SYSTEM FOR THINNING A SEMICONDUCTOR WORKPIECE

DESCRIPTION

TECHNICAL FIELD

[0001] The invention relates to a process and apparatus for use with workpieces, such as semiconductor wafers, flat panel displays, rigid disk or optical media, thin film heads or other workpieces formed from a substrate on which microelectronic circuits, data storage elements or layers, or micro-mechanical elements may be formed. These and similar articles are collectively referred to herein as a "wafer" or "workpiece." Specifically, the present invention relates to a process and apparatus for use in thinning semiconductor workpieces.

BACKGROUND OF THE INVENTION

[0002] State of the art electronics (e.g., cellular phones, personal digital assistants, and smart cards) demand thinner integrated circuit devices ("ICD"). In addition, advanced packaging of semiconductor devices (e.g., stacked dies or "flip-chips") provide dimensional packaging constraints which also require an ultra-thin die. Moreover, as operating speeds of ICDs continue to increase heat dissipation becomes increasingly important. This is in large part due to the fact that ICDs operated at extremely high speeds tend to generate large amounts of heat. That heat must be removed from the ICD to prevent device failure due to heat stress and to prevent degradation of the frequency response due to a decrease in carrier mobility. One way to enhance thermal transfer away from the ICD, thereby mitigating any deleterious temperature effects, is by thinning the semiconductor wafer from which the ICD is fabricated. Other reasons for thinning the semiconductor wafer include: optimization of signal transmission characteristics; formation of via holes in the die; and minimization of the effects of thermal coefficient of expansion between an individual semiconductor device and a package.

[0003] Semiconductor wafer thinning techniques have been developed in response to this ever increasing demand for smaller, higher performance ICDs. Typically, semiconductor devices are thinned while the devices are in wafer form. Wafer thicknesses vary depending on the size of the wafer. For example, the thickness of a 150 mm diameter silicon

semiconductor wafer is approximately 650 microns, while wafers having a diameter of 200 or 300 mm are approximately 725 microns thick. Mechanical grinding of the back side of a semiconductor is one standard method of thinning wafers. Such thinning is referred to as "back grinding." Generally, the back grinding process employs methods to protect the front side or device side of the semiconductor wafer. Conventional methods of protection of the device side of the semiconductor wafer include application of a protective tape or a photoresist layer to the device side of the wafer. The back side of the wafer is then ground until the wafer reaches a desired thickness.

[0004] However, conventional back grinding processes have drawbacks. Mechanical grinding induces stress in the surface and edge of the wafer, including micro-cracks and edge chipping. This induced wafer stress can lead to performance degradation and wafer breakage resulting in low yield. In addition, there is a limit to how much a semiconductor wafer can be thinned using a back grinding process. For example, semiconductor wafers having a standard thickness (as mentioned above) can generally be thinned to a range of approximately 250 - 150 microns.

[0005] Accordingly, it is common to apply a wet chemical etch process to a semiconductor wafer after it has been thinned by back grinding. This process is commonly referred to as stress relief etching, chemical thinning, chemical etching, or chemical polishing. The aforementioned process relieves the induced stress in the wafer, removes grind marks from the back side of the wafer and results in a relatively uniform wafer thickness. Additionally, chemical etching after back grinding thins the semiconductor wafer beyond conventional back grinding capabilities. For example, utilizing a wet chemical etch process after back grinding allows standard 200 and 300 mm semiconductor wafers to be thinned to 100 microns or less. Wet chemical etching typically includes exposing the back side of the wafer to an oxidizing/reducing agent (e.g., HF, HNO_3, H_3PO_4, H_2SO_4) or alternatively to a caustic solution (e.g., KOH, NaOH, H_2O_2). Examples of wet chemical etching processes may be found in co-pending U.S. Patent Application Serial No. 10/631,376, filed on July 30, 2003, and assigned to the assignee of the present invention. The teachings of Application Serial No. 10/631,376 are incorporated herein by reference.

[0006] Although methods for thinning semiconductor wafers are known, they are not without limitations. For example, mounting a semiconductor wafer to a submount or "chuck" (as it is commonly known) so that the wafer can be thinned requires expensive coating and

bonding equipment and materials, increased processing time, and the potential for introducing contaminates into the process area. Additionally, adhesives for bonding a wafer to a chuck that may be useful in a mechanical grinding process will not withstand the chemical process fluids used in wet chemical etching. Furthermore, the current use of a photoresist or adhesive tape fails to provide mechanical support for very thin wafers either during the back grind process or in subsequent handling and processing. The use of tape also creates obstacles in the removal process. For example, tape removal may subject a wafer to unwanted bending stresses. In the case of a photoresist, the material is washed off the device side of a wafer with a solvent, adding to the processing time and use of chemicals, and increasing the risk of contamination. The use of taping and protective polymers are also costly, since both equipment and materials are necessary to apply and remove the protective media.

[0007] Further, thinned semiconductor wafers are prone to warping and bowing. And because thinned semiconductor wafers can be extremely brittle, they are also prone to breakage when handled during further processing. Thinned semiconductor wafers (e.g., below 250 microns) also present complications in automated wafer handling because, in general, existing handling equipment has been designed to accommodate standard wafer thicknesses (e.g., 650 microns for 150 mm wafer and 725 microns for 200 and 300 mm wafers).

[0008] Accordingly there is a need for a process and equipment for producing thinner semiconductor workpieces. At the same time, there is a need to provide thinner workpieces that are strong enough to minimize the risk of breakage, yet remain compatible with conventional automated semiconductor wafer handling equipment. Finally, it would be advantageous to develop a system that reduces the number of processing steps for thinning a semiconductor workpiece.

SUMMARY OF THE INVENTION

[0009] The present invention provides a system, method and apparatus for use in processing semiconductor wafers. The new system and apparatus allows for the production of thinner wafers that at the same time remain strong and resistant to bowing and warping. As a result, the wafers produced by the present process are less susceptible to breakage. The

process and equipment of the present invention also offer an improved product structure for handling thinned wafers, while reducing the number of processing steps. This results in, among other things, improved yields and improved process efficiency.

[0010] In one aspect, the present invention provides a chuck for receiving and supporting a semiconductor workpiece having a device side, a bevel and a back side. The chuck has a body for supporting the workpiece, a retainer removeably attached to the body and adapted to cover a peripheral portion of the back side of the workpiece, and at least one member for creating a seal between the retainer and the back side of the workpiece. Due to its configuration, the chuck permits an interior region of the back side of the workpiece to be exposed, while protecting the peripheral portion of the back side of the workpiece. The workpiece is then thinned via a wet etching process. The result is a processed semiconductor workpiece that has a thinned main body (e.g., less than approximately 125 microns) and a thick rim (e.g., in a range of approximately 600 to 725 microns). The relatively thicker rim provides strength to the thinned workpiece and permits the workpiece to be handled for additional processing with conventional automated handling equipment.

[0011] In another aspect, the present invention provides a semiconductor workpiece having a main body and a rim comprised of semiconductor material. The main body is integrally connected to the rim and has a thickness less than approximately 50% of the rim thickness. The relatively thick rim provides strength to the workpiece, preventing the main body from bowing and warping. Meanwhile, the main body of the semiconductor workpiece can be thinned to a thickness less than 300 microns, preferably less than 125 microns, more preferably less than 100 microns, especially less than 50 microns and even less than 25 microns. The structural configuration of thinned semiconductor workpieces of the present invention meet the industry demand for thinned ICDs necessary in today's state of the art electronics and advanced packaging techniques, while at the same time, reducing the risk of breakage due to the fragile state of the thinned workpiece.

[0012] The present invention also provides several processes for thinning a semiconductor workpiece. In one aspect, the process includes the steps of placing the semiconductor workpiece into a chuck adapted to cover a peripheral portion of the back side of the workpiece, leaving approximately 95% of the back side surface of the workpiece exposed. The semiconductor workpiece is then thinned via a wet chemical etching process wherein the back side of the workpiece is exposed to an oxidizing agent (e.g., HF, HNO_3,

H_3PO_4, H_2SO_4) or alternatively to a caustic solution (e.g., KOH, NaOH, H_2O_2). During the wet chemical etching step, the exposed back side of the workpiece is thinned to a thickness less than 50% of the pre-wet chemical etching thickness of the workpiece. As a result, a rim is formed at the periphery of the workpiece, or as it is commonly referred to in the industry, the "exclusion zone." The rim has a thickness approximately equal to the thickness of the workpiece prior to the wet chemical etch step (e.g., in a range of 600 to 725 microns). The remainder of the workpiece (i.e., the thinned main body) has a thickness less than 50% of the rim thickness (e.g., less than 300 microns, preferably less than 125 microns, more preferably less than 100 microns, especially less than 50 microns and even less than 25 microns). This process eliminates the limitations associated with known methods of thinning semiconductor workpieces mentioned above, while increasing overall manufacturing efficiencies.

[0013] A process for thinning a batch of semiconductor workpieces is also provided. The process includes the step of placing the semiconductor workpieces into a chuck body so that a back side of the workpieces is exposed. Inserting a batch of the workpieces into the carrier assembly. Loading the carrier assembly into a rotor assembly such that the semiconductor pieces are positioned at an incline. Rotating the rotor assembly, which subsequently provides rotational motion to the carrier assembly and the workpieces therein, and spraying a process fluid on the exposed back sides of the workpieces. Through this system the back sides of the workpieces are then thinned to a desired thickness (preferably less than 125 microns). After the workpieces are thinned, the tool and system disclosed provide for rinsing and drying the workpieces. The system also provides for recirculating and recycling used process fluid.

[0014] In order to carry out batch processing of semiconductor wafers, the present invention also provides a system that includes a process chamber that allows for batch wet chemical thinning of semiconductor workpieces down to less than 125 microns. The process chamber comprises a chamber body having a first end, an outer wall, and an opening at the first end leading into a cavity. The process chamber is supported at an incline within the processing machine, and the semiconductor workpieces within the process chamber are similarly supported at an incline therein. A door assembly is provided adjacent the first end of the chamber body. The door assembly has a door that selectively closes the opening of the chamber body. The process chamber also has a spray assembly having a nozzle to spray a process fluid into the cavity of the chamber body and onto the exposed portions of the semiconductor workpieces therein. In one embodiment, the spray assembly has a dual

inlet/outlet mechanism that introduces fluid into the process chamber from opposing directions.

[0015] According to another aspect, the process chamber has an exhaust vent and a exit port or drain. The exhaust vent exhausts gases and vapors from the cavity of the processing chamber. The drain removes excess and used process fluid from the cavity of the chamber body of the process chamber. The drain may be connected to a recirculation system to deliver the excess and used process fluid from the process chamber to a delivery tank.

[0016] According to another aspect, the system includes a carrier assembly to retain a plurality of the workpieces. The carrier assembly is positioned in the cavity of the process chamber, and rotates within the process chamber to allow for better coverage for the sprayed process fluid on the workpieces. In one embodiment, the carrier assembly has a plurality of positioning members about a length of its body. The positioning members are used to retain the semiconductor workpieces in a specific location in the carrier assembly, and to provide a gap between adjacent semiconductor workpieces. Further, because of the geometry of the positioning members of the carrier assembly, the workpieces in the carrier assembly generally rotate both with the carrier assembly, and somewhat independently of the rotation of the carrier assembly.

[0017] According to another aspect, the system includes a rotor assembly. The rotor assembly is positioned within the cavity of the process chamber, and the carrier assembly is generally positioned within a cavity of the rotor assembly. A motor associated with the process chamber drives the rotor assembly to rotate the rotor assembly within the cavity of the chamber body. The rotor assembly subsequently provides rotational motion to the carrier assembly and the semiconductor workpieces therein.

[0018] Any of the described aspects of the invention may be combined and/or repeated one or more times to achieve optimal results. The invention resides as well in sub-combinations of the aspects described. These and other objects, features and advantages of this invention are evident from the following description of preferred embodiments of this invention, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1A is a perspective view of a chuck according to the present invention with a semiconductor workpiece secured therein prior to thinning.

[0020] FIG. 1B is a cross-sectional view of the chuck and workpiece shown in FIG. 1A.

[0021] FIG. 1C is a partial enlarged view of the chuck and workpiece shown in FIG. 1B, demonstrating the cooperation between the chuck and the workpiece.

[0022] FIG. 1D is an exploded cross-sectional view of the chuck and workpiece shown in FIG. 1A.

[0023] FIG. 1E is a partial enlarged view of the chuck and workpiece section identified as X shown in FIG. 1D.

[0024] FIG. 2A is a cross-sectional view of another embodiment of a chuck according to the present invention with a workpiece secured therein prior to thinning.

[0025] FIG. 2B is a partial enlarged view of the chuck and workpiece shown in FIG. 2A, demonstrating the cooperation between the chuck and the workpiece.

[0026] FIG. 3A is a cross-sectional view of yet another embodiment of a chuck according to the present invention with a workpiece secured therein prior to thinning.

[0027] FIG. 3B is a partial enlarged view of the chuck and workpiece shown in FIG. 3A, demonstrating the cooperation between the chuck and the workpiece.

[0028] FIG. 4A is a cross-sectional view of another embodiment of a chuck according to the present invention with a workpiece secured therein prior to thinning.

[0029] FIG. 4B is a partial enlarged view of the chuck and workpiece shown in FIG. 4B, demonstrating the cooperation between the chuck and the workpiece.

[0030] FIG. 5A is a cross-sectional view of another embodiment of a chuck according to the present invention with a workpiece secured therein prior to thinning.

[0031] FIG. 5B is a partial enlarged view of the chuck and workpiece shown in FIG. 5A, demonstrating the cooperation between the chuck and the workpiece.

[0032] FIG. 6A is a cross-sectional view of yet another embodiment of a chuck according to the present invention with a workpiece secured therein prior to thinning.

[0033] FIG. 6B is a partial enlarged view of the chuck and workpiece shown in FIG. 6A, demonstrating the cooperation between the chuck and the workpiece.

[0034] FIG. 7A is a cross-sectional view of an embodiment of a chuck according to the present invention with a workpiece secured therein prior to thinning.

[0035] FIG. 7B is a partial enlarged view of the chuck and workpiece shown in FIG. 7A, demonstrating the cooperation between the chuck and the workpiece.

[0036] FIGS. 8 and 9 are flow diagrams depicting aspects of process flows in accordance with the present invention.

[0037] FIG. 10 is a perspective view of a semiconductor workpiece thinned according to a process of the present invention.

[0038] FIG. 11 is a cross-sectional view of the thinned semiconductor workpiece shown in FIG. 10.

[0039] FIG. 12 is a perspective view of a tool for treating semiconductor workpieces;

[0040] FIG. 13 is a perspective view of the tool of FIG. 12, with a panel removed to disclose an inclined work station in the tool;

[0041] FIG. 14 is an exploded perspective view of one embodiment of a process chamber used in a work station of the tool of FIG. 12;

[0042] FIG. 15 is a perspective view of one embodiment of a carrier assembly for use with a process chamber;

[0043] FIG. 16 is a side cross-sectional elevation view of the carrier assembly taken about line A-A of FIG. 15;

[0044] FIG. 17 is a perspective view of another embodiment of a carrier assembly for use with the process chamber of FIG. 14;

[0045] FIG. 18 is a front perspective view of the rotor assembly used in the processing system for the workpieces;

[0046] FIG. 19 is an exploded rear perspective view of the rotor assembly of FIG. 18;

[0047] FIG. 20 is a front perspective view of the process chamber of FIG. 14;

[0048] FIG. 21 is a rear perspective view of the process chamber of FIG. 14;

[0049] FIG. 22 is a rear cross-sectional view of the process chamber of FIG. 21;

[0050] FIG. 23 is a side cross-sectional view, through the vent and drain assemblies, of the process chamber of FIG. 21;

[0051] FIG. 24 is a side cross-sectional view, through the spray assembly, of the process chamber of FIG. 21;

[0052] FIG. 25 is a flow diagram illustrating a one process for thinning a workpiece in a process chamber;

[0053] FIG. 26 is a flow diagram illustrating one process fluid delivery schematic; and,

[0054] FIG. 27 is a schematic of a tool incorporating the process chamber of FIG. 14

DETAILED DESCRIPTION

A. CHUCK FOR SUPPORTING A SEMICONDUCTOR WORKPIECE

[0055] With reference to FIGS 1A-1E, there is shown a chuck 10 for supporting a semiconductor workpiece 50 during processing in accordance with one embodiment of the present invention. The chuck 10 is comprised of a supporting body 12, a retainer 14 and a sealing members 16, 24. The retainer 14 has two grooves or recesses 18. The sealing members 16, 24 are housed in the annular grooves 18, respectively. The retainer 14 is preferably in the form of a ring and is removeably attached to the supporting body 12. In use, the workpiece 50, which has a device side 51, a bevel (i.e., peripheral edge) 52 and a back side 53, is placed onto a supporting surface 18 of the supporting body 12 of chuck 50, device side 51 down. The retainer 14 is then attached to the outer periphery of the supporting body 12. As shown specifically in FIG. 1C, when the retainer 14 is engaged to the supporting body 12, the retainer 14 wraps around the outer end of the supporting body 12 and covers a peripheral portion of the back side 53 of the workpiece 50, securing the workpiece 50 in the chuck 10.

[0056] When engaged, preferably the retainer 14 covers only a small peripheral portion of the back side 53 of the workpiece 50, leaving a majority of the back side 53 of the workpiece 50 exposed. In a preferred embodiment, the back side 53 surface area covered by the retainer 14 extends inwardly from the bevel 52 for about a distance of approximately 1-10 mm, more preferably between about 1-5 mm, and especially between about 2-4 mm. Preferably, at least 95% (or even 97% or 99%) of the back side 53 surface area of the workpiece 50 is left exposed. The exposed portion of the back side 53 of the workpiece 50 is then subjected to a process fluid and thinned to a desired thickness. As a result of covering the peripheral portion of the back side 53 of the workpiece 50, during thinning, process fluid cannot interact with the periphery of the back side 53 of the workpiece 50. Accordingly, the periphery of the back side 53 of the workpiece 50 remains in substantially its same pre-thinning form, configuration and thickness. For purposes of this invention, the semiconductor material remaining at the periphery of the workpiece 50 after thinning is referred to as a rim. It is the rim that imparts strength to the thinned workpiece 50 and permits automated handling equipment to handle the thinned semiconductor workpieces 50 processed according to the present invention.

[0057] Turning to FIGS. 1D and 1E, in order to facilitate attachment of the retainer 14 to the supporting body 12, the retainer 14 has an engagement member 20 that cooperates with a recess 22 formed in the supporting body 12. In this manner, a simple mechanical snap connection between the retainer 14 and the supporting body 12 is achieved. Although not shown in FIGS. 1A-1D, the present invention includes a configuration where the engagement member 20 extends from the supporting body 12 and cooperates with a recess 22 formed in the retainer 14 to removeably connect the retainer 14 and supporting body 12. In either configuration, preferably the engagement member 20 and the recess 22 are positioned between the first and second sealing member 16, 24.

[0058] With reference to FIG. 1C, the retainer 14 has an outer peripheral end 30 with an angled surface 32. When the retainer 14 is attached to the supporting body 12, the angled surface 32 of the outer peripheral end 30 of the retainer 14 mates with an angled surface 34 at an outer peripheral end of the supporting body 12 to form a notch 36. The notch 36 accepts a tool (not shown) and facilitates removal of the retainer 14 from the supporting body 12.

[0059] Turning now to FIG. 1E, the supporting body 12 has a lip or step 26 formed circumferentially therein. The lip 26 acts to register or guide the workpiece 50 as it is loaded into the chuck 10. When properly aligned, the workpiece 50 will rest entirely on the supporting surface 28 of the supporting body 12. While the chuck 10 can be any shape (e.g., square, rectangular, circular, etc), as shown in FIGS. 1A-1E, in a preferred embodiment the chuck is disk-shaped and will have a diameter slightly larger than the diameter of the workpiece 50 to be processed.

[0060] With reference now to FIGS. 2A-2B, there is shown an alternative embodiment of a chuck 10 according to the present invention. Like the chuck 10 shown in FIGS. 1A-1E, the chuck 10 includes a supporting body 12 and a retainer 14. The retainer 14 has first and second sealing members 16, 24 disposed within annular grooves 18, 38. The mechanical attaching mechanism in the embodiment illustrated in FIGS 2A-2B, however, is slightly different than the mechanism shown in FIGS. 1A-1E. An engagement member 20 extends from the outer periphery of the supporting body 12. The retainer 14, in turn, has a recess 22 that cooperates with the engagement member 20 of the supporting body 12 to provide a simple snap engagement that attaches the retainer 14 to the supporting body 12. An upper portion of the retainer 14, including sealing member 16, covers the exclusion zone of the back side 53 of the workpiece 50 in the engaged position. In this preferred embodiment, the

retainer 14 has a plurality of rinse holes 40 for allowing processing fluid to escape from cavities formed in the chuck 10. A lower portion 42 of the retainer 14 which creates the mechanical snap connection with the engaging member 20 forms an annular recess 44 with a mating lower portion 46 of the supporting body 12. A tool (not shown) can be inserted into the annular recess 44 so that the retainer 14 can be simply popped off the chuck 10 supporting body 12 after processing is completed.

[0061] In the embodiments having two sealing members 16, 24 (as disclosed in FIGS. 1A-1E and 2A-2B), sealing member 16 creates a flexible interface and seal between the workpiece 50 and the retainer 14 to prevent process fluid from accessing the device side 51 and bevel 52 of the workpiece 50. This flexible interface also relieves some of the stress that is exerted on the workpiece 50 during assembly and disassembly of the chuck 10. Sealing member 24 creates a flexible interface between the retainer 14 and the supporting body 12 and also helps relieve some of the stress that is exerted on the workpiece 50 during assembly and disassembly of the chuck 10.

[0062] With reference now to FIGS. 3A-3B through 7A-7B, there is shown various chuck 10 designs having only a single sealing member 16. Specifically, FIGS. 3A-3B illustrate a chuck 10 having a retainer 14, supporting body 12 and a engagement mechanism similar to the engagement mechanism shown in FIGS. 2A-2B and described above. The retainer 14, however, has only a single annular groove 18 which is adapted to house sealing member 16. In this embodiment, the annular groove 18 is V-shaped and receives a square-shaped compressible sealing member 16. Preferably the square-shaped sealing member 16 has semi-circular extensions projecting from each corner to ensure an adequate fit in groove 18.

[0063] FIGS. 4A-4B and 5A-5B show chucks 10 having an engagement ring 48 attached circumferentially to the bottom outer periphery of the supporting body 12. The engagement ring 48 extends radially outwardly from the supporting body 12, creating a stepped-relationship between the supporting body 12 and engagement ring 48, and forming engagement member 20. The retainer 14 has a lower portion 42 with a U-shaped recess 22 formed therein. The U-shaped recess 22 receives the engagement member 20. The lower portion 42 of the retainer 14 has an extension 49 that wraps around the engagement member 20 to form a mechanical snap connection between the retainer 14 and the engagement ring 46 of the supporting body 12. In FIGS. 4A-4B, the retainer 14 has a two-step annular groove 18 which receives a sealing member 16 having a top part with one width for insertion into one-

step of the annular groove 18, and a bottom part with a second width for insertion into the second step of the annular groove 18. In FIGS. 5A-5B, the retainer 14 has a single V-shaped annular groove 18 for housing the sealing member 16, which in this embodiment is a compressible O-ring.

[0064] FIGS. 6A-6B illustrate another preferred embodiment of a chuck 10 according to the present invention. In this embodiment, the lower portion 42 of the retainer 14 has an inner side wall 60 with a convex protrusion 62 extending outwardly therefrom. The supporting body 12 has an end wall 64 with a concave recess 66 for accepting the convex protrusion 62 of the inner side wall 60 of the lower portion 42 of the retainer 14. In this manner, the retainer 14 engages the supporting body 12 and secures the workpiece 50 on the supporting surface 28 of the chuck 10.

[0065] In the embodiments having only a single sealing member 16 (as disclosed in FIGS. 3A-3B through 6A-6B), sealing member 16 creates a flexible interface between the workpiece 50 and the supporting body 12 to prevent process fluid from interacting with the device side 51 and bevel 52 of the workpiece 50, and to relieve stress exerted on the workpiece during the assembly/disassembly process.

[0066] Turning now to FIGS. 7A-7B, there is shown a preferred embodiment of a chuck 10, which combines the retainer 14 and sealing member 16 of the prior embodiments. In this embodiment, retainer 14 is a single-component, compressible annular ring with an annular groove 18 running circumferentially through the middle of the retainer 14. The supporting body 12 has an outer end 13, which is inserted into the annular groove 18 in the retainer 14. The retainer 14 remains engaged to the supporting body 12 as a result of a compression force exerted by the retainer 14 onto the supporting body 12 and the workpiece 50. In the attached position, an outer peripheral portion of the workpiece 50 (e.g., the exclusion zone) is also positioned within the annular groove 18. In this preferred embodiment, retainer 14 creates a seal with the back side 53 of the workpiece 50, preventing process fluid from accessing the bevel 52 and device side 51 of the workpiece 50 during processing.

[0067] Suitable materials for use in the chuck 10 embodiments according to the present invention will now be discussed. Generally, the chuck 10 can be made from a number of different polymer materials that are stable and highly chemically resistant. Preferably the supporting body 12 comprises polytetrafluoroethylene and the retainer 14 preferably comprises a fluoropolymer such as polyvinylidene fluoride sold by Atofina Chemicals under

the KYNAR tradename. In the embodiment illustrated in FIGS. 7A-7B, the retainer 14 is preferably formed from a material having a Durometer hardness less than that of a fluoropolymer, but greater than the elastomeric materials discussed below with respect to the sealing member. That is, a material compressible enough to form a seal with the workpiece 50, but stiff enough to provide structure to the retainer 14 for receiving the supporting body 12. In any embodiment of the present invention, in order to enhance the attachability of the retainer 14 to the supporting body 12, it is preferred that the supporting body 12 is comprised of a material having a Durometer hardness greater than the Durometer hardness of the material from which the retainer 14 is formed.

[0068] As illustrated in FIGS. 1A-1E, 2A-2B, 5A-5B and 6A-6B, the sealing members 16, 24 are preferably shaped like an "O-ring," but it is contemplated that other shapes can be used as well (e.g., as shown in FIGS. 3A-3B and 4A-4B). The sealing members 16, 24 are preferably formed from a compressible material having a Durometer hardness equal to or greater than 50. Specific examples of suitable elastomeric materials include: a perfluoroelastomer sold by DuPont under the tradename Kalrez; a perfluoroelastomer sold by Greene, Tweed & Co. under the tradename Chemraz; fluoruelastomers sold by DuPont under the tradename Viton; and hydrocarbon elastomers sold under the tradename EPDM.

B. PROCESS FOR THINNING A SINGLE SEMICONDUCTOR WORKPIECE

[0069] Turning now to the workpiece thinning processes according to the present invention, FIG. 8 illustrates one embodiment of a process that may be implemented when the chuck 10 and workpiece 50, described above, are used to thin the back side 53 of the workpiece 50. At step 200, a workpiece 50 is provided having a device side 51, a bevel 52 and a back side 53. The back side 53 of the workpiece 50 will have a given surface area depending on its dimensions. Also, the workpiece 50 has a given thickness.

[0070] At step 210, the workpiece 50 is placed onto the supporting surface 28 of chuck 10 with the device side 51 immediately adjacent to the supporting body 12 of the chuck 10. The retainer 14 is attached to the supporting body 12 so that a peripheral portion (e.g., the exclusion zone of the workpiece 50) of the back side 53 of the workpiece 50 is covered. In step 210, the workpiece 50 is secured to the chuck 10. As a result of the chuck 10 configuration, upon attaching the retainer 14 to the supporting body 12, in step 220 a majority (and preferably at least 95%, more preferably at least 97% and especially at least 99%) of the

back side 53 surface area is exposed, while a small peripheral portion of the back side 53 of the workpiece 50 is covered.

[0071] The workpiece 50 is then thinned to a desired thickness at step 230 by applying a process fluid to the exposed back side 53 of the workpiece 50. Due to the overlapping configuration of the retainer 14, by thinning the exposed back side 53 of the workpiece, at step 240, a rim and a main body is formed in the workpiece 50. The rim is formed at the outer periphery of the workpiece 50 and has a thickness, RT and the main body of the workpiece 50 has a thickness, MBT. In the preferred embodiment of FIG. 8, the MBT is less than approximately 50% of the RT. A desired MBT is preferably less than approximately 40% of the RT; more preferably less than approximately 30% of the RT; especially less than approximately 20% of the RT; and even less than approximately 10% of the RT. It should be understood that after thinning the workpiece 50, the RT should be substantially the same as the workpiece 50 thickness prior to the thinning process. Thus, for conventional 200 mm and 300 mm workpieces, the RT after thinning will be about 725 microns. And the RT of a conventional 150 mm workpiece after thinning will be about 650 microns.

[0072] It is within the scope of the present invention, however, to process a workpiece 50, which has previously been thinned by some other method, e.g., mechanical grinding. Thus, a workpiece 50 having a thickness of anywhere from 150 - 725 microns can be thinned according to the present invention to create a workpiece 50 with a rim having a RT in a range of substantially the same thickness as the workpiece 50 (i.e., about 150 – 725 microns, even about 600-725, or even about 300-725) and a main body having a MBT in a range of about 25 – 300 microns, preferably in a range of about 100-125 microns, more preferably in a range of about 50-100 microns, especially in a range of about 25-50 microns.

[0073] Turning now to FIG. 9, there is shown another embodiment of a process that may be implemented when the chuck 10, described above, is used to thin a workpiece 50. At step 300, a workpiece 50 having a thickness, WPT, is provided. The workpiece 50 has a device side 51, a bevel 52 and a back side 53. The workpiece 50 is placed onto the chuck 10 with the device side 51 immediately adjacent to the supporting body 12 of the chuck 10 at step 310. At step 320, the retainer 14 is attached to the supporting body 12 so that a peripheral portion of the back side 53 of the workpiece 50 is covered. In this step, the workpiece 50 is secured to the chuck 10. As a result of the chuck 10 configuration, when the retainer 14 is

attached to the supporting body 12, with the exception of the covered exclusion zone, substantially all of the back side 53 of the workpiece 50 is exposed.

[0074] Still referring to FIG. 9, at step 330 the chuck 10 and workpiece 50 are placed into a process chamber. The process chamber may be manual or automated and is preferably within a spray acid tool platform like those available from Semitool, Inc., of Kalispell, Montana. Once inside the process chamber, a process fluid is applied to the exposed back side 53 of the workpiece 50 at step 340. The thinning process of step 340 preferably comprises a conventional wet chemical etch process or a polishing process. In either process, the process fluid preferably consists of one, or a combination of: deionized water, hydrogen peroxide, ozone, potassium hydroxide, sodium hydroxide, hydrofluoric acid, nitric acid, sulfuric acid, acidic acid and phosphoric acid. A number of other acidic and basic solutions may also be used, depending on the particular surface to be treated and the material that is to be removed.

[0075] The process fluid can be applied to the workpiece 50 in any conventional manner. In one preferred embodiment, however, the process fluid is sprayed through a nozzle or a plurality of nozzles onto the back side 53 of the workpiece 50. In another preferred embodiment, the chuck 10 and workpiece 50 are immersed into a volume of process fluid, or sequentially into a plurality of volumes of the same process fluid (at different concentrations or temperatures) or different process fluids.

[0076] Depending on the composition of the material to be removed and the amount of material to be removed (i.e., the desired end thickness of the workpiece), the process fluid will have a desired concentration, a temperature and a flow rate. By monitoring and maintaining these process fluid variables, the process fluid can be applied to the exposed back side 53 of the workpiece 50 at a first etch rate, and then subsequently at a second etch rate. Preferably, the first etch rate is greater than the second etch rate. That is, semiconductor material is etched away quickly at first, and then more slowly as the thickness of the workpiece 50 approaches the desired thickness.

[0077] Referring to step 350 of FIG. 9, the thinning process forms a rim 70 and a main body 72 in the workpiece 50. The thinning process is carried out until the main body 72 reaches a desired thickness, MBT. Preferably, the MBT is less than 50% of the WPT, more preferably less than 40% of the WPT, even more preferred less than 30% of the WPT , especially less than 20% of the WPT and especially preferred less than 10% of the WPT. It is

preferable to measure the thickness of the main body 72 of the semiconductor workpiece 50 throughout the thinning process. This can be accomplished by employing conventional infrared monitoring technology in the process chamber, or by any other known measuring technique such as a capacitive measurement technique. If need be, the process fluid variables described above can be adjusted based on the continued monitoring of the workpiece thickness.

[0078] At step 360, the thinned workpiece 50 is rinsed and dried. For example, the workpiece may be sprayed with a flow of deionized water, nitrogen or phosphoric acid during the rinsing step and may then be subject to any one or more known drying techniques thereafter. Finally, the workpiece 50 is then removed from the chuck (step 370) and the thinned workpiece 50 is diced into a plurality of dies (step 380).

C. BATCH PROCESS CHAMBER AND SYSTEM FOR THINNING SEMICONDUCTOR WORKPIECES

[0079] Thinning of semiconductor workpieces 50 can be carried out on a single workpiece 50, or on a plurality of workpieces 50 simultaneously, according to the present invention. When thinning a plurality of workpieces 50, it is desirable to place each workpiece 50 into a corresponding chuck 10 and then place the plurality of chucks 10 and workpieces 50 into a carrier such as the carriers disclosed in co-pending U.S. Patent Applications Nos. 10/200,074 and 10/200,075, the disclosures of which are incorporated herein by reference. Once the plurality of workpieces 50 (and associated chucks 10) are placed in the carrier, the carrier is loaded into a process vessel and a process fluid is applied to the exposed back sides 53 of the plurality of workpieces 50. In order to ensure an adequate application of the process fluid to the workpieces 50, it is preferable to rotate the chucks 10 or the carrier, or both, within the process vessel during processing. The process vessel can be a stand alone tool, or one of a plurality of workstations making up a larger, workpiece 50 processing system.

[0080] Referring now to FIGS. 12, 13 and 27, there is shown a machine or tool 410 for processing workpieces 412. The tool 410 preferably includes a cabinet 414 that houses a first processing module 416 and a second processing module 418, however, it is understood that additional work-in-progress pods or modules may also be provided in the tool 410. The first processing module 416 is typically a process chamber to thin the semiconductor workpieces 412, such as the process chamber 420 shown in FIG. 14, and the second processing module

418 is typically a drying and rinsing chamber 422 to dry and rinse the workpieces 412 after they have been thinned. The tool 410 also has electronic control area 425, which is associated with such equipment as a control panel 424, a display 426, and a processor for controlling and monitoring operation of the system. Additionally, the tool 410 has another module 427 which houses the work in process pods. Other features and components of the system will be described in detail herein.

[0081] As explained above, in the present system a plurality of workpieces 412 is thinned in the process chamber 420. In a preferred embodiment, prior to being placed in the process chamber 420 each workpiece 412 is mounted in a separate chuck 430 for processing. The arrangement between the workpiece and various chuck configurations has been described in detail above in connection with FIGS. 1-7. A plurality of mounted workpieces are then placed into a carrier assembly 452 for retaining a plurality of workpieces 412. With reference to FIGS. 15-16, the carrier assembly 452 generally retains the workpieces 412 about a peripheral portion thereof. In this embodiment, the carrier assembly 452 comprises a first carrier member 454 and a second carrier member 456 that connect to form the overall carrier assembly 452. Approximately 25 workpieces 412 can be retained within this carrier assembly 452. Each carrier member 454, 456 have a plurality of support legs 458 to provide rigidity to the carrier assembly 452. In a preferred embodiment, as shown in FIG. 15, each carrier member 454, 456 has four radially extending and generally equally spaced support legs 458. The spacing between the support legs 458 allows the process fluid to reach the workpieces 412 in the process chamber 420. Further, the support legs 458 have a plurality of apertures 460 therethrough to reduce the weight of the carrier members 454, 456. As shown in FIG. 15, when the first and second carrier members 454, 456 are joined, first and second engaging members 457, 459 extend from the carrier assembly 452. The engaging members 457, 459 mate with the rotor assembly 474 (explained below) to positionally retain the carrier assembly 452 within the rotor assembly 474.

[0082] The carrier assembly 452 has a central bore area 462. At a perimeter of the central bore area 462 the carrier assembly 452 has a plurality of positioning members 464 which position and retain the semiconductor workpieces 412 within the carrier assembly 452. The positioning members 464 generally extend radially inward from the support legs 458. Thus, the positioning members 464 provide a gap between adjacent workpieces 412 in the carrier assembly 452 to allow the process fluid to interact with the entire backside of the

workpieces 412. As best shown in FIG. 16, the positioning members 464 assist in retaining the workpieces 412, which are mounted in the chucks 430 as explained above, on-edge in the carrier assembly 452. Notwithstanding, the geometry of the positioning members 464 generally allows the workpieces 412 slight free movement both axially and rotationally when positioned in the carrier assembly 452. Thus, the workpieces 412 are able to somewhat independently rotate within the carrier assembly 452. The carrier assembly 452 is typically made of polytetrafluoroethylene or stainless steel. In a preferred embodiment, it is made of polytetrafluoroethylene.

[0083] Another carrier assembly 466 is shown in FIG. 17. In this embodiment, the carrier assembly 466 has a first end plate 468, a second end plate 470 and a plurality of linking members 472 extending between the first end plate 468 to the second end plate 470. At least one of the linking members 472 has positioning members 464 depending therefrom and extending radially inward to position and retain the workpieces 412 within the carrier assembly 466. As in the carrier assembly 452 described above, the positioning members 464 in this carrier assembly 466 assist in retaining the workpieces 412, secured in the chucks 430, on-edge in the carrier assembly 468. Further, as in the carrier assembly described above, the positioning members 464 allow the workpieces 412 slight free movement both axially and rotationally when positioned in the carrier assembly 466. The carrier assemblies 452, 466 may be used to process workpieces 412 of various sizes, however they are typically configured to process workpieces 412 of one size, such as 200 mm or 300 mm diameter semiconductor wafers.

[0084] After the appropriate carrier assembly (for purposes of example, this disclosure will utilize carrier assembly 452 in further discussions herein) is loaded with the workpieces 412, it is fitted into a rotor assembly 474 contained in the cavity 506 of the process chamber 420. An example of a rotor assembly 474 is shown in FIGS. 18 and 19, and an example of a rotor assembly 474 loaded with a carrier assembly 452 is shown in FIG. 14. The rotor assembly 474 generally comprises a generally cylindrical rotor 476, a generally circular base plate 478 and a drive shaft 480. The rotor 476 has an exterior ring 482, a base 484, and a plurality of connecting members 486 extending between the base 484 and the exterior ring 482. A cavity 488 is defined between the interior of the base 484, connecting members 486 and exterior ring 482. The cavity 488 is shaped to accept the carrier assembly 452. The drive shaft 480 is connected to a drive plate 490 and rotates with the drive shaft 480. In turn,

a plurality of auxiliary drive rods 492 are connected to the drive plate 490. The drive rods 492 extend through the connecting members 486 to assist in driving the rotor assembly 474. Typically, the rotor 476 is made of a polytetrafluoroethylene, however, other materials are acceptable. Additionally, in order to maintain sufficient rigidity, but to reduce the weight, the auxiliary drive rods 492 are made of carbon graphite. The drive shaft 480 and drive plate 490 are typically made of stainless steel, or some other appropriate material. A seal 494 is utilized to ensure that the process fluid does not enter into the internal components of the rotor assembly 474.

[0085] Referring to FIGS. 14 and 22, the carrier assembly 452 is loaded into the rotor assembly 474 in a cavity 506 of the process chamber 420. The process chamber 420 comprises a chamber body 496 having a first end 498, a second end 500, an outer wall 502, and an opening 504 at the first end 498 of the chamber body 496 leading into the cavity 506 of the process chamber 420. The cavity 506 is shaped to contain a rotor assembly 474 that is to be filled with a carrier assembly 452 loaded with a plurality of workpieces 412. The chamber body 496 may have a split ring assembly 497 which connects to the first end 498 of the chamber body 496. In a preferred embodiment, the chamber body 496 is made of a substantially thick, e.g., approximately 25 mm. thick, polytetrafluoroethylene. This material is substantially inert to various corrosive and caustic etchants that are used in the etching/thinning process. It is understood, however, that other materials which provide similar qualities may also be utilized for the liner. Alternatively, the process chamber 420 may have a liner 507 which is made of such materials.

[0086] The process chamber 420 also has various assemblies connected thereto, including a door assembly 508 and a motor assembly 512. As shown in FIGS. 14 and 21, the motor assembly 512 generally comprises a motor 514 and a mounting plate 516. The motor 514 is connected to the mounting plate 516, and the mounting plate 516 is in turn connected to the second end 500 of the chamber body 496 of the process chamber 420. In a preferred embodiment, the motor 512 comprises a brushless D.C. servo motor. As shown in FIG. 23, the drive shaft 480 of the rotor assembly 474 extends out of the process chamber 420 and through an aperture 518 in the second end 500 of the chamber body 496. The drive shaft 480 is inserted into the motor 514 to allow the motor 514 to drive, i.e., provide rotational motion to, the drive shaft 480. Accordingly, through the drive shaft 480 of the rotor assembly 474, the motor 514 is able to rotate the carrier assembly 452 and the workpieces 412 therein.

[0087] The process chamber 420 also includes a spray assembly 510 to inject process fluid into the process chamber. In a preferred embodiment, the spray assembly 510 is integral with the process chamber 420. In a preferred embodiment as shown in FIGS. 14 and 20-24, the spray assembly 510 has a pair of dual, overlapping spray manifolds 520 to provide more uniform delivery of the process fluid. Each of the manifolds 520 has two inlet ports 521, a plurality of nozzles 522 positioned in nozzle receptacles 523, and a plurality of openings 525 through which the processing fluid is sprayed into the process chamber 420 from the nozzles 522. The manifolds 520 receive the process fluid at the inlet port 521 from a delivery tank 546, and distribute the process fluids along the length of the manifold 520 to a plurality of nozzles 522 as shown in FIG. 24. A nozzle retainer 524 covers the nozzles 522. The nozzles 522 spray the process fluid into the cavity 506 of the process chamber 420 and onto the exposed portion of the workpieces in the carrier assembly 452 as they are rotated by the rotor assembly 474.

[0088] In a preferred embodiment, each of the manifolds 520 have inlet ports 521 at both the first end 498 and the second end 500 of the process chamber 420, and nozzles 522 extending substantially along the entire length of the process chamber 420. This provides for a dual inlet of process fluid in opposing directions about the manifold 520. By having a dual inlet of the process fluid in the manifolds 520, the pressure drop across the manifold 520 is decreased and the amount of flow or volume of fluid able to be introduced into the process chamber 420 is increased.

[0089] Referring to FIG. 20, the door assembly 508 extends adjacent the first end 498 of the chamber body 496 to provide access into the cavity 506 of the process chamber 420. The door assembly 508 preferably forms a seal with the first end 498 of the process chamber 420. As shown in FIG. 20, the door assembly 508 generally comprises a support plate 526, a front panel plate 528, a door 530 and a pair of linear tracks or guides 532. In a preferred embodiment, the liner tracks 532 comprise linear actuators. The support plate 526 is connected to the chamber body 496 to fix the door assembly 508 to the process chamber 420. The front panel plate 528 extends below the support plate 526 and provides a support for a lower end of the linear actuators 532. The linear actuators 532 support the door 530 and provide for moving the door 530 from a first position, wherein the door 530 sealingly closes the opening 504 to the cavity 506 of the chamber body 496, to a second position (as shown in

FIG. 20) wherein the cavity 506 is accessible. The door 530 may also have a window 534 for allowing visual inspection into the process chamber 420.

[0090] As best shown in FIG. 13, the process chamber 420 is generally fixed within the cabinet 414 of the machine 410 at an inclined angle. In a preferred embodiment, the process chamber 420 has mounting members 536 on the sides of the chamber body 596. The mounting members 536 mate with receivers (not shown) in the machine 410 to support the process chamber 420. In this embodiment, the mounting members 536 operate as male-type mating members, and the receivers operate as female-type mating members. It is understood, however, that other types of mounting is possible without departing from the scope of the present invention, including that the mounting members 536 on the chamber body 496 may be of the female type, and the receiving members in the machine 410 may be of the male type.

[0091] While the process chamber 420 may be oriented horizontally, it is preferably orientated at an inclined angle. Moreover, in a preferred embodiment, the first end 498 of the chamber body 496 is inclined upwardly at an angle of, for example, 5 to 30°, and most preferably about 10°, so that the first end 498 of the process chamber 420 is at a higher elevation than the second end 500 of the processing chamber 420. To accomplish such an orientation, in a preferred embodiment the receiving members in the cabinet 414 are provided at the appropriate angle of inclination. The chamber body 496 of the process chamber 420 is connected to the receiving members via the mounting members 536 as described above. It is understood that the semiconductor workpieces are thus positioned at approximately the same angle of inclination as the process chamber 420.

[0092] As shown in FIGS. 21-23, the process chamber 420 has an exhaust vent 540 and a exit port or drain 542. The exhaust vent 540 exhausts gases and vapors from the cavity 506 of the processing chamber 420 and out a vent outlet 541. In a preferred embodiment, the exhaust vent 540 extends about substantially the entire length of the chamber body 496. The drain 542 comprises a drain trough that similarly extends about substantially the entire length of the chamber body 496 in a preferred embodiment to drain spent process fluid and removed silicon down and out of the process chamber 420. As shown in FIG. 22, the vent 540 may be located in an opposing portion of the chamber body as the drain 542. The drain 542 has a drain outlet 543 that is connected to a recirculation system 544 to drain the excess and used process fluid and silicon from the cavity 506 of the chamber body 496 of the process chamber

420. The recirculation system 544 typically delivers the excess and used process fluid from the process chamber to the appropriate delivery tank 546. Additionally, the process fluids and removed silicon may be drained out of the process chamber 420 and discarded instead of being recirculated. The vent 540 and the drain 542 are configured to provided remove the excess/used process fluid and fumes from the process chamber in a single pass. The fumes vent upward out the exhaust vent 540, and the spent process fluid and silicon are drained downward and out the drain 542.

[0093] In a preferred embodiment, the process fluid utilized in the current system comprises one or more of: water, hydrogen peroxide, ozone, potassium hydroxide, sodium hydroxide, hydrofluoric acid, nitric acid, sulfuric acid, acidic acid and phosphoric acid. Other process fluids are also possible. The process fluid can be mixed and adjusted to address the specific needs of the system.

[0094] A volume of the process fluid is typically housed in the delivery tank 546 for delivery to the process chamber 420. Additional components, however, may be provided as part of an overall system in delivering fluids from the delivery tank 546 to the process chamber 420. An example of a fluid delivery schematic is shown in FIG. 26. In that example, a pump 548 is used to pump the process fluid from the delivery tank 546 to the process chamber 420. A filter 550 is provided between the delivery tank 546 and the process chamber 420 to filter the process fluid. Additionally, a concentration monitor 552 may be provided between the delivery tank 546 and the process chamber 420 to monitor the concentration of the process fluid being delivered to the process chamber 420. Finally, a flow meter 554 is utilized to monitor the volume of process fluid delivered to the process chamber 420. A heat exchanger 556 may also be provided in connection with the delivery tank 546 to regulate the temperature of the process fluid therein. These components are typically housed in the overall tool 410.

[0095] The system may also include concentrated metering vessels 558 that contain concentrated volumes of the various processing fluids. For example, as shown in FIG. 26, three metering vessels 558 are provided. In this example one metering vessel contains hydrofluoric acid, another metering vessel contains nitric acid, and another metering vessel contains phosphoric acid. Each metering vessel 558 typically has its own metering pump 560 to deliver a specific process fluid from the metering vessel 558 to the delivery tank 546. Depending on the concentration of the process fluid, usually determined by the concentration

monitor 552, one or more of the metering pumps 560 may dose the bath of process fluid in the appropriate delivery tank 546 to maintain the required concentration of fluid therein. The metering vessels 558 may be housed within the tool 410, or they may be housed outside the tool and the fluid merely pumped to via the metering pumps 560 into the tool 410.

[0096] As explained below in the method for processing the workpieces, various cleaning and etching steps are provided. For each step, a separate delivery tank 546 is typically provided. Accordingly, the processing fluid necessary for the pre-cleaning step 612 may be housed in one delivery tank 546, the processing fluid necessary for the coarse etching step 614 may be housed in a separate delivery tank 546, the processing fluid necessary for the polish etching step 616 may be housed in another separate delivery tank 546, and the processing fluid necessary for the rinsing step 618 may be housed in yet another separate delivery tank 546. The metering vessels 558 may therefore be utilized to separately deliver fluid to the appropriate delivery tank 546 (only one delivery tank is shown in FIG. 26). Additionally, the recirculation system delivers the excess and used process fluid from the process chamber to the appropriate delivery tank 546 depending on the current process step.

D. PROCESS FOR THINNING A BATCH OF SEMICONDUCTOR WORKPIECES

[0097] One method for processing a batch of semiconductor workpieces is illustrated in FIG. 25. As illustrated therein, the first step 600 that is usually performed in processing the workpieces is to place the workpieces 412 in chucks 430 with the back side of the workpiece 412 exposed. The second step 602 includes loading the workpieces 412 (already in the chucks 430) into the carrier assembly 452 between the positioning members of the carrier assembly. After the carrier assembly 452 is fully loaded with a plurality of workpieces 412, typically 25 to 50 workpieces, the carrier assembly 452 is placed in the rotor assembly 474 within the cavity 506 of the process chamber 420 in step 604. After the workpieces 412 are loaded into the rotor assembly 474 in the process chamber 420, the door 530 is moved to the first position to sealingly close the opening 504 to the cavity 506 of the chamber body 496 (step 608).

[0098] After the workpieces 412 are placed in the cavity 506 and the door 530 to the process chamber 420 is closed, the workpieces are prepared to be processed. Typically, the workpieces 412 are processed while rotating in the process chamber 420. Accordingly, at step 610, the motor 514 is charged to rotate the rotor assembly 474 within the process

chamber 420. The workpieces 412 rotate with the carrier assembly 452 in the rotor assembly 474, however, the workpieces 412 also somewhat independently rotate and move axially as explained above. Next, process fluid is sprayed through the nozzles 522 of the spray assembly 510 onto the exposed portion of the workpieces in the carrier assembly 452 as they are rotated by the rotor assembly 474.

[0099] In one embodiment, a first pre-cleaning spray step (step 612) is performed. In this step 612, a cleaning fluid is sprayed through the spray assembly 510 and onto the exposed portion of the workpieces 412 in the process chamber 420 to remove surface contamination on the workpieces 412. The cleaning solution is housed in a first delivery tank and may comprise at least one of H_2O, H_2O_2 and NH_4OH. Next, a first coarse chemical etch is performed at step 614. In the first chemical etch step, an increased etch rate is utilized to remove larger quantities of the substrate from the workpiece 412. After the coarse chemical etch is performed on the workpieces 412, a polish chemical etch is performed on the workpieces 412 at step 616. The etch rate of the polish chemical etch is less than the etch rate of the coarse chemical etch. In a preferred embodiment, the step of chemically etching the workpieces 412 comprises applying a solution of HF, HNO_3 and H_3PO_4 to the workpieces 412. Two different delivery tanks are used to house the fluid for the coarse and polish etching processes. Through these two steps the batch of workpieces 412 are thinned in the process chamber 420. The workpieces 412 may be thinned to a thickness of less than 100 microns. Next, the workpieces 412 are rinsed in the process chamber at step 618. Rinsing the workpieces 412 generally comprises applying a solution of H_3PO_4 to the workpieces 412 in the process chamber 420. This solution is housed in yet another delivery tank 546. During each of these steps, the used process fluid is typically reclaimed via the recirculation system 544, and delivered from the process chamber 420 to the appropriate delivery tank 546.

[0100] After the workpieces 412 have been thinned and rinsed, they are typically removed from the process chamber 420 at step 620. Generally, the workpieces 412 remain in the carrier assembly 452, and the carrier assembly 452 is removed from the rotor assembly 474 in the process chamber 420. At step 624, the carrier assembly 452, holding the workpieces 412, is placed in the secondary processing module 418 for drying and rinsing thereof. The step of drying and rinsing the workpieces 412 in the drying and rinsing chamber 422 generally comprises first applying deionized water to the workpieces 412 to rinse the workpieces 412, and then applying isopropyl alcohol vapor or hot nitrogen gas to the

workpieces to dry the workpieces 412, all while spinning the workpieces 412. Each of these fluids may be held in yet another delivery tank.

[0101] After the workpieces 412 have been cleaned and dried, the carrier assembly 452 is removed from the secondary process chamber 422 at step 626. At step 628 the workpieces 412 are removed from the carrier assembly 452, and finally at step 630 the workpieces 412 are removed from the chucks 430.

E. THINNED SEMICONDUCTOR WORKPIECE

[0102] With reference now to FIGS. 10-11, the resulting thinned semiconductor workpiece 50 processed according to the process of the present invention will be described. As described above, the thinned workpiece 50 is comprised of a rim 70 and a main body 72. The rim 70 is formed at the periphery of the workpiece 50 and is integral with the main body 72. Generally, when processing standard semiconductor workpieces 50, the processed workpiece 50 will have a main body 72 with a thickness less than 125 microns and a rim 70 with a thickness in a range of approximately 600 to 725 microns. In a preferred embodiment, however, the main body 72 thickness will be less than 100 microns, preferably less than 50 microns, and especially less than 25 microns. As mentioned, the rim 70 is formed at the exclusion zone of the workpiece 50 and will have a width (shown as w in FIG. 10) in a range of 1-10 mm, preferably a range of 1-5 mm and especially in a range of 1-2 mm. The main body 72 and rim 70 are formed from substantially the same material as the pre-thinned workpiece 50. Most preferably the main body 72 and rim 70 are comprised of silicon.

[0103] As also mentioned above, it is contemplated that workpieces 50 that have previously been thinned by another process can be thinned according to the present invention. In these instances, the initial thickness of a workpiece 50 to be thinned according to the present invention may be 200 microns or less. In such case, a workpiece 50 thinned according to the present invention will have a main body 72 thickness less than about 50% of the rim 70 thickness, preferably less than about 40% of the rim 70 thickness, more preferably less than 30% of the rim 70 thickness, preferentially less than 20% of the rim 70 thickness, even less than 10% of the rim 70 thickness and especially less than 5% of the rim 70 thickness. It is also contemplated that the present invention can be used to thin workpieces 50 of varying sizes. Accordingly, the rim 70 will preferably comprise less than approximately 5% of the back side 53 surface area (BSSA) of the workpiece 50, more preferably less than 3% of the BSSA, and even less than 1% of the BSSA.

[0104] Numerous modifications may be made to the foregoing invention without departing from the basic teachings thereof. Although the present invention has been described in substantial detail with reference to one or more specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the scope and spirit of the invention.

CLAIMS

What is claimed is:

1. A chuck for receiving and supporting a semiconductor workpiece with a device side and a back side, the chuck comprising:

a body for supporting the workpiece;

a retainer removeably attached to the body and adapted to cover a peripheral portion of the back side of the workpiece; and

a member forming a seal between the retainer and the back side of the workpiece.

2. The chuck of claim 1, wherein said body comprises a groove for accepting a portion of the retainer.

3. The chuck of claim 1, wherein said body is comprised of polytetrafluoroethylene.

4. The chuck of claim 1, wherein the retainer is comprised of polyvinyldienefluoride.

5. The chuck of claim 1, wherein the member is comprised of a compressible material.

6. The chuck of claim 5, wherein the compressible material is a fluoroelastomer.

7. The chuck of claim 5, wherein the compressible material has a Durometer hardness greater than or equal to 50.

8. The chuck of claim 1, wherein the member is a fluoroelastomer O-ring.

9. The chuck of claim 1, wherein the member is positioned in an annular groove in the retainer.

10. The chuck of claim 1, wherein the retainer covers between about 1 mm and 10 mm of the periphery of the back side of the workpiece.

11. The chuck of claim 10, wherein the retainer covers between about 1 mm and 5 mm of the periphery of the back side of the workpiece.

12. The chuck of claim 11, wherein the retainer covers between about 2 mm and 4 mm of the periphery of the back side of the workpiece.

13. A chuck for receiving and supporting a semiconductor workpiece with a device side, a bevel and a back side, the chuck comprising:

a body having a semiconductor workpiece support surface;

a retainer removeably attached to the body and adapted to cover a peripheral portion of back side of the workpiece;

a first seal disposed in the retainer and forming a seal between the retainer and the back side of the workpiece; and

a second seal disposed in the retainer and forming a seal between the retainer and the body.

14. The chuck of claim 13, wherein the body has a step formed therein to center the semiconductor workpiece on the workpiece support surface.

15. The chuck of claim 13, wherein the retainer comprises an engagement member and the body comprises a recess configured to accept the engagement member and engage the retainer to body.

16. The chuck of claim 13, wherein the body comprises an engagement member and the retainer comprises a recess configured to accept the engagement member and engage the retainer to the body.

17. The chuck of claim 15, wherein the engagement member and the recess are positioned between the first and second seal.

18. The chuck of claim 16, wherein the engagement member and the recess are positioned between the first and second seal.

19. The chuck of claim 13, wherein the retainer covers the bevel and a peripheral portion of the back side of the workpiece when it is attached to the body.

20. The chuck of claim 13, wherein the retainer and the body each have an outer end configured to form a notch when the retainer is engaged to the body.

21. The chuck of claim 18, wherein the notch facilitates disengagement of the retainer from the body.

22. The chuck of claim 13, wherein the body is comprised of a material having a Durometer hardness, BDH, and the retainer is comprised of a material having a Durometer hardness, RDH, BDH being greater than RDH.

23. A chuck for supporting a workpiece having a device side, a bevel and a back side and preventing a process fluid from contacting the device side, bevel and a peripheral portion of the backside of the workpiece during a thinning process, the chuck comprising:

a body having a recess and a surface for supporting the workpiece;

a retaining ring having:

an engagement member configured to cooperate with the recess in the body and removeably attach the retaining ring to the body such that the retaining ring covers the bevel and the peripheral portion of the back side of the workpiece; and

an annular cavity with a compressible member disposed therein for forming a seal between the retaining ring and the workpiece, the seal preventing the process fluid from contacting the peripheral portion of the backside and the bevel of the workpiece.

24. The chuck of claim 23, wherein the retaining ring further comprises a second annular cavity with a second compressible member disposed therein for forming a seal between the retaining ring and the workpiece.

25. The chuck of claim 23, wherein the compressible member is comprised of a corrosion resistant material.

26. The chuck of claim 23, wherein the body supports the entire workpiece.

27. A process chamber for processing a plurality of semiconductor workpieces, the process chamber comprising:

a chamber body having a first end, a second end, an outer wall, and an opening at the first end leading into a cavity, wherein a carrier retaining a plurality of workpieces is removeably positioned within the cavity of the chamber;

a door assembly adjacent the first end of the chamber body, the door assembly having a door that closes the opening of the chamber body;

a motor connected to the chamber body to rotate the carrier within the cavity of the chamber body, and;

a spray assembly having a nozzle to spray a process fluid into the cavity of the chamber body and onto exposed portions of the plurality of workpieces in the carrier;

a vent in the chamber body to vent vapors from the cavity of the process chamber, the vent extending from proximal the first end to proximal the second end of the chamber body; and,

an drain trough in the chamber body, the drain trough extending from proximal the first end to proximal the second end of the chamber body to drain process fluid from the cavity of the chamber body.

28. The process chamber of claim 27, wherein the vent and the drain trough are provided in radially opposing areas of the chamber body.

29. The process chamber of claim 27, further comprising a rotor assembly positioned within the cavity of the chamber body, the carrier being positioned within the rotor assembly, and wherein the motor drives the rotor assembly to rotate the rotor assembly within the chamber body, the rotor assembly providing rotational motion to the carrier and the plurality of workpieces therein.

30. The process chamber of claim 27, wherein the carrier has a plurality of positioning members retaining the workpieces on edge in the carrier, the positioning members providing a gap between adjacent workpieces.

31. The process chamber of claim 30, wherein the workpieces are free to independently rotate within the carrier.

32. The process chamber of claim 27, wherein the housing has a liner in the cavity thereof, the liner being made of at least one of polytetrafluoroethylene or stainless steel.

33. The process chamber of claim 27, wherein the spray assembly extends from generally adjacent the first end of the chamber body to a distance proximal the second end of the chamber body.

34. The process chamber of claim 27, wherein the spray assembly comprises a spray manifold having a plurality of nozzles.

35. The process chamber of claim 34, wherein the spray manifold has two inlet ports.

36. The process chamber of claim 35, wherein the inlet ports are provided at opposing ends of the spray manifold.

37. The process chamber of claim 27, wherein the spray assembly comprises a first spray manifold having a plurality of nozzles, and a second spray manifold having a plurality of nozzles.

38. The process chamber of claim 37, wherein the first spray manifold has two inlet ports, and wherein the second spray manifold has two inlet ports.

39. The process chamber of claim 27, further comprising mounting members connected to the chamber body to secure the chamber body and the workpieces therein at an incline.

40. The process chamber of claim 27, wherein the door moves from a first position to a second position, the door sealingly closing the opening of the cavity of the chamber body in the first position, and the cavity being accessible through the opening when the door is in the second position.

41. The process chamber of claim 40, further comprising a linear track supporting the door, the door moving from the first position to the second position about the linear track.

42. A process chamber for processing a plurality of semiconductor workpieces, the process chamber comprising:

a chamber body having a first end, a second end, an outer wall, and an opening at the first end leading into a cavity, wherein a carrier retaining a plurality of workpieces is removeably positioned within the cavity of the chamber;

a door assembly adjacent the first end of the chamber body, the door assembly having a door that closes the opening of the chamber body;

a motor connected to the chamber body to rotate the carrier within the cavity of the chamber body, and;

a spray assembly having a manifold and a plurality of nozzles in communication therewith to spray a process fluid into the cavity of the chamber body and onto exposed portions of the plurality of workpieces in the carrier, the manifold having a first inlet port and an opposing second inlet port to provide fluid into the manifold.

43. The process chamber of claim 42, wherein the first inlet port is at a first end of the manifold, and wherein the second inlet port is at a second end of the manifold.

44. The process chamber of claim 42, further comprising a second manifold having a plurality of nozzles in communication therewith, the second manifold having a first inlet port and an opposing second inlet port.

45. The process chamber of claim 44, wherein the first inlet port for the second manifold is positioned at a first end of the second manifold, and wherein a second inlet port for the second manifold is positioned at a second end of the second manifold.

46. A tool for thinning a plurality of semiconductor workpieces, the tool comprising:

a cabinet;

a process chamber in the cabinet, the process chamber comprising:

a chamber body having a first end, a second end, an outer wall, an opening at the first end leading into a cavity, a vent in the chamber body to vent vapors from the cavity, and a drain trough in the chamber body to drain the process fluid from the cavity;

a door assembly connected to the chamber body adjacent the first end of the chamber body, the door assembly having a door that closes the opening of the chamber body;

a spray assembly having a manifold in association with a plurality of nozzles to spray a process fluid into the cavity of the chamber body and onto the semiconductor workpieces;

a delivery tank in fluid communication with the process chamber, wherein the delivery tank retains a volume of the process fluid, and wherein the process fluid is delivered from the delivery tank to the spray assembly of the process chamber; and,

a recirculation system fluidly connected between the exit port of the process chamber and the delivery tank to communicate used process fluid from the process chamber to the delivery tank.

47. The tool of claim 46, wherein the vent extends from substantially the first end to the second end of the chamber body, and wherein the drain trough in extends from substantially the first end to the second end of the chamber body to drain process fluid from the cavity of the chamber body.

48. The tool of claim 46, wherein the spray assembly extends from generally proximal the first end of the chamber body to a distance proximal the second end of the chamber body.

49. The tool of claim 46, wherein the manifold has two inlet ports.

50. The tool of claim 49, wherein the inlet ports are provided at opposing ends of the manifold.

51. The tool of claim 46, wherein the spray assembly comprises a first manifold having a plurality of nozzles, and a second manifold having a plurality of nozzles.

52. The tool of claim 51, wherein the first manifold has two opposing inlet ports, and wherein the second manifold has two opposing inlet ports.

53. The tool of claim 46, further comprising a carrier retaining a plurality of the workpieces, the carrier being removeably located within a rotor assembly positioned within the cavity of the chamber body, and wherein the motor drives the rotor assembly to rotate the rotor assembly within the chamber body, the rotor assembly providing rotational motion to the carrier and semiconductor workpieces therein.

54. The process chamber of claim 53, wherein the carrier has a plurality of positioning members retaining the semiconductor workpieces on edge in the carrier, the positioning members providing a gap between adjacent semiconductor workpieces to allow the workpieces to independently rotate within the carrier.

55. The tool of claim 46, wherein the delivery tank has a heat exchanger coil to regulate the temperature of the processing fluid in the delivery tank.

56. The tool of claim 46, further comprising a mounting member of the chamber body mating with a receiver in the cabinet to support the chamber body at an incline within the cabinet.

57. The tool of claim 46, further comprising a plurality of metering vessels in fluid communication with the processing chamber, the metering vessels containing processing fluid for use in the processing chamber to thin the semiconductor workpiece.

58. The tool of claim 57, further comprising a metering pump for each metering vessel to selectively dose the processing fluid in the delivery tank to maintain an appropriate concentration of chemicals therein.

59. The tool of claim 46, further comprising a pump, a filter and a flow meter between the delivery tank and the process chamber, wherein the pump assists in delivering processing fluid from the delivery tank to process chamber, wherein the filter filters the processing fluid transferred to the process chamber, and wherein the flow meter measures the amount of processing fluid being delivered to the process chamber.

60. The tool of claim 59, further comprising a concentration monitor between the delivery tank and the process chamber to determine the concentration of fluids in the processing fluid delivered to the process chamber.

61. The tool of claim 46, further comprising a secondary process chamber in the cabinet.

62. The tool of claim 46, further comprising a drying and rinsing chamber within the cabinet to dry and rinse the workpiece after it has been thinned.

63. A method for simultaneously processing a plurality of semiconductor workpieces, comprising the steps of:

placing a plurality of workpieces in a carrier;

loading the carrier in a process chamber, the process chamber comprising:

a chamber body having a first end, a second end, an outer wall, and an opening at the first end leading into a cavity;

a door assembly connected to the chamber body adjacent the first end of the chamber body, the door assembly having a door that moves from a first position whereby the door closes the opening to the cavity of the chamber body, to a second position whereby the opening to the cavity of the chamber body is accessible;

a spray assembly having a manifold in communication with a plurality of nozzles to spray a process fluid into the cavity of the chamber body, the manifold having a first inlet port and a second opposing inlet port for receiving the process fluid;

rotating the carrier in the cavity of the process chamber; and,

spraying a process fluid from through the nozzles and on an exposed portion of the workpieces in the carrier.

64. The method of claim 63, wherein the carrier has a plurality of positioning members, wherein the workpieces are inserted into the carrier on-edge between the positioning members.

65. The method of claim 63, wherein the retainers for the workpieces comprise chucks, and further comprising the steps of:

placing the chucks in the carrier and between positioning members thereof.

66. The method of claim 65, wherein the chucks cover a peripheral portion of a backside the workpieces, leaving at least 95% of a surface area of the backside of the workpieces exposed.

67. The method of claim 63, further comprising the steps of:

placing the carrier in a rotor assembly in the process chamber, the process chamber having a motor; and,

powering the motor to rotate the rotor assembly in the process chamber.

68. The method of claim 63, wherein the carrier is made at least partially of polytetrafluoroethylene.

69. The method of claim 63, further comprising the step of simultaneously venting and draining the cavity of the process chamber, the process chamber having a vent that extends from proximal the first end of the chamber body to proximal the second end of the chamber body, and the process chamber having a drain trough that extends from proximal the first end of the chamber body to proximal the second end of the chamber body.

70. The method of claim 63, further comprising the steps of rinsing and drying the workpieces after they have been thinned.

71. The method of claim 70, wherein the step of rinsing the workpieces comprises applying deionized water to the workpieces.

72. The method of claim 70, wherein the step of drying the workpieces comprises applying at least one of isopropyl alcohol or heated nitrogen to the workpieces.

73. The method of claim 63, wherein the step of spraying a process fluid on the workpieces comprises spraying a process fluid on the workpieces through a plurality of nozzles of the spray assembly when the workpieces are rotated in the process chamber.

74. The method of claim 73, wherein the process fluid is a selected from the group consisting of water, hydrogen peroxide, ozone, potassium hydroxide, sodium hydroxide, hydrofluoric acid, nitric acid, sulfuric acid, acidic acid and phosphoric acid.

75. The method of claim 73, further comprising the step of reclaiming used process fluid from within the process chamber.

76. The method of claim 63, wherein the step of spraying a process fluid from the spray assembly on an exposed portion of the workpieces in the carrier assembly comprises the steps of:

pre-cleaning the workpieces in the process chamber with a cleaning solution to remove surface contamination;

chemically etching the workpieces in the process chamber with an etching fluid to thin the workpieces; and,

rinsing the workpieces in the process chamber.

77. The method of claim 76, wherein the step of conducting a pre-clean of the workpiece comprises applying a cleaning solution to the workpieces.

78. The method of claim 77, wherein the cleaning solution comprises at least one of H_2O, H_2O_2 and NH_4OH.

79. The method of claim 76, wherein the step of chemically etching the workpieces in the carrier assembly comprises the steps of: conducting a coarse chemical etch of the workpieces in the process chamber and conducting a polish chemical etch of the workpieces in the process chamber.

80. The method of claim 79, wherein an etch rate of the coarse chemical etch is greater than an etch rate of the polish chemical etch.

81. The method of claim 76, wherein the step of chemically etching the workpieces comprises applying a solution of HF, HNO_3 and H_3PO_4 to the workpiece.

82. The method of claim 76, wherein the step of rinsing the workpieces comprises applying a solution of H_3PO_4 to the workpieces in the process chamber.

83. A system for chemically thinning a batch of semiconductor workpieces, the system comprising:

a plurality of workpiece stations, with at least one station having an apparatus comprising:

a process chamber having a chamber body having a first end, a second end, an outer wall, and an opening at the first end leading into a cavity, the process chamber having a vent to vent vapors from the cavity of the process chamber, the vent extending from proximal the first end of the chamber body to proximal the second end of the chamber body, the process chamber also having a drain trough to drain process fluid from the cavity of the process chamber, the drain trough extending from proximal the first end of the chamber body to proximal the second end of the chamber body;

a carrier for holding a plurality of the workpieces, the workpieces being retained about a peripheral portion of the workpieces, and the carrier being positioned in the cavity of the process chamber;

a door assembly adjacent the first end of the chamber body, the door assembly having a door that selectively closes the opening of the chamber body;

a motor connected to the chamber body to rotate the carrier and the workpieces therein; and,

a spray assembly associated with the process chamber, the spray assembly having a nozzle to spray a process fluid into the cavity of the chamber body and onto the semiconductor workpiece to thin the workpiece.

84. The system of claim 83, further comprising a rotor assembly supporting the carrier, the rotor assembly having a drive member that is coupled to the motor, the motor providing rotational motion to the drive member to rotate the rotor assembly.

85. The system of claim 84, wherein the carrier has a plurality of positioning members, wherein the workpieces are retained between the positioning members of the carrier, and wherein the carrier is positioned within the rotor assembly.

86. The system of claim 83, further comprising mounting members of the process chamber which mate with receiving members of the cabinet to support the process chamber at an incline in the cabinet.

87. The system of claim 83, wherein the spray assembly extends from generally adjacent the first end of the chamber body to a distance proximal the second end of the chamber body, and wherein the spray manifold has two inlet ports provided at opposing ends of the spray manifold.

88. The system of claim 87, wherein the spray assembly further comprises a second spray manifold having a plurality of nozzles, the second spray manifold has two inlet ports at opposing ends of the second manifold.

89. The system of claim 83, wherein the door assembly further comprises a linear actuator guide about which the door moves from a first closed position to a second open position.

90. The system of claim 83, where at least another one station has an apparatus comprising a secondary process chamber.

91. The system of claim 90, wherein the secondary process chamber comprises a drying and rinsing chamber to dry and rinse the workpieces after they have been thinned.

92. The system of claim 83, further comprising a delivery tank in fluid communication with the process chamber, the delivery tank housing a volume of the process fluid.

93. The system of claim 92, wherein the process fluid comprises at least one of water, hydrogen peroxide, ozone, potassium hydroxide, sodium hydroxide, hydrofluoric acid, nitric acid, sulfuric acid, acidic acid and phosphoric acid.

94. The system of claim 92, further comprising a recirculation system in fluid communication with the exit port and the delivery tank to communicate process fluid from the process chamber to the delivery tank.

95. A semiconductor workpiece comprising:

a main body having a thickness less than approximately 150 microns; and

a rim connected to the main body and having a thickness in a range of approximately 150 to 725 microns.

96. The semiconductor workpiece of claim 95, wherein the main body thickness is less than 100 microns.

97. The semiconductor workpiece of claim 95, wherein the main body thickness is less than 50 microns.

98. The semiconductor workpiece of claim 95, wherein the main body thickness is less than 25 microns.

99. The semiconductor workpiece of claim 95, wherein the rim and the main body are integral.

100. The semiconductor workpiece of claim 95, wherein the rim and the main body are comprised of silicon.

101. The semiconductor workpiece of claim 95, wherein the rim has a thickness in a range of approximately 600-725 microns.

102. The semiconductor workpiece of claim 95, wherein the rim has a thickness in a range of approximately 300-725 microns.

103. A semiconductor workpiece having a back side surface area, BSSA, the semiconductor workpiece comprising:

a rim comprising less than approximately 5% of the BSSA and having a thickness, RT; and

a main body having a thickness, MBT, less than approximately 50% of RT.

104. The semiconductor workpiece of claim 103, wherein the rim comprises less than approximately 3% of the BSSA.

105. The semiconductor workpiece of claim 103, wherein the rim comprises less than approximately 1% of the BSSA.

106. The semiconductor workpiece of claim 103, wherein the MBT is less than approximately 40% of the RT.

107. The semiconductor workpiece of claim 103, wherein the MBT is less than approximately 30% of the RT.

108. The semiconductor workpiece of claim 103, wherein the MBT is less than approximately 20% of the RT.

109. The semiconductor workpiece of claim 103, wherein the MBT is less than approximately 10% of the RT.

110. The semiconductor workpiece of claim 103, wherein the MBT is less than approximately 5% of the RT.

111. The semiconductor workpiece of claim 103, wherein the rim imparts structural integrity to the main body.

112. A semiconductor workpiece having a back side surface area, BSSA, the semiconductor workpiece comprising:

a main body comprising at least 95% of the BSSA;

a rim connected to the main body and comprising less than approximately 5% of the BSSA, having a thickness RT, and formed from the same material as the main body; and

the main body having a thickness less than approximately 50% of the RT.

113. The semiconductor workpiece of claim 112, wherein the same material is silicon.

114. The semiconductor workpiece of claim 112, wherein the main body has a thickness less than approximately 40% of the RT.

115. The semiconductor workpiece of claim 112, wherein the main body has a thickness less than approximately 30% of the RT.

116. The semiconductor workpiece of claim 112, wherein the main body has a thickness less than approximately 20% of the RT.

117. The semiconductor workpiece of claim 112, wherein the main body has a thickness less than approximately 10% of the RT.

118. A process for thinning a back side of a semiconductor workpiece having a surface area, BSSA, the process comprising the steps of:

placing the semiconductor workpiece into a chuck adapted to cover a peripheral portion of the back side of the workpiece leaving at least 95% of the BSSA is exposed; and

thinning the exposed back side of the workpiece to create a rim having a thickness, RT, and a main body having a thickness less than approximately 50% of the RT.

119. The process of claim 118, wherein the main body has a thickness less than approximately 40% of the RT.

120. The process of claim 118, wherein the main body has a thickness less than approximately 30% of the RT.

121. The process of claim 118, wherein the main body has a thickness less than approximately 20% of the RT.

122. The process of claim 118, wherein the main body has a thickness less than approximately 10% of the RT.

123. The process of claim 118, wherein at least 97% of the BSSA is exposed.

124. The process of claim 118, wherein at least 99% of the BSSA is exposed.

125. The process of claim 118, wherein the rim is formed at the periphery of the workpiece.

126. The process of claim 118, wherein RT is in a range of 200 to 725 microns.

127. The process of claim 126, wherein the main body has a thickness in a range of about 100 to 120 microns.

128. The process of claim 126, wherein the main body has a thickness in a range of about 50 to 100 microns.

129. The process of claim 126, wherein the main body has a thickness in a range of about 25 to 50 microns.

130. The process of claim 118, wherein the main body has a thickness in a range of about 100 to 120 microns.

131. The process of claim 118, wherein the main body portion has a thickness in a range of about 50 to 100 microns.

132. The process of claim 118, wherein the main body portion has a thickness in a range of about 25 to 50 microns.

133. A process for thinning a back side of a semiconductor workpiece having a thickness, WPT, the process comprising the steps of:

placing the semiconductor workpiece onto a chuck body so that the back side of the workpiece is exposed;

attaching a retainer to the chuck body so that the workpiece is secured to the chuck and a peripheral portion of the back side of the workpiece is covered by the retainer; and

thinning the exposed portion of the back side of the workpiece to create a rim and a main body portion, the main body portion having a thickness, MBT, less than 50% of the WPT.

134. The process of claim 133, wherein the step of thinning the exposed portion of the back side of the workpiece comprises chemically etching semiconductor material away from the exposed portion of the back side of the workpiece.

135. The process of claim 134, wherein the step of thinning the exposed portion of the back side of the workpiece further comprises the step of polishing the exposed portion of the back side of the workpiece.

136. A process for thinning a back side of a semiconductor workpiece having a thickness, WPT, the process comprising the steps of:

placing the semiconductor workpiece onto a chuck adapted to surround a peripheral portion of the back side of the workpiece so that a main body portion of the back side of the workpiece is exposed;

placing the chuck and workpiece into a process vessel; and

applying a process fluid to the exposed main body portion of the back side of the workpiece to thin the main body portion to less than 50% of the WPT.

137. The process of claim 136, wherein the step of applying a process fluid to the exposed main body portion comprises spraying the process fluid through a nozzle onto the main body portion of the back side of the workpiece.

138. The process of claim 136, wherein the step of applying a process fluid to the exposed main body portion comprises immersing the exposed main body portion into a volume of the process fluid.

139. The process of claim 136, wherein the process fluid is a process fluid selected from the group consisting of water, hydrogen peroxide, ozone, potassium hydroxide, sodium hydroxide, hydrofluoric acid, nitric acid, sulfuric acid, acidic acid and phosphoric acid.

140. The process of claim 136 further comprising a step of rinsing the main body portion of the workpiece after it is thinned.

141. The process of claim 140, wherein the rinsing step comprises applying phosphoric acid to the main body portion of the workpiece after it is thinned.

142. The process of claim 140 further comprising a step of drying the thinned workpiece.

143. The process of claim 136, wherein the process fluid is applied to the exposed main body portion at a first etch rate and then subsequently applied at a second etch rate.

144. The process of claim 143, wherein the first etch rate is greater than the second etch rate.

145. The process of claim 136 further comprising the step of measuring the thickness of the main body portion of the workpiece.

146. The process of claim 136, wherein the process fluid has a flow rate, a concentration and a temperature and the process further comprises a step of monitoring at least one of the flow rate, concentration and temperature of the process fluid.

147. A process for thinning a back side of a semiconductor workpiece, the process comprising the steps of:

placing the semiconductor workpiece onto a chuck;

attaching the retainer to the chuck to secure the work piece to the chuck and surround a peripheral portion of the back side of the workpiece so that a main body portion of the back side of the workpiece is exposed;

placing the chuck in a carrier;

loading the carrier into a process vessel;

rotating the chuck in the process vessel; and

applying a process fluid to the exposed main body portion of the back side of the workpiece as the chuck rotates to thin the main body portion of the back side of the workpiece to a thickness and create a rim having a thickness greater than the main body portion thickness.

148. A semiconductor workpiece produced by:

providing the semiconductor workpiece having a device side and a back side, an interior region and an outer peripheral region, and a thickness, WPT;

shielding the outer peripheral region of the back side of the semiconductor work piece; and

exposing the interior region of the back side of the semiconductor workpiece to a process fluid to thin the interior region to a thickness less than 0.5 x WPT.

149. The semiconductor workpiece of claim 148, wherein the interior region has been thinned to a thickness less than 0.4 x WPT.

150. The semiconductor workpiece of claim 148, wherein the interior region has been thinned to a thickness less than 0.3 x WPT.

151. The semiconductor workpiece of claim 148, wherein the interior region has been thinned to a thickness less than 0.2 x WPT.

152. The semiconductor workpiece of claim 148, wherein the step of exposing the interior region of the back side of the semiconductor workpiece to a process fluid to thin the interior region creates a rim at the outer peripheral region of the semiconductor workpiece.

153. The semiconductor workpiece of claim 152, wherein the rim has a thickness substantially equal to WPT.

154. The semiconductor workpiece of claim 152, wherein the rim has a configuration substantially the same as a pre-processing configuration of the outer peripheral region of the semiconductor workpiece.

155. The semiconductor workpiece of claim 152, wherein the rim imparts structural integrity to the semiconductor workpiece.

156. A semiconductor workpiece having a device side, a bevel and a back side, the semiconductor workpiece thinned according to the process of:

providing a semiconductor workpiece comprised of silicon and having a thickness, WPT;

placing the semiconductor workpiece device side down on a chuck having a body and a retainer;

engaging the retainer to the body so that the retainer extends around the bevel and shields a peripheral portion of the back side of the workpiece;

exposing an interior region of the back side of the semiconductor workpiece; and

applying a process fluid to the exposed interior region of the back side of the semiconductor workpiece to thin the interior region to a thickness less than 0.50 x WPT and form a rim comprised of silicon having a thickness substantially the same as the WPT.