to a sixth mode of the invention, which provides (a) a method of manufacturing a polishing body used for polishing work in a CMP method, the polishing body including a matrix resin and a large number of polishing particles and being formed in a circular disc, the method including: (b) a dissolving and mixing step for dissolving the matrix resin into a solvent and mixing water-soluble particles, insoluble to the solvent or having a solubility less than a predetermined limit with respect to the solvent, and the polishing particles to prepare a fluidic raw material; (c) a forming step for forming the fluidic raw material into a sheet-shaped compact with a predetermined thickness; (d) an aging step for aging the sheet-shaped compact, obtained at the forming step, with humidifying with moisture in air to cause the matrix resin to be gelatinized; (e) a solvent extracting step for extracting the solvent from an inside of the sheet-shaped compact, subjected to the aging step, by substituting with a saturated aqueous solution of the water-soluble particles to remove the solvent from the inside of the compact; (f) a water-soluble particle extracting step for extracting the water-soluble particles from the inside of the sheet-shaped compact, subjected to the solvent extracting step, by substituting with water to remove the water-soluble particles from the inside of the compact; and (g) a drying step for drying the sheet-shaped compact subjected to the water-soluble particle extracting step.

[0016] The object indicated above can be achieved according to a seventh mode of the invention, which provides the method of manufacturing a polishing body according to the sixth mode, wherein: (a) the water-soluble particles have an average particle diameter ranging from 0.05 to 0.2 (mm); and (b) the polishing particles are mixed in the dissolving and mixing step such that the polishing particles have a volumetric fraction ranging from 1 to 49 (%) with respect to the polishing body.

[0017] The object indicated above can be achieved according to an eighth mode of the invention, which provides the method of manufacturing a polishing body according to the sixth or seventh mode, wherein: the water-soluble particles in volume to allow the polishing body to have an ASKER C hardness ranging from 60 to 95 with a thickness of

4.5 (mm) of the polishing body are mixed in the dissolving and mixing step.

[0018] The object indicated above can be achieved according to a ninth mode of the invention, which provides the method of manufacturing a polishing body according to any one of the sixth to eighth modes, wherein the solvent is dimethylformamide and the water-soluble particles are made of sucrose or sodium chloride.

[0019] The object indicated above can be achieved according to a tenth mode of the invention, which provides the method of manufacturing a polishing body according to any one of the sixth to ninth modes, wherein the matrix resin has a critical surface tension ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m).

[0020] The object indicated above can be achieved according to a eleventh mode of the invention, which provides the method of manufacturing a polishing body according to any one of the sixth to tenth modes, wherein the polishing particles are mixed in the dissolving and mixing step such that the polishing particles have a weight fraction ranging from 2 to 90 (%) with respect to the polishing body.

[0021] According to the first mode of the invention, the polishing body of the invention includes matrix resin having the plurality of interconnected pores containing the polishing particles, and the plurality of large-size pores, whose one cross-sectional area is larger than that of the interconnected pores and which are isolated from each other by the interconnected pores and matrix resin. This enables the polishing body to exhibit appropriate compressive elasticity against the polishing work. Thus, it becomes possible to suppress the occurrence of non-polished area on the polishing work and the occurrence of scratches or the like during polishing work in contrast to a conventional LHA pad without the large-size pores and having relatively large hardness. The polishing body of the present invention maintains the polishing characteristics that are provided in the conventional LHA pad including polishing particles, matrix resin and interconnected pores. The polishing particles are present in the interconnected pores such that a part of the polishing particles are adhered onto inner walls of the interconnected pores or other part of the polishing particles are present in a state where the polishing particles in the interconnected pores are isolated from matrix resin. The polishing particles are easily liberated from matrix resin during polishing work with the CMP method and, in addition, the plural polishing particles are favorably dispersed in each of the interconnected pores. This results in an advantageous effect of accomplishing polishing work with increased precision with reduced risk of causing defect such as scratches (scar).

[0022] According to the second mode of the invention, the large-size pores have an average pore diameter ranging from 0.05 to 0.2 (mm) and, the large-size pores can be uniformly

dispersed to minimize unevenness of the surface of the polishing body due to the existence of the large-size pores. Then, it is possible to suppress the polishing body damage which is caused by the polishing object such as the semiconductor wafer or the like during polishing work. Further, the polishing particles have the volumetric fraction ranging from 1 to 49 (%) with respect to the polishing body. This results in an advantage that the polishing body has sufficient polishing efficiency and polishing performance during polishing work with the CMP method and that the polishing body can be easily formed during production. Furthermore, for a polishing body which has the large-size pores having the average pore diameter less than 0.05 (mm), as the particles to form the large-size pores, are likely to easily agglutinate, it is difficult to form the large-size pores to be uniformly dispersed in the polishing body. For a polishing body which has the large-size pores having the average pore diameter greater than 0.2 (mm), as a surface of the polishing body is likely to be locally cut with, for instance, an outer edge of the semiconductor wafer during polishing work, the polishing body is easily to be damaged. In addition, for a polishing body in which the polishing particles having the volumetric fraction less than 1 (%), it is difficult to obtain sufficient polishing efficiency and polishing performance. In contrast, for a polishing body in which the polishing particles having the volumetric fraction higher than 49 (%), it is difficult to form the polishing body in production. Moreover, the definition that the average pore diameter of the large-size pores belongs in a range ranging from 0.05 to 0.2 (mm) corresponds that an average diameter of particles which are supposed to fill the large-size pores belongs in a range from 0.05 to 0.2 (mm).

[0023] According to the third mode of the invention, the polishing body has a hardness ranging from ASKER C 60 to 95 for a thickness of 4.5 (mm). With such feature, the polishing body is capable of preventing from shortening a product life with a lowered hardness in contrast to a conventional LHA pad without the large-size pores. When the polishing body has the hardness falling below ASKER C 60 for the thickness of 4.5 (mm), the polishing body has an increasing abrasive wear in polishing process with the CMP method and product life thereof are decreased. When the polishing body has the hardness exceeding ASKER C 95 for the thickness of 4.5 (mm), there is a risk that the polishing body becomes too hard to exhibit adequate compressive elasticity against an object to be polished (polishing work).

[0024] According to the fourth mode of the invention, matrix resin have the critical surface tension of a value ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m) and, with such a characteristic, the matrix resin and the polishing particles are bonded to each other with proper bonding forces. Accordingly, in polishing work with the CMP method, thus, the polishing particles are easily liberated from matrix resin, then, the liberated grinding particles can be self-supplied between the polishing body and the polishing work. That is, it

becomes possible to provide the polishing body, used in polishing work with the CMP method, which exhibits sufficient polishing efficiency and polishing performance without the supply of slurry. Moreover, when the critical surface tension of matrix resin is less than 1.6×10^{-2} (N/m), the polishing body is likely to repel water needed for polishing work with the CMP method, and then, polishing efficiency is suppressed. When the critical surface tension exceeds 4.0×10^{-2} (N/m), the polishing particles become hard to be liberated during polishing work with the CMP method.

[0025] According to the fifth mode of the invention, the weight fraction of the polishing particles with respect to the polishing body falls in a value ranging from 2 to 90%. That is, the polishing body can exhibit adequate polishing efficiency and polishing performance during polishing work with the CMP method and, in addition, an advantageous effect arises that forming is easily executed in the production. Moreover, when polishing particles having the weight fraction in a range less than 2 (%) are used, it is difficult to obtain sufficient polishing efficiency and polishing performance, and when polishing particles having the weight fraction higher than 90(%) are used, it becomes difficult to be formed in production of the polishing body.

[0026] According to the sixth mode of the invention, the method of manufacturing the polishing body includes: (a) a dissolving and mixing step for dissolving the matrix resin into a solvent and mixing water-soluble particles, insoluble to the solvent or having a solubility less than a predetermined limit with respect to the solvent, and the polishing particles to prepare a fluidic raw material; (b) a forming step for forming the fluidic raw material into a sheet-shaped compact with a predetermined thickness; (c) an aging step for aging the sheet-shaped compact, obtained at the forming step, with humidifying with moisture in air to cause the matrix resin to be gelatinized; (d) a solvent extracting step for extracting the solvent from an inside of the sheet-shaped compact, subjected to the aging step, by substituting with a saturated aqueous solution of the water-soluble particles to remove the solvent from the inside of the compact; (e) a water-soluble particle extracting step for extracting the water-soluble particles from the inside the sheet-shaped compact, subjected to the solvent extracting step, by substituting with water to remove the water-soluble particles from the inside of the compact; and (f) a drying step for drying the sheet-shaped compact subjected to the water-soluble particle extracting step. Accordingly, by mixing the water-soluble particles as well as the polishing particles at the dissolving and mixing step, the large-size pores, substituted with the water-soluble particles can be uniformly dispersed inside the polishing body as well as the polishing particles. Further, not both of the solvent and the water-soluble particles are simultaneously removed from the

inside of the sheet-shaped compact body and the water-soluble particle extracting step is executed after the solvent extracting step. This appropriately precludes the occurrence of defect where the large-size pores are formed inadequately due to removal of the water-soluble particles from the matrix resin remained under a gelatinized (gelled) state. Further, the water-soluble particles are not soluble in the solvent or have solubility with a predetermined limit or less with respect to the solvent. In brief, almost none of the water-soluble particles are dissolved into the solvent. Therefore, the water-soluble particles nearly remain intact in their original shapes on a process up to a step preceding to the water-soluble particle extracting step. Thus, size of the large-size pores are easily determined by suitably selecting the average particle diameter of the water-soluble particles. Furthermore, since not water but a saturated aqueous solution of the water-soluble particles is used at the solvent extracting step, the water-soluble particles is not dissolved at the solvent extracting step and the water-soluble particles can remain intact on the process up to the completion of the solvent extracting step. Moreover, since a process is conducted, after the step of forming, in three stages including the gelation (gelling, gelatinization), the substitution of the solvent and the water-soluble particles, and the removal of moisture in sequence to uniformly accomplish the constriction, thereby occurrence of cracking or waviness of the polishing body is decreased favorably. At the solvent extracting step, when the solvent is removed from the gelled matrix resin, the matrix resin is shrunken (constricted) and hardened. Thus, a plurality of interconnected pores are formed in the matrix resin with a progress of the matrix resin being hardened. In addition, it is idealistic for the water-soluble particles not to be dissolved in the solvent for the purpose of forming the large-size pores. Thus, the predetermined limit of the solubility is set to represent solubility at which almost no water-soluble particle is dissolved in the solvent and, for example, is set such that the large-size pores, substituted for the water-soluble particles, are sized to the extent causing the polishing body to have sufficient compressive elasticity. Moreover, the predetermined thickness is determined to realize a product thickness of the polishing body in consideration of shrinkage of the sheet-shaped compact body.

[0027] According to the seventh mode of the invention, the water-soluble particles have the average particle diameter ranging from 0.05 to 0.2 (mm). Thus, the water-soluble particles can be uniformly dispersed in the sheet-shaped compact body, thereby an unevenness of a surface of the polishing body due to the large-size pores formed by removing the water-soluble particles at the water-soluble particle extracting step is minimized. This may

result in minimizing the occurrence of damage to the polishing body caused by the polishing work such as the semiconductor wafer or the like during polishing work. Further, the dissolving and mixing step includes mixing the polishing particles such that the polishing particles have a volumetric fraction ranging from 1 to 49 (%) with respect to the polishing body. This result in an advantage that the polishing body may exhibit sufficient polishing efficiency and polishing performance during polishing work with the CMP method and the formation of the polishing body is easily made in production.

[0028] According to the eighth mode of the invention, the water-soluble particles in volume to allow the polishing body to have the ASKER C hardness ranging from 60 to 95 with the thickness of 4.5 (mm) of the polishing body are mixed in the dissolving and mixing step. Accordingly, the polishing body is capable of having low hardness without occurrence of deterioration in product life in contrast to the conventional LHA pad without having the large-size pores. In addition, the greater the mixing ratio (in volume) of the water-soluble particles with respect to the fluidic raw material is, the greater is the volumetric fraction of the large-size pores, substituted for the water-soluble particles at the water-soluble particle extracting step, with respect to the polishing body. Then, the polishing body has lower hardness.

[0029] According to the ninth mode of the invention, the solvent is dimethylformamide and the water-soluble particles are made of sucrose or sodium chloride. Thus, the present invention can be applied to the production of a practical LHA pad, thereby the polishing particles can be easily obtained at low cost. In addition, when sucrose is used as the water-soluble particles, there is no risk that sodium remains in the polishing body.

[0030] According to the tenth mode of the invention, matrix resin have the critical surface tension of a value ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m) and, with such a characteristic, the matrix resin and the polishing particles are bonded to each other with proper bonding forces in the polishing body. Accordingly, in polishing work with the CMP method, thus, the polishing particles are easily liberated from matrix resin, then, the liberated grinding particles can be self-supplied between the polishing body and the polishing work. That is, it becomes possible to provide the polishing body, used in polishing work with the CMP method, which exhibits sufficient polishing efficiency and polishing performance without the supply of slurry. Moreover, when the critical surface tension of matrix resin is less than 1.6×10^{-2} (N/m), the polishing body is likely to repel water needed for polishing work with the CMP method, and then, polishing efficiency is suppressed. When the critical surface tension exceeds 4.0×10^{-2} (N/m), the polishing particles become hard to be

liberated during polishing work with the CMP method. In other words, with matrix resin having the critical surface tension equal to or less than 4.0×10^{-2} (N/m), when matrix resin is caused to shrink and be hardened to form the interconnected pores in the solvent extracting step, the polishing particles are disposed inside the interconnected pores in a manner where the polishing particles do not penetrate into matrix resin and remain in the liberated states or where the polishing particles are bonded to matrix resin to be easily liberated during polishing work with the CMP method. Therefore, the polishing body which can suitably self-supply liberated grinding particles as set forth above can be manufactured.

[0031] According to the eleventh mode of the invention, the polishing particles are mixed in the dissolving and mixing step such that the polishing particles have a weight fraction ranging from 2 to 90 (%) with respect to the polishing body. This results in an advantage that the polishing body exhibits sufficient polishing efficiency and polishing performance during polishing work with the CMP method and that the formation can be easily made in production of the polishing body.

[0032] Here, the matrix resin may preferably include at least one of poly(vinyl fluoride), copolymer of vinyl fluoride and hexafluoropropylene, poly(vinylidene fluoride), copolymer of vinylidene fluoride and hexafluoropropylene, polyethylene and poly(methyl methacrylate). With such composition, the matrix resin has necessarily sufficient critical surface tension as well as excellent material strength. Then, there is an advantage that a practical polishing body can be obtained.

[0033] Further, the polishing particles may preferably include at least one of silica, ceria, alumina, zirconia, titania, manganese oxide, barium carbonate, chromium oxide and ferric oxide. With such composition, there is an advantage that a practical polishing body can be obtained due to the presence of the polishing particles with hardness depending on the polishing work.

[0034] Furthermore, the water-soluble particles may preferably include fine particles subjected to pulverization. With such structure, because the water-soluble particles are non-uniform or irregular in individual particle surface relative to the particles of crystal bodies, the water-soluble particles are less likely to agglutinate with each other. Accordingly, the water-soluble particles can be dispersed more uniformly in the sheet-shaped compact body than crystal particles.

[0035] Moreover, the forming step may preferably include casting by pouring the fluidic raw material into a casting mold such that the fluidic raw material is formed in a sheet-shape with a predetermined thickness.

[0036] Besides, at the aging step, humidifying may preferably executed for the sheet-shaped

compact body, formed at the forming step, at the relative humidity ranging from 50 to 95 % for about 15 to 20 hours. With such treatment, under a circumstance where the matrix resin is composed of, for instance, poly(vinyl fluoride) or the like, the matrix resin can be uniformly gelled with increased efficiency and homogeneity after the forming step.

[0037] Further, the aging step may preferably include: (a) first aging step humidifying the sheet-shaped compact body, formed at the forming step, at the relative humidity ranging from 70 to 95 (%) for 1.5 to 6 hours; and (b) second aging step holding the compact, subjected to the first aging step, under an airtight condition. With such steps, under a circumstance where the matrix resin is composed of, for instance, polyether sulphone (PES) resin or the like, the matrix resin can be gelled with increased efficiency and homogeneity after forming.

[0038] Furthermore, the solvent extracting step may preferably include immersing the sheet-shaped compact body in a saturated aqueous solution of the water-soluble particles for constricting the matrix resin. With such treatment, in the matrix resin, the solvent can be isolated, and favorably substituted with the saturated aqueous solution to be removed from the matrix resin without the drying step, thereby favorably preventing the occurrence of cracking on the surface due to localized constriction thereof caused by drying. At the solvent extracting step, moreover, the sheet-shaped compact body is immersed in the saturated aqueous solution to cause the solvent in the matrix resin to be substituted for the saturated aqueous solution such that the matrix resin is caused to constrict. This allows the matrix resin to be formed with the plural interconnected pores. In this case, the polishing particles are present in the interconnected pores in a state partly bonded to inner walls of the interconnected pores or in another state separated from the matrix resin and filled in the interconnected pores. Thus, a plurality of the polishing particles are uniformly dispersed in the interconnected pores. In addition to that, the polishing particles are further easily liberated from the matrix resin during polishing work with the CMP method. This results in an advantage that a polishing work can be performed with high precision and without causing any defect such as cracking (scarring) or the like.

[0039] Furthermore, as the drying step may preferably include holding the sheet-shaped compact body under atmosphere with a sheet-like water absorbing material intervening in a stacked state, thereby the sheet-shaped compact body can be uniformly dried with increased efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] FIG. 1 is a perspective view showing a sheet-like polishing body of one embodiment according to the present embodiment used for polishing work in a CMP method.

FIG. 2 is a view showing an appearance of a surface of the polishing body, shown in FIG. 1, magnified by a scanning electron microscope.

FIG. 3 is a view showing an appearance of the surface of the polishing body, shown in FIG. 2, with an area A, where large-scale pores are absent, magnified by the scanning electron microscope at a higher magnification rate than that of in FIG. 2.

FIG. 4 is a view typically showing the polishing body, shown in FIG. 1, with a structure being magnified.

FIG. 5 is a plan view of a polishing apparatus, as viewed in an axial direction of a polishing platen, for showing an essential structure of the polishing apparatus operative in the CMP method to which the polishing body, shown in FIG. 1, is used.

FIG. 6 is a front view of the polishing apparatus shown in FIG. 5.

FIG. 7 is a process chart of a first embodiment illustrating a method of manufacturing the polishing body shown in FIG. 1.

FIG. 8 is a view showing the relationship between a hardness of the polishing body obtained in the manufacturing method of the polishing body shown in FIG. 7, and a volumetric fraction of water-soluble particles mixed in such a manufacturing process with respect to the polishing body.

FIG. 9 is a process chart of a second embodiment, illustrating a method of manufacturing the polishing body shown in FIG. 1, which corresponds to FIG. 7.

BEST MODE FOR CARRYING OUT THE INVENTION

[0041] One embodiment of the present invention will be described below in detail with reference to the accompanying drawings. In the embodiment described below, drawing figures are suitably simplified or modified, and various parts are not necessarily described in dimensional ratio and shape or the like with accuracy.

[Embodiment 1]

[0042] FIG. 1 is a perspective view showing a polishing body 10 of one embodiment of the present invention. As shown in this drawing figure, the polishing body 10 of the present embodiment includes a matrix resin 12 and a large number of polishing particles 14 and is formed in a disc-shape with a dimension of, for instance, an outer diameter of approximately 300 (mm ϕ) $\times$ thickness of 5 (mm). As described below, the polishing body 10 is attached to a polishing platen 20 of a polishing apparatus 18, and mainly used for a polishing process in a CMP (Chemical Mechanical Polishing) method.

[0043] The matrix resin 12 preferably includes a synthetic resin material having a critical surface tension γ_{CL} (a surface tension at $\theta = 0$, i.e., $\cos \theta = 1$ that is obtained by extrapolation of a straight line corresponding to plots of a relation between a contact angle

θ and a surface tension γ_L when a variety of low-molecular liquids are placed on a high polymer surface) ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m). That is, examples of such a matrix resin 12 may be, for instance, poly(vinylidene difluoride). However, the matrix resin 12 may be at least one of other resins such as, for instance, poly(vinyl fluoride), copolymer of vinyl fluoride and hexafluoropropylene, copolymer of vinylidene fluoride and hexafluoropropylene, polyethylene and poly(methyl methacrylate). Examples of polyethylene may preferably include those which have a molecular weight of one million or larger.

[0044] Further, although the polishing particles 14 may preferably have an average particle diameter ranging from 0.05 to 10 (μm) and include, for instance, silica. However, the polishing particle may include at least one of, for instance, ceria, alumina, zirconia, titania, manganese oxide, barium carbonate, chromium oxide and ferric oxide. For instance, fumed silica (such as silica fine particles obtained by combusting silicon tetrachloride or chlorosilane at high temperatures in the presence of hydrogen and oxygen) may preferably be employed as examples of the silica. The polishing particles 14 may preferably have a volumetric fraction ranging from 1 to 49 (%) and a weight fraction ranging from 2 to 90 (%) with respect to the polishing body 10 respectively. When polishing particle having the volumetric fraction in a range less than 1 (%) or having the weight fraction in a range less than 2 (%) are used, it is difficult to obtain sufficient polishing efficiency and polishing performance. In contrast, when polishing particles having the volumetric fraction higher than 49 (%) or having the weight fraction higher than 90 (%) are used, it is difficult to be formed in production. In addition, the particle diameters of the polishing particles 14 are measured using a laser diffraction and scattering method, i.e., measured by, for instance, a particle size and particle size distribution measuring device "Microtrack MT 3300" manufactured by, for instance, Nikkiso. The average particle diameter may refer to an arithmetic average of the particle diameters. This similarly applies to the particle diameter of the other particles in the present embodiment. The particle diameter, falling below measurement limitation of the laser diffraction and scattering method, may be measured in a dynamic light scattering method, using, for instance, a particle size and particle size distribution measuring device "Nanotrack UPA-EX250" manufactured by, for instance, Nikkiso.

[0045] FIGS. 2 and 3 are views showing the surface of the polishing body 10 of the present embodiment enlarged by a differential interference microscope. FIG. 3 is a view showing an encircled area A, in which there are not large-size pores 11 in the surface of the polishing body 10 shown in FIG. 2, which is scaled up at a higher magnification rate than FIG. 2. As shown in FIG. 2, the large-size pores 11 are uniformly scattered on the surface of or in an internal area of the polishing body 10. As shown in FIG. 3, further, matrix resin 12 is formed in a fibrous shape whose an average cross-sectional diameter is approximately 0.05 (μm), for

instance,. The polishing particles 14, having, for instance, an average particle diameter of approximately 0.25 (μm), are present in clearances of matrix resin 12, where some part of the polishing particles 14 are adhered onto outer peripheries of matrix resin 12 or other part of the polishing particles 14 are present in the clearances isolated from matrix resin 12. That is, the fibrous matrix resin 12 have an average cross-sectional diameter in the order of, for instance, one tenth or one third of the average particle diameter of the polishing particles 14. Thinking that the clearances among the fibrous matrix resin 12 correspond to a plurality of interconnected pores (pores) 16, it can be said that the polishing particles 14 are provided in the interconnected pores 16. A volumetric fraction of the interconnected pores 16 relative to the polishing body 10 falls in a value ranging, for instance, from 15 to 60 (%). The polishing body 10 of the present embodiment has a hardness varying such that the greater the volumetric fraction of the large-size pores 11 with respect to the polishing body 10, the less will be the hardness. Preferably, the polishing body 10 has the hardness in a value ranging from 60 to 95 in terms of ASKER C with a thickness of 4.5 (mm). This hardness is specified in a Standard Specification (SRIS) under Specification No. SRIS 0101 of The Japan Rubber Association. The hardness is measured by pressing a measuring element of a hardness meter onto a disc-like polishing body 10 in thickness direction thereof, i.e., in an axial direction. When the polishing body 10 has the hardness falling below ASKER C 60 for the thickness of 4.5 (mm), the polishing body 10 has an increasing abrasive wear when subjected to polishing process with the CMP method and product life thereof is decreased. When the polishing body 10 has the hardness exceeding ASKER C 95 for the thickness of 4.5 (mm), the polishing body 10 becomes too hard with a difficulty caused in exhibiting adequate compressive elasticity against an object to be polished (polishing work), which causes a risk of ununiform surface pressure being applied to the polishing work.

[0046] FIG. 4 is a view typically showing a structure of the polishing body 10 of the present embodiment. As shown in this drawing figure, the polishing particles 14 are present in a state where some part of the polishing particle 14 are adhered onto inner walls of the interconnected pores 16 or other part are isolated from matrix resin 12 within the interconnected pores 16. That is, as shown in FIGs. 3 and 4, the respective interconnected pores 16 are formed in matrix resin 12 including the polishing particles 14 therein. As shown in FIGs. 2 and 4, further, a plurality of large-size pores 11, having a sufficiently larger cross-sectional surface area on one cross-section than that of the interconnected pores 16, are uniformly scattered and provided in the polishing body 10, and they are isolated by the interconnected pores 16 and/or matrix resin 12. The interconnected pores 16 and matrix resin 12 are formed to be held in contact with the large-size pores 11, i.e., in a state so as to surround the large-size pores 11. In such a way, the polishing body 10 of the present embodiment has the hardness, providing an appropriate compressive elasticity against the

polishing work, which falls, for instance, in a value ranging from ASKER C 60 to 95 for the polishing body 10 having a thickness of 4.5 (mm) due to the large number of large-size pores 11. Further, a structure is provided to allow the polishing particles 14 to be easily released from matrix resin 12 during polishing work with the CMP method that will be described later. To describe more in detail, matrix resin 12 has a critical surface tension γ_{CL} ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m) and matrix resin 12 and the polishing particles 14 are adhered to each other with a necessary and sufficient bonding force. Therefore, the polishing body 10 can appropriately self-supply (supply by itself) liberated grinding particles, i.e., isolated polishing particles 14 between the polishing body 10 and the polishing work. That is, although it is indispensable for polishing work with the conventional CMP method to be supplied with slurry containing, for instance, colloidal silica, the polishing body 10 of the present embodiment is capable of performing polishing work in the CMP method with the supply of polishing liquid with no inclusion of liberated grinding particles, i.e., without supplying such slurry. Here, preferably, the large-size pores 11 have an average pore diameter ranging from 0.05 to 0.2 (mm). The presence of the large-size pores 11 having the average pore diameter ranging from 0.05 to 0.2 (mm) corresponds to the fact that when assuming particles, i.e., water-soluble particles PL_{WS}, described later, that fill the large-size pores 11, those particles (water-soluble particles PL_{WS}) have an average diameter ranging from 0.05 to 0.2 (mm). When the large-size pores 11 have the average pore diameter less than 0.05 (mm), it is difficult that large-size pores 11 are dispersed uniformly in the polishing body 10 because the water-soluble particles PL_{WS} which form the large-size pores 11 tend to coagulate. In addition, the amount of the water-soluble particles PL_{WS} used for the polishing body 10 is increased to have a desired hardness, thus, production cost of the polishing body 10 is increased. Moreover, when the large-size pores 11 have the average pore diameter greater than 0.2 (mm), the polishing body 10 is easily damaged such as a surface of the polishing body 10 being locally cut by an outer edge of a semiconductor wafer 26, for example, then, a product life of the polishing body 10 may be decreased. In addition, because the polishing body 10 has a surface with increased surface roughness, and therefore polished debris occurring during polishing work are increased. A feeling of quality and usability of the polishing body 10 as a product is degraded.

[0047] FIGs. 5 and 6 are schematic views showing structures of essential parts of a polishing apparatus 18 based on the CMP method in which the polishing body 10 of the present embodiment is used. FIG. 5 is a plan view viewed in an axial direction of a polishing platen 20 and FIG. 6 is a front view. As apparent from these drawing figures, in the polishing apparatus 18, the polishing platen 20 is provided in a state where the polishing platen 20 is supported to be rotatable about an axis of the polishing platen 20. The polishing platen 20 is

rotatably driven by a platen driving motor, not shown, in one rotating direction indicated by an arrow in the drawing figure. The polishing platen 20 has an upper surface, i.e., a surface, onto which the polishing work is pressed, to which the polishing body 10 of the present embodiment is attached. Meanwhile, a workpiece holding member 22 for holding the polishing work (workpiece) is placed in the vicinity of the polishing platen 20 in a state where the workpiece holding member 22 is supported to be rotatable about the axis thereof and to be moveable in the axial direction thereof. The workpiece holding member 22 is rotatably driven by a workpiece driving motor, not shown, in one rotating direction as indicated by an arrow in the drawing figure. Such workpiece holding member 22 has a lower surface, i.e., a surface facing the polishing body 10, which a semiconductor wafer 26, serving as the polishing work, is attached to and held with by means of an adsorption layer 24. In addition, a polishing liquid supply nozzle 28 is placed in the vicinity of the workpiece holding member 22 such that the polishing liquid supply nozzle 28 allows polishing liquid in the form of an alkaline or acidic aqueous solution, delivered from a tank, which is not shown, during polishing work.

[0048] In conducting polishing work with the CMP method, the platen drive motor and the workpiece drive motor operate to rotatably drive the polishing platen 20 with the polishing body 10 attached thereto and the workpiece holding member 22 with the semiconductor wafer 26 attached thereto, about the axes of the respective component parts respectively. In such a state, the semiconductor wafer 26 adsorbed and held to the workpiece holding member 22 is pressed against the polishing body 10 while the polishing liquid supply nozzle 28 is operated to supply polishing liquid such as, for instance, an amine solution or the like onto the surface of the polishing body 10. By so doing, a polishing surface, i.e., a surface facing the polishing body 10, of the semiconductor wafer 26 is polished to be planar due to chemical polishing action caused by the polishing liquid and a mechanical polishing action caused by the polishing particles 14 self-supplied from the polishing body 10.

[0049] As shown in FIGs. 5 and 6, further, the polishing apparatus 18 includes an adjustment tool holding member 30 disposed to be rotatable about an axis parallel to an axis of the polishing platen 20 and moveable in such axial direction and a radial direction of the polishing platen 20, and a polishing body adjustment tool 32 mounted on a lower surface of the adjustment tool holding member 30, e.g., a surface facing the polishing body 10. The adjustment tool holding member 30 and the polishing body adjustment tool 32 are pressed against the polishing body 10 in a state where the adjustment tool holding member 30 and the polishing body adjustment tool 32 are drivably rotated by an adjustment tool drive motor that is not shown. The adjustment tool holding member 30 and the polishing body adjustment tool 32 are moved reciprocatingly in the radial direction of the polishing platen 20 depending on needs. As described above, the adjustment of the polishing body 10 is conducted to allow

the polishing body 10 to have a surface condition maintained in an appropriate state for polishing work.

[0050] FIG. 7 is a flow chart showing a method of manufacturing the polishing body 10 of the present embodiment. The method of manufacturing the polishing body 10 will be described below in accordance with this drawing figure. First, at dissolving step P1, matrix resin 12 is dissolved in a solvent SLV such as, for instance, DMF (dimethylformamide) or the like. That is, for instance, matrix resin 12 and the solvent SLV are fed into a stirring apparatus, and the mixture is mixed and stirred while applying heat at temperatures of approximately 40 to 60°C for obtaining a fluidic raw material. Here, matrix resin 12 and the solvent SLV preferably have a volumetric fraction in the order of about 1 : 4 to 1 : 6. The solvent SLV function to increase formability at forming step P3 that will be described below and to form the interconnected pores 16 in matrix resin 12 at aging step P4 and solvent extracting step P51. The amount of solvent SLV fed at dissolving step P1 involves in a volumetric fraction of the interconnected pores 16 in the polishing body 10 after forming. If matrix resin 12 and the solvent SLV have the volumetric fraction to the extent mentioned above, the polishing body 10 is formed with the interconnected pores 16 in volumetric fraction of approximately 30 to 40 (%) after forming.

[0051] Next at mixing and stirring step P2, the polishing particles 14 and a water-soluble particles PL_{WS} are added to the fluidic raw material for mixing and stirring. This can be preferably achieved by using, for instance, continuously the stirring apparatus used at dissolving step P1, and feeding the polishing particles 14 and the water-soluble particles PL_{WS} to the fluidic raw material for mixing and stirring. Here, preferably, the amount of the polishing particles 14 to be fed is determined such that the polishing particles 14 has a volumetric fraction falling in a range from 1 to 49 (%) with respect to the polishing body 10 and a weight fraction falling in a range from 2 to 90 (%). Moreover, preferably, the amount of the polishing particles 14 and the amount of water-soluble particles PL_{WS} to be fed are determined such that a sum of the polishing particles 14 and the water-soluble particles PL_{WS} has a volumetric fraction being in a range from 2 to 50 (%) with respect to the polishing body 10. If the volumetric fraction of the sum of the polishing particles 14 and the water-soluble particles PL_{WS} with respect to the polishing body 10 is higher than 50 (%), it becomes difficult to form the polishing body 10 at forming step P3 explained later. Further, with a view that the water-soluble particles PL_{WS} to be mixed may contribute to a reduction in hardness of the polishing body 10, it is preferred that the water-soluble particles PL_{WS} has the volumetric fraction of 1 (%) or more with respect to the polishing body 10. The polishing particles 14 preferably have the volumetric fraction falling in the range from 1 to 49 (%) with respect to the polishing body 10 as stated above. Therefore, the sum of the polishing particles 14 and the water-soluble particles PL_{WS} preferably has a lower limit of the

volumetric fraction of 2 (%) with respect to the polishing body 10. The dissolving step P1 and the mixing and stirring step P2 correspond to dissolving and mixing step of the present invention.

[0052] The water-soluble particles PL_{ws} may be preferably water-soluble but it is preferable not to be dissolved in the solvent SLV with a view to forming the large-size pores 11. However, it doesn't matter if the solubility of the water-soluble particles PL_{ws} relative to the solvent SLV is equal to or smaller than a limit, determined experimentally in advance where, for instance, almost no water-soluble particles PL_{ws} are dissolved in the solvent SLV in a process up to water-soluble particle extracting step P52 described later and the water-soluble particles PL_{ws} nearly remain in original forms. In particular, the water-soluble particles PL_{ws} is sucrose (sugar and cane sugar), the water-soluble particles PL_{ws} may be a salt such as, for instance, sodium chloride or the like that is water-soluble. The water-soluble particles PL_{ws} may take the form of crystal bodies such as granulated sugar or the like or particles obtained by pulverizing treatment to form fine particulates such as powdered sugar. However, for the purpose of causing individual water-soluble particles PL_{ws} to be uniformly dispersed with no aggregation, the water-soluble particles PL_{ws} should be better to take the form of particles obtained by pulverizing treatment to form fine particulates. The water-soluble particles PL_{ws} have an average particle diameter falling in the same range as that of the average pore diameter of the large-size pores 11 and preferably falling in a value ranging from 0.05 to 0.2 (mm). Further, the greater the volumetric fraction of the water-soluble particles PL_{ws} with respect to the polishing body 10 is, the lower will be the hardness of the polishing body 10. Thus, the amount of the water-soluble particles PL_{ws} to be fed at mixing and stirring step P2 is determined so that the hardness of the polishing body 10 fall in a value ranging from ASKER C 60 to 95 for the polishing body 10 having a thickness of 4.5 (mm).

[0053] The fluidic row material, obtained at dissolving step P1 and mixing and stirring step P2, is subjected to subsequent forming step P3 at which the fluidic row material is scraped into a predetermined thickness by means of a doctor blade or pushed out of a elongated shaped flat nozzle of a T-die (of a flat nozzle type) into the predetermined thickness. Thus, the fluidic row material is shaped into a sheet-like configuration on a flat belt made of flattened steel or a shaping plate made of flattened aluminum alloy that are moved relative to the doctor blade or the T-die. The predetermined thickness is set to realize a product thickness of the polishing body 10 in consideration of, for instance, shrinkage induced in a sheet-shaped compact body due to drying thereof or the like.

[0054] At subsequent aging step P4, the sheet-shaped compact body (compact product), formed at forming step P3, is humidified with moisture in air to achieve the gelation of matrix resin 12. For instance, the sheet-shaped compact body, formed at forming step P3, is

placed under a relatively hermetic environment (in a sealed airspace, covered with a resin sheet, or a sealed container) which is controlled in moisture such that a relative humidity falls in a value ranging from 50 to 95 % at, for instance, a normal temperature of 20°C and under normal pressures and held for a time interval of, for instance, 15 to 20 hours, i.e., more preferably, for a time interval of 18 hours. Then, while the evaporation of the solvent SLV is suppressed, the matrix resin 12 contained in the sheet-shaped compact body to gradually precipitated for adequate gelation. With the sheet-shaped compact body (hereinafter referred to as a “sheet-shaped compact”), the solvent SLV has a low dissolving power with respect to matrix resin 12 due to existence of moisture and matrix resin 12 dissolved in the solvent SLV have a nature to be hardened (gelled). Further, when the solvent SLV, in which matrix resin 12 is dissolved, is volatilized with a resultant increase in concentration of the solvent SLV, the hardening (gelation) of the matrix resin 12 is accelerated. The hardening (gelation) of the matrix resin 12 is accelerated at a surface layer and that causes uneven gelation as a whole. Then, that may be a cause of waviness or cracking of the polishing body 10 at the surface thereof. At aging step P4, therefore, the sheet-shaped compact is kept under relatively hermetic environment that is controlled in moisture at a relative humidity of 50% or more and 95% or less not to cause the occurrence of dew condensation for a time interval of approximately 15 to 20 hours. This allows matrix resin 12 to be exposed to humidified air, under which moisture in the form of steam in air is supplied into matrix resin 12 and then, the gelation of matrix resin 12 is performed uniformly. At this stage, matrix resin 12 remains in a swelling state containing the solvent SLV and no interconnected pores 16 are formed.

[0055] If the relative humidity exceeds 95%, then, locally condensed water may be brought into contact with the sheet-shaped compact and resultantly localized hardening may occur. If the relative humidity is less than 50%, then, not only a difficulty is encountered in obtaining a speed of the gelation but also the waviness of the sheet-shaped compact occurs due to accelerating the drying of the sheet-shaped compact at the surface layer thereof. The normal temperature is not limited to the temperature of approximately 20°C but may include temperatures ranging from 15°C to 30°C. In addition, the hermitic environment, under which the solvent SLV, in which the matrix resin 12 is dissolved, is prevented from volatilizing, may achieved in a way to maintain a vapor pressure of the solvent SLV in atmospheric air in the vicinity of the sheet-shaped compact to a level closer to a saturated vapor pressure. Therefore, the hermitic environment may take a form in which the neighborhood of the sheet-shaped compact is covered with a resin sheet to sustain the humidified environment as mentioned above and no such a strict air tightness is required.

[0056] At subsequent solvent extracting step P51, the solvent SLV, remaining in the sheet-shaped compact subjected to aging step P4, is substituted for a saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS}, and the solvent SLV is removed from

the sheet-shaped compact. More particularly, the sheet-shaped compact, in which matrix resin 12 is gelled at aging step P4, is immersed in the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} to allow the solvent SLV in matrix resin 12 to be substituted for the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} and to allow the solvent SLV to be removed from matrix resin 12. Upon removal of the solvent SLV in such a way, matrix resin 12 is caused to shrink and hardened and the interconnected pores 16 are formed in matrix resin 12. Here, the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} is a water solution dissolving the maximum amount of water-soluble particles PL_{WS} that can be dissolved under environment under which solvent extracting step P51 is carried out. Thus, at solvent extracting step P51, none of the water-soluble particles PL_{WS} existing in the sheet-shaped compact as solids is dissolved, and the solvent SLV can be selectively removed from matrix resin 12.

[0057] At water-soluble particle extracting step P52, consecutively, the water-soluble particles PL_{WS} , remained inside the sheet-shaped compact subjected to solvent extracting step P51, is substituted for water, and the water-soluble particles PL_{WS} are removed from the sheet-shaped compact. In particular, the sheet-shaped compact, in which the solvent SLV has been removed and the matrix resin 12 has been shrunk in the solvent extracting step P51, is immersed in water such that the water-soluble particles PL_{WS} , present in the inside of the sheet-shaped compact and the surface thereof, are substituted with water, and thereby removed from the matrix resin 12. When the water-soluble particles PL_{WS} is removed from the sheet-shaped compact in such a way, no shrinkage of matrix resin 12 occurs and the water-soluble particles PL_{WS} is replaced by the large-size pores 11 having forms just like the water-soluble particles PL_{WS} in matrix resin 12. Thereby a large number of large-size pores 11 are formed in the same shapes as those of a large number of water-soluble particles PL_{WS} . At water-soluble particle extracting step P52, the interconnected pores 16 have been already formed in the sheet-shaped compact at preceding steps. Therefore, water can pass through the interconnected pores 16 to penetrate into the interior of the sheet-shaped compact. Thus, not only the water-soluble particles PL_{WS} exposed on the surface of the sheet-shaped compact but also the water-soluble particles PL_{WS} remaining inside the same, may be substituted by water and removed. That is, at water-soluble particle extracting step P52, since the water-soluble particles PL_{WS} remaining in the interior of the sheet-shaped compact are removed due to the presence of the interconnected pores 16, it is possible to obtain the polishing body 10 with adequate compressive elasticity. Moreover, solvent extracting step P51 and water-soluble particle extracting step P52 are conducted at, for instance, the normal temperature and under a normal pressure. The normal pressure represents a pressure that is not pressurized nor depressurized and is in a level of, for instance, approximately 1 (atm).

[0058] At drying step P6, the sheet-shaped compacts, subjected to water-soluble particle

extracting step P52, and absorbing sheets are alternately stacked on one another, and left in atmospheric air at the normal temperature for about 14 days to remove moisture from the sheet-shaped compact body and to dry. After the sheet-shaped compact body has been dried, for example, the polishing body 10 of the present embodiment is produced with a structure shown in FIGs. 2 to 4.

[0059] With the present embodiment as set forth above, as shown in FIGs. 2 to 4, the polishing body 10 includes matrix resin 12 having the plurality of interconnected pores 16 containing the polishing particles 14, and the plurality of large-size pores 11, whose one cross-sectional area is larger than that of the interconnected pores 16 and which are isolated from each other by the interconnected pores 16 and matrix resin 12. This enables the polishing body 10 to exhibit appropriate compressive elasticity against the polishing work. Thus, it becomes possible to suppress the occurrence of non-polished area on the polishing work and/or the occurrence of scratches or the like during polishing work in contrast to a conventional LHA pad without the large-size pores 11 and having relatively large hardness.

[0060] With the present embodiment, preferably, the large-size pores 11 have an average pore diameter ranging from 0.05 to 0.2 (mm) and, with such a dimension, the large-size pores 11 can be uniformly dispersed to minimize unevenness of the surface of the polishing body 10 due to the existence of the large-size pores 11. Then, damages to the polishing body 10 that would otherwise be caused by the polishing work such as the semiconductor wafer 26 or the like during polishing work are suppressed.

[0061] With the present embodiment, preferably, the polishing body 10 has a hardness ranging from ASKER C 60 to 95 for a thickness of 4.5 (mm). With such feature, the polishing body 10 is capable of preventing from shortening a product life with a lowered hardness in contrast to the conventional LHA pad without the large-size pores 11. To describe for confirmation, further, although the hardness of the polishing body 10 is specified in terms of a measured value when the polishing body 10 has the thickness of 4.5 (mm), such thickness is specified as a thickness for the hardness measurement. Therefore, it does not mean that the polishing body 10 of the present embodiment has the thickness of 4.5 (mm) and the thickness of the polishing body 10 is not limited to 4.5 (mm).

[0062] With the present embodiment, further, the solvent SLV, used in the process of manufacturing the polishing body 10 shown in FIG. 7, is, for instance, DMF (dimethylformamide) and the water-soluble particles PL_{WS} are sucrose. This enables the manufacturing process of the polishing body 10 shown in FIG. 7 to be applied to the production of a practical LHA pad and, hence, the water-soluble particles PL_{WS} can be easily obtained at low cost. Further, no sucrose is dissolved in DMF, i.e., no water-soluble particles PL_{WS} are dissolved in the solvent SLV or the solubility of the water-soluble particles PL_{WS} for the solvent SLV is less than a predetermined limit. This allows the water-soluble particles

PL_{WS} to nearly remain in their original shapes during a process up to the completion of the preceding step P51 that is executed before the water-soluble particle extracting step P52 shown in FIG. 7. Thus, a size (average pore diameter) of the large-size pores 11 can be set easily by suitably selecting the average particle diameter of the water-soluble particles PL_{WS}. In addition, since sucrose is water-soluble, it is possible to use inexpensive water with no need to prepare specified solvents or the like for the purpose of removing the water-soluble particles PL_{WS} at the water-soluble particle extracting step P52. Moreover, if the water-soluble particles PL_{WS} are sucrose, no risk arises for sodium to remain in the polishing body 10 in comparison to a case where the water-soluble particles PL_{WS} are sodium chloride. [0063] With the present embodiment, furthermore, the water-soluble particles PL_{WS} may preferably include pulverized and finely particulated particles rather than crystalline particles. In this case, each of the water-soluble particles PL_{WS} has ununiform or irregular surfaces. Thus, the water-soluble particles PL_{WS} are less likely to aggregate with each other than the crystalline particles, and therefore, the water-soluble particles PL_{WS} can be uniformly dispersed in the sheet-shaped compact.

[0064] With the present embodiment, furthermore, in the manufacturing process of the polishing body 10 shown in FIG. 7, matrix resin 12 is dissolved into the solvent SLV with which the polishing particles 14 and the water-soluble particles PL_{WS} are mixed to obtain the fluidic raw material and the fluidic raw material is formed into the sheet-shaped compact body with a predetermined thickness. Subsequently, the sheet-shaped compact body (sheet-shaped compact) is humidified with moisture in air, i.e., steam such that matrix resin 12 is gelled, after which the solvent SLV, contained in the sheet-shaped compact, is substituted for saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} to remove the solvent SLV from the sheet-shaped compact body. In addition, the water-soluble particles PL_{WS}, remaining in the sheet-shaped compact body, is substituted for water, thereby the water-soluble particles PL_{WS} are removed from the sheet-shaped compact body, after which the sheet-shaped compact body, from which the solvent SLV and the water-soluble particles PL_{WS} are removed, is dried. As described above, the process in three stages, including the gelation, substitution of the solvent and the water-soluble particles and removal of moisture, is conducted in sequence after forming, therefore, the sheet-shaped compact body shrinks uniformly. This favorably suppresses the occurrence of cracking or waviness of the sheet-like polishing body 10.

[0065] With the present embodiment, moreover, at mixing and stirring step P2 shown in FIG. 7, the water-soluble particles PL_{WS} are mixed to the fluidic raw material subjected to dissolving step P1 and, hence, the large-size pores 11, replaced the water-soluble particles PL_{WS} by, and the polishing particles 14 are uniformly dispersed inside the polishing body 10. In the manufacturing process of the polishing body 10 shown in FIG. 7, further, the solvent

SLV and the water-soluble particles PL_{WS} are not simultaneously removed from interior of the sheet-shaped compact. As shown in FIG. 7, the water-soluble particle extracting step P52 is conducted after solvent extracting step P51, then, it becomes possible to appropriately preclude the occurrence of defect in which the large-size pores 11 are not sufficiently formed in the polishing body 10 due to a consequence of the water-soluble particles PL_{WS} being removed when matrix resin 12 is gel. In addition, not water but the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} is used at solvent extracting step P51, then, the water-soluble particles PL_{WS} are not dissolved at solvent extracting step P51, and the water-soluble particles PL_{WS} may remain in the process up to the water-soluble particle extracting step P52. The large-size pores 11 of the polishing body 10 are formed by removing the water-soluble particles PL_{WS} using water. This enables the polishing body 10 to be made of matrix resin 12 having a low melting point in contrast to a case in which pore is formed by combusting, for instance, expanded polystyrene or the like in the sheet-shaped compact for removal.

[0066] With the present embodiment, for instance, the aging step P4 is to humidify the sheet-shaped compact body, formed at forming step P3, at the relative humidity ranging from 50 to 95% for the time interval of 15 to 20 hours. Thus, when the matrix resin 12 is particularly made of poly(vinylidene difluoride), the gelation of matrix resin 12 after being formed can be efficiently and homogeneously performed. In addition, if the humidifying time interval exceeds 20 hours, then, efficiency in gelation of the matrix resin 12 is gelled. If the humidifying time interval is less than 15 hours, then, matrix resin 12 has difficulty in homogeneous gelatinization.

[0067] With the present embodiment, at the solvent extracting step P51, sheet-shaped compact is immersed in the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} to shrink matrix resin 12. Thus, the solvent SLV is isolated in the matrix resin 12, is favorably substituted with the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} without using drying step P6, and thereby is removed out of matrix resin 12. This favorably prevents the occurrence of cracking due to localized shrinkage on the surface due to drying thereof. In addition, at the solvent extracting step P51, the sheet-shaped compact is immersed in the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} to allow the solvent SLV in matrix resin 12 to be substituted with the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} . Then, the matrix resin 12 shrinks. When this takes place, the plurality of interconnected pores 16 are formed inside matrix resin 12. The polishing particles 14 are present in the interconnected pores 16 such that a part of the polishing particles 14 are adhered onto inner walls of the interconnected pores 16 or other part of the polishing particle 14 are present in a filled state where the polishing particles 14 in the interconnected pores 16 are isolated from matrix resin 12.

Accordingly, the polishing particles 14 are easily liberated from matrix resin 12 during polishing work with the CMP method and, in addition, the plural polishing particles 14 are favorably dispersed in each of the interconnected pores 16. This results in an advantageous effect of accomplishing polishing work with increased precision with reduced risk of causing defect such as scratches (scar).

[0068] With the present embodiment, the sheet-shaped compact is immersed in water to cause the water-soluble particles PL_{WS} in matrix resin 12 to be substituted with water such that the plurality of large-size pores 11 are formed in matrix resin 12 at the water-soluble particle extracting step P52. Accordingly, each of the plural large-size pores 11 in the polishing body 10 is placed with boundaries of the interconnected pores 16 and matrix resin 12. Therefore, the polishing body 10 can have appropriate compressive elasticity during polishing work with the CMP method. This results in an advantageous effect of accomplishing polishing work with increased precision without causing any defect such as the occurrence of a non-polished area.

[0069] With the present embodiment, at the drying step P6, the sheet-shaped compacts are kept in atmosphere such that the sheet-shaped compacts, subjected to the water-soluble particle extracting step P52, and the sheet-like water absorbents are intervened and stacked on each other with. This enables the sheet-shaped compact body to be uniformly dried at increased efficiency.

[0070] With the present embodiment, matrix resin 12 preferably have the critical surface tension γ_{CL} of a value ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m) and, with such a characteristic, the matrix resin 12 and the polishing particles 14 are bonded to each other with proper bonding forces. Accordingly, In performing polishing work with the CMP method, the polishing particles 14 are likely to easily liberate from matrix resin 12, then, the liberated grinding particles can be self-supplied to between the polishing body 10 and the semiconductor wafer 26 serving as the polishing work. That is, it becomes possible to provide the polishing body 10, used in polishing work with the CMP method, which exhibits sufficient polishing efficiency and polishing performance without supply of slurry. Moreover, when the critical surface tension γ_{CL} of the matrix resin 12 is less than 1.6×10^{-2} (N/m), the polishing body 10 is likely to repel water needed for polishing work with the CMP method, and then, polishing efficiency is suppressed. On the contrary, when the critical surface tension γ_{CL} exceeds 4.0×10^{-2} (N/m), the polishing particles 14 become hard to be liberated during polishing work with the CMP method. In other words, with matrix resin 12 having the critical surface tension γ_{CL} equal to or less than 4.0×10^{-2} (N/m), when matrix resin 12 is caused to shrink and be hardened to form the interconnected pores 16 in the solvent extracting step P51, the polishing particles 14 are disposed inside the interconnected pores 16 in a manner where the polishing particles 14 do not penetrate into

matrix resin 12 and remain in the liberated states or where the polishing particles 14 are bonded to matrix resin 12 to be easily liberated during polishing work with the CMP method. Therefore, the polishing body 10 which can suitably self-supply liberated grinding particles as set forth above can be manufactured with capability of suitably self-supplying liberated grinding particles as set forth above.

[0071] With the present embodiment, matrix resin 12 is formed having the plurality of interconnected pores 16 and the interconnected particles 14 are disposed in the interconnected pores 16. And a part of the polishing particles 14 are bonded to the inner walls of the interconnected pores 16 or other part of the polishing particles 14 are liberated from matrix resin 12 in the interconnected pores 16. Thus, during polishing work with the CMP method, the polishing particles 14 can be easily liberated from matrix resin 12 and, in addition, the plural polishing particles 14 are properly dispersed in the interconnected pores 16. This results in an advantageous effect of enabling polishing work to be done with increased precision without causing the occurrence of any defect such as scratch or the like.

[0072] With the present embodiment, preferably, the volumetric fraction of the polishing particles 14 with respect to the polishing body 10 falls in a value ranging from 1 to 49% and the weight fraction falls in a value ranging from 2 to 90%. That is, at mixing and stirring step P2 shown in FIG. 7, the polishing particles 14 are fed to be mixed to the fluidic raw material such that the volumetric fraction of the polishing particles 14 with respect to the polishing body 10 falls in a value ranging from 1 to 49% and the weight fraction falls in a value ranging from 2 to 90%. With such treatment, the polishing body 10 can exhibit adequate polishing efficiency and polishing performance during polishing work with the CMP method and, in addition, an advantageous effect arises that forming is easily executed in the production. Moreover, when a volumetric fraction of a sum of the polishing particles 14 and the water-soluble particles PL_{WS} with respect to the polishing body 10 is higher than 50 (%) or the weight fraction is higher than 90(%), it becomes difficult in forming during the production of the polishing body 10.

[0073] With the present embodiment, matrix resin 12 include at least one of poly(vinyl fluoride), copolymer of vinylidene fluoride and hexafluoropropene, poly(vinylidene fluoride), copolymer of vinylidene fluoride and hexafluoropropene, polyethylene and poly(methacrylate methyl). This results in an advantageous effect that the practical polishing body 10 can be provided having the matrix resin 12 with necessary and sufficient critical surface tension γ_{CL} with excellent material strength.

[0074] With the present embodiment, the polishing particles 14 include at least one of silica, ceria, alumina, zirconia, titania, manganese oxide, barium carbonate, chromium oxide and ferric oxide. Thus, the polishing particles 14, having hardness complying with the polishing

work such as the semiconductor wafer 26 or the like, provides an advantageous effect offering capability of providing the practical polishing body 10.

[0075] With the present embodiment, at forming step P3 shown in FIG. 7, the sheet-shaped compact body is formed with the elongated flat nozzle of the T-die by being squeezed with a predetermined thickness. It doesn't matter if the sheet-shaped compact body is formed by cast molding in which the fluidic raw material, obtained at the dissolving step P1 and mixing and stirring step P2, is poured into a predetermined casting mold. For instance, matrix resin 12 is dissolved in the solvent SLV to prepare the fluidic raw material at dissolving step P1, and the polishing particles 14 and the water-soluble particles PL_{WS} are mixed to the resulting fluidic raw material for mixing and stirring at the mixing and stirring step P2. Then, the resulting fluidic raw material, containing the polishing particles 14 and the water-soluble particles PL_{WS}, is poured into a predetermined circular casting mold at subsequent forming step P3 for molding. By doing so, the solvent SLV, isolated from the matrix resin 12 with progress of the matrix resin 12 being solidified, causes the plurality of interconnected pores 16 to be formed in the matrix resin 12 with the polishing particles 14 being appropriately dispersed inside the interconnected pores 16. As a result, the polishing body 10 in which the matrix resin 12 is formed with the plurality of interconnected pores 16 and the polishing particles 14 are incorporated inside the interconnected pores 16 can be provided. With such polishing body 10, because a part of the polishing particles 14 are bonded to the inner walls of the interconnected pores 16 or other part of the polishing particles 14 are present inside the interconnected pores 16 in a state isolated from matrix resin 12, the polishing particles 14 can be easily liberated from matrix resin 12 during a polishing work with the CMP method. And, in addition, since the plural polishing particles 14 are appropriately dispersed inside the interconnected pores 16, a polishing work can be performed with increased precision without causing the occurrence of any defect such as scratch or the like. That is, it becomes possible to provide a method of manufacturing the polishing body 10, used in polishing work with the CMP method, which does not rely on slurry and has adequate polishing efficiency and polishing performance.

[0076] FIG. 8 shows a result on an experimental test conducted by the present inventors. The experimental test is to show hardnesses of the polishing bodies 10 for the thickness of 4.5 (mm) obtained when, in the manufacturing process shown in FIG. 7, the volumetric fraction of the water-soluble particles PL_{WS} with respect to the polishing body 10, i.e., the volumetric fraction of the water-soluble particles PL_{WS} was set to values of 0%, 10%, 20%, 30%, 40% and 50% in stepwise fashion respectively. If this hardness lies in a range of ASKER C 96 to 99, then, the polishing body 10 has extremely insufficient compressive elasticity. This results in increased probability of causing unpolished areas to be present on the polishing work during polishing work with the CMP method. Meanwhile, if the volumetric fraction of the

water-soluble particles PL_{WS} was set to 50%, it was difficult to form the polishing body 10. As apparent from FIG. 8, it is considered that, to achieve that the polishing body 10 has hardness in a range from ASKER C 60 to 95 for the thickness of 4.5 (mm), the volumetric fraction of the water-soluble particles PL_{WS} needs to be set in a value ranging from approximately 10 to 48%. A test piece of the polishing body 10, used in the present experimental test, had a thickness of 4.5 (mm). Although the test result, shown in FIG. 8, represents a case where powdered sugar with an average particle diameter of 0.17 (mm), manufactured upon pulverizing crystal sugar, was used as the water-soluble particles PL_{WS}, the same result will appear even when granulated sugar in the form of crystalline body with an average particle diameter of 0.5 (mm) was used. However, when the granulated sugar with an average particle diameter of 0.5 (mm) was used as the water-soluble particles PL_{WS}, the test resulted in the polishing body 10, having a rougher surface than that the polishing body 10 employing powdered sugar with an average particle diameter of 0.17 (mm), and polishing debris occurred in polishing work increased.

[Example 2]

[0077] Next, another embodiment of the present invention will be described below. In the following description, the component parts, common to those of the embodiments, bear like reference numerals to omit description.

[0078] FIG. 9 is a process diagram showing another method of manufacturing the polishing body 10. Hereunder, the method of manufacturing the polishing body 10 will be described with reference to this drawing figure.

[0079] Dissolving step P1 and mixing and stirring step P2 are conducted under the same conditions as those for dissolving and mixing and stirring described in the first embodiment with the exception that polyether sulphone (PES) resin is used as the matrix resin 12. That is, the matrix resin 12 is dissolved in the solvent SLV, such as DMF (dimethylformamide) and the polishing particles 14 and the water-soluble particles PL_{WS} are additionally mixed thereto to prepare a fluidic raw material.

[0080] The fluidic raw material, obtained at dissolving step P1 and mixing and stirring step P2, is poured into a circular casting mold and casted, or is poured into a circular container and sequentially flattened on surface using a predetermined blade so that the thickness is uniformly same at the forming step P3. Then, vibration is applied to the compact body depending on needs or deaeration under a vacuum state is executed.

[0081] At first aging step P41 and second aging step P42, subsequently, the matrix resin 12 is adequately gelled. That is, at the first aging step P41, the sheet-shaped compact body, formed at forming step P3, is held under relatively hermetic environment (a sealed airspace covered with the resin sheet or a sealed container) for a time interval of, for instance, 1.5 to 6 hours, i.e., more preferably, for a time interval of about 3 hours. In this moment, moisture at

the relatively hermetic environment is controlled at a relative humidity ranging from 10 to 95 % at a normal temperature of, for instance, 20°C and under a normal pressure and preferably controlled at a relative humidity ranging from 70 to 95 %. At subsequent second aging step P42, the sheet-shaped compact body is covered with a resin sheet to be sealed airtightly in the container or the airspace and kept for, for instance, a time period of from three days to two weeks. Such treatment causes the matrix resin 12, contained in the sheet-shaped compact body, to gradually be separated while suppressing evaporation of the solvent SLV such that the matrix resin 12 is sufficiently and uniformly gelatinized.

[0082] Like the previous embodiment described above, the sheet-shaped compact body has a nature in that as dissolving power of the solvent SLV with respect to the matrix resin 12 is decreased due to the presence of moisture, the matrix resin 12, dissolved in the solvent SLV, becomes hardened (gelled). Further, the sheet-shaped compact body has another nature in that as the solvent SLV dissolved in the matrix resin 12 evaporates, the concentration of the matrix resin 12 in the solvent SLV increases, which leads to acceleration of the hardening (gelation) of the matrix resin 12. The accelerated hardening (gelation) of the matrix resin 12 occurs on a surface layer and it causes ununiform gelation as a whole and therefore this leads to waviness or cracking of the polishing body 10 on the surface thereof. At first aging step P41 and the second aging step P42, therefore, the sheet-shaped compact body is kept under relatively hermetic environment at a normal temperature for about 72 hours that is controlled in moisture at the relative humidity ranging between 50% or more and 95% or less where no dew condensation occurs. Accordingly, the matrix resin 12 is exposed to humidifying air and moisture is supplied to the matrix resin 12 in the form of steam in air. Then, the matrix resin 12 is uniformly gelled. At this stage, since the matrix resin 12 remains in swelled state containing the solvent SLV, none of the interconnected pores 16 is formed.

[0083] Subsequent solvent extracting step P51, water-soluble particle extracting step P52 and drying step P6 are similar to those of the first embodiment.

[0084] Like the first embodiment set forth above, in the method of manufacturing the polishing body 10 of the present embodiment, shown in FIG. 9, the matrix resin 12 is dissolved in the solvent SLV, then, the polishing particles 14 and the water-soluble particles PL_{WS} are added to be mixed thereto to prepare the fluidic raw material, and the fluidic raw material is formed into sheet-shaped compact body (sheet-shaped compact) with a predetermined thickness. Then, the sheet-shaped compact is humidified with moisture in air, i.e., steam and the matrix resin 12 is be gelled. Next, the solvent SLV contained inside the sheet-shaped compact is substituted for the saturated aqueous solution WS_{STR} of the water-soluble particles PL_{WS} and removed from the compact. The water-soluble particles PL_{WS} contained in the inside of the compact are substituted for water and removed from the compact. Further, the sheet-shaped compact from which the solvent SLV and the

water-soluble particles PL_{WS} are removed is dried. Thus, a process is carried out on three stages including the gelation, the substitutions of the solvent and the water-soluble particles, and the removing of moisture in sequence after forming the sheet-shaped compact body. Accordingly, the sheet-shaped compact is uniformly constricted, thereby the occurrence of cracking or waviness of the sheet-shaped polishing body 10 is suppressed.

[0085] With the present embodiment, the aging step includes the first aging step P41, in which the sheet-shaped compact, formed at forming step P3, is humidified preferably at the relative humidity ranging from 70 to 95 % for 1.5 to 6 hours, and the second aging step P42 in which the compact, subjected to the first aging step, is kept under the airtight condition. Thus, under a circumstance where the matrix resin 12 is comprised of, for example, polyether sulphone (PES) resin, the formed matrix resin 12 can be efficiently and uniformly gelled.

[0086] While the present invention has been described above in detail with reference to the preferred embodiments shown in the accompanying drawings, the present invention is not limited to such embodiments and may also be implemented in other modes.

[0087] With the embodiments described above, although the matrix resin 12 takes, for instance, the fibrous shape, such shape merely represents the preferred embodiments of the present invention and it doesn't matter if the matrix resin 12, forming the polishing body 10 of the present invention, includes, for instance, babble-like interconnected pores 16 connected to each other. That is, the matrix resin 12 may take various forms as far as the liberated grinding particles are self-supplied during polishing work with the CMP method.

[0088] With the embodiments described above, although the mixing and stirring step P2 is conducted on a stage subsequent to the dissolving step P1, the mixing and stirring step P2 and the dissolving step P1 may be conducted nearly at the same time. That is, the matrix resin 12, the polishing particles 14, the water-soluble particles PL_{WS} and the solvent SLV may be poured into the stirring device nearly at the same time for mixing and stirring purposes. Alternatively, the dissolving step P1 may be conducted subsequent to the stirring step P2. That is, the polishing particles 14 and the water-soluble particles PL_{WS} may be mixed to and stirred with any one of the matrix resin 12 and the solvent SLV before the matrix resin 12 is dissolved into the solvent SLV.

[0089] Moreover, although at dissolving step P1 mentioned above, DMF (dimethylformamide) is used as the solvent SLV, the solvent SLV may be, for instance, an organic solvent such as N-methylpyrrolidone. A solvent may be employed as the solvent SLV of the present invention as far as the matrix resin 12 is favorably dissolved at dissolving step P1, but none of the water-soluble particles PL_{WS} is completely dissolved or none of the water-soluble particles PL_{WS} is almost dissolved therefore the plurality of interconnected pores 16 are formed at forming step P3, and the solvent is favorably volatilized at drying

step P6.

[0090] With the embodiments described above, although the alkaline aqueous solution having no liberated grinding particles is used as a polishing liquid for polishing work with the CMP method employing the polishing body 10, it doesn't matter absolutely if the polishing body 10 of the present invention is used for polishing work with the CMP method employing, for instance, slurry. Even in such a case sufficient polishing efficiency and polishing performance is obtained due to slurry containing a slight amount of liberated grinding particles. An advantage may be expected that further excellent polishing efficiency and polishing performance than those attained when a conventional polishing pad and slurry are used.. In addition, it doesn't matter if the polishing body 10 of the present invention is used for polishing work using a neutral liquid, such as deionized water or the like, as the polishing liquid. Accordingly, the polishing body 10 of the present invention may have applications to a wide variety of polishing work.

[0091] With the embodiments described above, although the polishing body 10 is used for polishing work for a whole surface area of the semiconductor wafer 26 such as a bare silicon wafer or a silicon wafer with silicon dioxide film and the like, the polishing body 10 of the present invention may be used for polishing work or the like for, for instance, on an outer circumferential edge surface (outer circumferential surface) of the semiconductor wafer 26 and glass substrates for various electronic devices. That is, various kinds of the polishing work can be applied as far as an advantage of the present invention can be enjoyed.

[0092] With the embodiments described above, the average pore diameter of the large-size pores 11 may be expressed in terms of arithmetic average of pore diameters measured by using an appropriate measuring method such as a mercury intrusion method i.e., measured by for instance, a micromeritics automated mercury porosimeter such as AutoPore IV-9520 manufactured by Shimadzu Manufacturing, Inc.

[0093] Although no illustrative description will be made on every little thing, the present invention may be implemented in various modifications without departing from the scope of the invention.

CLAIMS:

1. A polishing body formed in a circular disc, having a matrix resin and multiple polishing particles, for use in polishing work in a CMP method:

the matrix resin including a plurality of interconnected pores containing the polishing particles respectively, and a plurality of large-size pores isolated from each other by the interconnected pores and the matrix resin with a cross sectional area of the large-size pore in one cross section greater than that of the interconnected pore.

2. The polishing body according to claim 1, wherein the large-size pores have an average pore diameter ranging from 0.05 to 0.2 (mm) and the polishing particles have a volumetric fraction ranging from 1 to 49 (%) with respect to the polishing body.

3. The polishing body according to claims 1 or 2, wherein the polishing body has an ASKER C hardness ranging from 60 to 95 with a thickness of 4.5 (mm).

4. The polishing body according to any one of claims 1 to 3, wherein the matrix resin has a critical surface tension ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m).

5. The polishing body according to any one of claims 1 to 4, wherein the polishing particles have a weight fraction ranging from 2 to 90 (%) with respect to the polishing body.

6. A method of manufacturing a polishing body used for polishing work in a CMP method, the polishing body including a matrix resin and a large number of polishing particles and being formed in a circular disc, the method comprising:

a dissolving and mixing step for dissolving the matrix resin into a solvent and mixing water-soluble particles, insoluble to the solvent or having a solubility less than a predetermined limit with respect to the solvent, and the polishing particles to prepare a fluidic raw material;

a forming step for forming the fluidic raw material into a sheet-shaped compact with a predetermined thickness;

an aging step for aging the sheet-shaped compact, obtained at the forming step, with

humidifying with moisture in air to cause the matrix resin to be gelatinized;

a solvent extracting step for extracting the solvent from an inside of the sheet-shaped compact, subjected to the aging step, by substituting with a saturated aqueous solution of the water-soluble particles to remove the solvent from the inside of the compact;

a water-soluble particle extracting step for extracting the water-soluble particles from the inside of the sheet-shaped compact, subjected to the solvent extracting step, by substituting with water to remove the water-soluble particles from the inside of the compact; and

a drying step for drying the sheet-shaped compact subjected to the water-soluble particle extracting step.

7. The method of manufacturing a polishing body according to claim 6, wherein:

the water-soluble particles have an average particle diameter ranging from 0.05 to 0.2 (mm); and

the polishing particles are mixed in the dissolving and mixing step such that the polishing particles have a volumetric fraction ranging from 1 to 49 (%) with respect to the polishing body.

8. The method of manufacturing a polishing body according to claims 6 or 7, wherein:

the water-soluble particles in volume to allow the polishing body to have an ASKER C hardness ranging from 60 to 95 with a thickness of 4.5 (mm) of the polishing body are mixed in the dissolving and mixing step.

9. The method of manufacturing a polishing body according to any one of claims 6 to 8, wherein the solvent is dimethylformamide and the water-soluble particles are made of sucrose or sodium chloride.

10. The method of manufacturing a polishing body according to any one of claims 6 to 9, wherein the matrix resin has a critical surface tension ranging from 1.6×10^{-2} to 4.0×10^{-2} (N/m).

11. The method of manufacturing a polishing body according to any one of claims 6 to 10, wherein the polishing particles are mixed in the dissolving and mixing step such that the polishing particles have a weight fraction ranging from 2 to 90 (%) with respect to the polishing body.