METHODS FOR FORMING INTERCONNECTS IN VIAS AND MICROELECTRONIC WORKPIECES INCLUDING SUCH INTERCONNECTS

TECHNICAL FIELD

[0001] The present invention relates to forming interconnects in deep vias to electrically couple conductive elements at different elevations of a microelectronic workpiece.

BACKGROUND

[0002] Microelectronic devices, micromechanical devices, and other devices with microfeatures are typically formed by constructing several layers of components on a workpiece. In the case of microelectronic devices, a plurality of dies are fabricated on a single workpiece, and each die generally includes an integrated circuit and a plurality of bond-pads coupled to the integrated circuit. The dies are separated from each other and packaged to form individual microelectronic devices that can be attached to modules or installed in other products.

[0003] One aspect of fabricating and packaging such dies is forming interconnects that electrically couple conductive components located in different layers. In some applications, it may be desirable to form interconnects that extend completely through the dies or through a significant portion of the dies. Such interconnects electrically couple bond-pads or other conductive elements proximate to one side of the dies to conductive elements proximate to the other side of the dies. Through-wafer interconnects, for example, are constructed by forming deep vias from the backside of the wafer to bond-pads on the front side of the wafer. The vias are often blind vias in that they are closed at one end. The blind vias are then filled with a conductive material. After further processing the wafer, it is eventually thinned to reduce the thickness of the final dies. Solder balls or other external electrical contacts are subsequently attached to the through-wafer interconnects at the backside of the wafer.

[0004] One concern of forming through-wafer interconnects in blind vias is that it is difficult to form such deep, narrow holes in the wafer. The blind vias are often formed at a stage when the workpieces are approximately 750–1,500 μm thick. The blind vias can be formed by etching the holes through a significant portion of the workpiece, but etching deep, narrow holes requires a significant amount of time. Moreover, the depth of the holes is difficult to control and the etchant may damage features on the backside of the workpiece.

[0005] The blind vias are also formed by laser drilling holes into the workpiece. Laser drilling deep, narrow holes through the workpiece is not practical in several applications. First, it is difficult to control the depth of the holes. More specifically, the bond-pad may not be exposed if the hole is not deep enough, or the bond-pad may be ablated if the hole is drilled too deep. Second, laser drilling deep into the workpiece produces large heat-affected zones that may affect neighboring structures within the wafer and slag that is difficult to clean. Therefore, etching or laser drilling such deep, high aspect ratio holes in a workpiece at this stage of the fabrication process may not be practical in many applications.

[0006] Another concern of forming through-wafer interconnects is that it is difficult to fill deep, narrow blind vias. Vapor deposition processes, for example, may not uniformly cover the sidewalls in such holes, and this may cause the openings of the holes to be "pinched-off" before the holes are filled with the conductive material. The resulting interconnects may have voids. Plating processes may also produce voids because the seed layers have similar nonuniformities that cause the plating rate to be higher at the openings than deep within the vias.

[0007] Furthermore, it is not feasible to further thin the workpieces before forming the interconnects because the workpiece may not have sufficient structural integrity to withstand the automatic handling equipment used in subsequent processes. For example, very thin wafers easily flex and will partially conform to vacuum chunks used in handling the wafer. Such thin wafers are also very delicate and are easily damaged or broken. Therefore, there is a need to more effectively form blind vias and other deep holes in microfeature workpieces.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figures 1A-1E are cross-sectional views illustrating a portion of a workpiece at stages of a method for forming interconnects in accordance with an embodiment of the invention.

[0009] Figures 2A-2B are cross-sectional views illustrating a portion of a workpiece in more detail at stages of a method for forming interconnects in accordance with an embodiment of the invention.

[0010] Figures 3A-3D are cross-sectional views illustrating a portion of a workpiece at stages of a method for forming interconnects in accordance with another embodiment of the invention.

[0011] Figure 4 is a cross-sectional view of a portion of a workpiece illustrating a stage of a method for forming interconnects in accordance with yet another embodiment of the invention.

[0012] Figures 5A-5E are cross-sectional views of a portion of a workpiece illustrating stages of a method for forming interconnects in accordance with another embodiment of the invention.

[0013] Figures 6A-6C are cross-sectional views of a portion of a workpiece illustrating stages of a method for forming interconnects in accordance with still another embodiment of the invention.

[0014] Figures 7A-7C are cross-sectional views of a portion of a workpiece illustrating stages of a method in accordance with another embodiment of the invention.

DETAILED DESCRIPTION

A. Overview

[0015] The following disclosure describes several embodiments of methods for forming interconnects in blind vias or other types of holes, and microelectronic workpieces having such interconnects. The blind vias extend to contact surfaces of conductive elements, and the interconnects engage the conductive elements to electrically couple the conductive elements with other features at a different level of

the workpiece. As explained below, many embodiments of the invention efficiently form the blind vias and also fill the blind vias with a conductive material in a manner that mitigates voids.

[0016] The blind vias can be formed by first removing a significant thickness of material from selected regions of the back side of the workpiece using a fast bulk removal process without thinning the entire workpiece. The bulk removal process, for example, can form a first opening that extends to an intermediate depth within the workpiece but does not extend to the contact surface of the electrically conductive element. The first opening can be formed with an abrasive disk, a laser, or an isotropic etch that quickly removes the material to the intermediate level. The first opening can be a trench or other depression having a first width larger than the desired width for the interconnects. After forming the first opening, a second opening is formed from the intermediate level in the first opening to the contact surface of the conductive element. The second opening has a second width less than the first width of the first opening. The second opening can be formed using a more precise laser or etching process. This two-step process is expected to reduce the time required to form the blind vias for the interconnects, provide better control for end-pointing the depth of the vias, and reduce undesirable collateral damage to the workpiece (e.g., heat-affected zones, etc.).

[0017] One embodiment of a method for forming an interconnect comprises forming a plurality of cavities in the workpiece and constructing blind vias from the cavities to the contact surfaces of the conductive elements. The cavities have a first width at a first exterior side of the workpiece and a depth extending to an intermediate level in the workpiece. The blind vias extend from the intermediate level in the cavities to the contact surfaces of the conductive elements. The blind vias have a second width less than the first width of the cavities. Several embodiments of this method further include filling the blind vias with a conductive material and subsequently thinning the workpiece from the exterior side until the cavities are eliminated. The workpiece can be thinned by removing material from the exterior surface of the workpiece to form a back surface at least at the intermediate depth. For example, the backside of the workpiece can be ground and/or planarized until the back surface is formed between the contact surfaces of the conductive elements and the intermediate level of the cavities.

[0018] Another embodiment of a method for forming an interconnect includes removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface. The end-surface is spaced apart from the contact surface of the conductive element. This embodiment further includes forming a blind via extending from the end-surface of the depression to the contact surface of the conductive element. The blind via has a second width less than the first width of the depression. Additional embodiments of this method further include depositing a conductive material into the blind via until the blind via is filled with the conductive material, and terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material.

[0019] Another aspect of the invention is directed toward microelectronic workpieces having suitable structures for forming interconnects engaged with a contact surface of a conductive element. In one embodiment, a microelectronic workpiece includes a substrate having a plurality of microelectronic dies at an active side of the substrate. The dies include conductive elements having blind contact surfaces (e.g., contact surfaces that are not exposed on an exterior surface of the workpiece). The workpiece further includes a cavity in a backside of the substrate and a via extending further into the substrate from the cavity. The cavity has a first width at the backside and a first depth extending from the backside to an intermediate level between the active side and the backside. The via is aligned with the cavity and extends from the intermediate level in the cavity to a contact surface of one of the conductive elements. The via has a second width less than the first width of the cavity. The workpiece further includes conductive material in the via. The conductive material fills the via, but not the cavity, such that a void remains in the cavity after filling the via. The void in the cavity, more specifically, can be an unoccupied depression that is eliminated after the wafer has been thinned.

[0020] Another embodiment of a microelectronic workpiece includes a substrate having a plurality of dies at an active side of the substrate. The workpiece further includes a first opening extending from a backside of the substrate to an intermediate level within the substrate. The first opening is located in a sacrificial portion of the substrate that is subsequently removed when the workpiece is thinned. The workpiece can further include a second opening aligned with the first opening.

The second opening extends to a contact surface at one of the conductive elements. The second opening is at least partially filled with a conductive material.

[0021] Specific details of several embodiments of the invention are described below with reference to through-wafer interconnects extending from a bond-pad proximate to the active side of a workpiece, but the methods and workpieces described below can be used for other types of interconnects within microelectronic workpieces. Several details describing well-known structures or processes often associated with fabricating microelectronic devices are not set forth in the following description for purposes of clarity. Also, several other embodiments of the invention can have different configurations, components or procedures than those described in this section. A person of ordinary skill in the art, therefore, will accordingly understand that the invention may have other embodiments with additional elements, or the invention may have other embodiments without several of the elements shown and described below with reference to Figures 1A-7C.

B. Forming Interconnects in Blind Vias

[0022] Figures 1A-1E illustrate forming blind vias and interconnects in a workpiece 10 in accordance with an embodiment of the invention. Figure 1A illustrates the workpiece 10 at an initial stage before the blind vias and interconnects have been formed. The workpiece 10 can include a substrate 12 having a first side 14 and a second side 16. The workpiece 10 can also include a plurality of microelectronic dies 20 at the second side 16 of the substrate 12. Each microelectronic die 20 can include an integrated circuit 22 and a plurality of conductive elements 24 operatively coupled to the integrated circuit 22. The conductive elements 24 shown in Figure 1A are internal features, such as bond-pads that have not been exposed at the second side 16, that include contact surfaces 26. In the embodiment shown in Figure 1A, the contact surfaces 26 are blind or embedded surfaces in that they are not at the exterior of the workpiece 10.

[0023] Figure 1B illustrates the workpiece 10 at a bulk removal stage of the method in which the workpiece 10 has been inverted such that the first side 14 faces upward and the second side 16 faces downward. At this stage, one or more first openings 30 are formed in the workpiece 10. The first openings 30 can be cavities or depressions having a first width W_1 at the first side 14 of the substrate 12 and a

depth D at an intermediate level within the workpiece. More specifically, the first openings 30 can have one or more sidewalls 34 separated by the first width W_1 and an end-surface 32 at the depth D. The depth D of the first openings 30 is selected to reduce the thickness of the workpiece 10 from an initial thickness T_i to a thickness at least proximate to a final desired thickness T_f in regions of the workpiece aligned with the conductive elements 24. The end-surface 32 of the first openings 30 is accordingly located at a level within the workpiece 10 at least proximate to the desired final thickness T_f after thinning the workpiece. As a result, the first openings 30 are located in a sacrificial portion of the workpiece 10 that is removed when the workpiece is thinned.

[0024] The first openings 30 can be a pattern of trenches or holes. The first openings 30, for example, can be formed using wet etches, dry etches, lasers, abrasive disks, abrasive-tipped routers, and/or microelectrode discharge units. A laser can quickly form the first openings 30 using the "trepan" method in which the laser beam makes multiple passes across the wafer in straight, square or circular patterns. Abrasive disks are well suited for forming trench-type first openings 30 by cutting a pattern of trenches into the first side. One aspect of forming the first openings 30 using lasers, abrasive articles, and aggressive etches is that the large area depressions are quickly formed in a sacrificial portion of the workpiece 10 without thinning the entire workpiece.

[0025] Figure 1C illustrates the workpiece 10 at a fine removal stage in which a plurality of second openings 40 are formed in the workpiece 10. The second openings 40 extend from the intermediate depth at the end-surfaces 32 of the first openings 30 to the contact surfaces 26 of the conductive elements 24. The first openings 30 and the second openings 40 have substantially different widths in the embodiment shown in Figure 1C. For example, the second openings 40 have a second width W_2 at the intermediate level of the end-surfaces 32 that is less than the first width W_1 of the first openings 30. The second width W_2 is generally approximately equal to the desired width of the interconnects, and the depth of the second openings 40 is at least as long as the desired length of the interconnects. The second openings 40 accordingly provide blind vias into which a conductive material is deposited to form the interconnects. As explained in more detail below with reference to Figures 2A-4, the second openings 40 can be formed using laser

drilling techniques, etching processes, or other suitable techniques for forming precise holes in the workpiece.

[0026] Figure 1D illustrates a filling stage in which a conductive material 50 is deposited onto the workpiece 10 to fill the second openings 40. The portions of the conductive material 50 in the second openings 40 define interconnects 52. The conductive material 50 deposited onto the workpiece 10 fills at least a portion of the second openings 40; the conductive material 50 preferably completely fills the second openings 40. The first openings 30, however, need not be completely filled by the conductive material 50. As such, an unoccupied void 60 can remain in the first openings 30 after filling the second openings 40 with the conductive material 50. In the embodiment shown in Figure 1D, the conductive material 50 can be deposited using vapor deposition processes, plating processes, and/or other suitable processes for filling the second openings 40. Several specific embodiments of filling the second openings 40 with the conductive material 50 are described below with reference to Figures 5A-7C.

[0027] Figure 1E illustrates a thinning stage in which the workpiece 10 is thinned to the desired final thickness T_f. The workpiece 10 can be thinned by dry grinding, wet grinding, and/or planarizing (e.g., CMP). In the illustrated embodiment, the workpiece 10 has been thinned from the original first side 14 to a back surface 18. The back surface 18 is formed at a level between the contact surfaces 26 and the end-surfaces 32 (Figures 1B and 1C). In several applications, the initial thickness T_i of the workpiece is approximately 750 µm, and the final thickness T_f is approximately 150-350 µm. The thinning stage accordingly eliminates the first openings 30 (Figures 1B-1D) and forms the back surface 18 at a level within the workpiece 10 such that the interconnects 52 are electrically isolated from each other.

[0028] Several embodiments of forming the interconnects 52 illustrated in Figures 1A-1E are expected to provide several advantages compared to laser drilling or etching conventional blind vias. For example, the second openings 40 can be formed faster because the first openings 30 are formed using fast bulk removal processes. The slower, more precise processes for forming the second openings 40 accordingly do not need to remove as much material from the workpiece 10 compared to conventional processes. As a result, several embodiments of the

method illustrated in Figures 1A-1E should increase the throughput of forming deep interconnects.

[0029] Another advantage of several of the embodiments of the method illustrated in Figures 1A-1E is that the narrow second openings 40 have a much lower aspect ratio compared to conventional holes having the same width W_2 from the initial thickness T_i to the contact surfaces 26. This provides a significant benefit because conventional high aspect ratio holes extending completely through the initial thickness T_i of the workpiece 10 are difficult to fill with conductive material without forming voids or other discontinuities in the interconnects. The lower aspect ratio second openings 40 are much easier to fill with the conductive material, and many more deposition techniques can be used to fill the second openings 40.

[0030] Still additional advantages of several of the embodiments of the method illustrated in Figures 1A-1E is that the width and depth of the second openings 40 can be accurately controlled and heat-affected zones can be mitigated. For example, compared to laser drilling through the entire initial thickness T_i of the workpiece 10, the second openings 40 can be formed through the much thinner portion of the workpiece between the contact surfaces 26 and the end-surfaces 32. This requires less energy and results in smaller heat-affected zones, less slag in the holes, and better end-pointing to avoid over-ablation or under-ablation.

[0031] The embodiments of the individual stages illustrated and described with reference to Figures 1A-1E can be executed by several different sub-processes. Figures 2A-4 illustrate several embodiments of the fine removal stage for forming the second openings 40, and Figures 5A-7C illustrate several embodiments of the filling stage for filling the second openings 40 and the thinning stage for thinning the workpiece. The more detailed embodiments of the stages shown in Figures 2A-7C are provided in addition to the general embodiments of these stages described above with reference to Figures 1A-1E. As such, the embodiments of the stages described in Figures 1A-1E are not limited to the embodiments of the stages described with reference to Figures 2A-7C.

C. Embodiments of Methods for Forming the Second Openings

[0032] Figures 2A and 2B are schematic cross-sectional views illustrating one embodiment of the fine removal stage for forming the second openings 40 (Figure

1C). Like reference numbers refer to like components in Figures 1A-2B. Referring to Figure 2A, this stage includes aligning a laser beam L with a conductive element 24 and directing the laser beam L through the first hole 30. As shown in Figure 2B, the laser beam L ablates the substrate starting at the end-surface 32 of the first opening 30 and finishing at the contact surface 26 of the conductive element 24. This process is then repeated at each conductive element 24 to form a plurality of the openings 40. Because the distance between the contact surface 26 and the end-surface 32 is significantly less than the distance between the contact surface 26 and the first side 14, the second opening 40 can be formed with much more precision than conventional methods. As explained above with reference to Figures 1D and 1E, the second openings 40 can be filled with a conductive material and the workpiece 10 can be thinned to form interconnects in the second openings.

[0033] Figures 3A-3D illustrate another embodiment of the fine removal stage for forming the second openings 40. Figure 3A illustrates a portion of the workpiece 10 as described above with reference to Figure 1B, and thus like reference numbers refer to like components in Figures 1A-3D. Referring to Figure 3B, this stage includes depositing a seed layer 310 onto the workpiece 10 using a vapor deposition process and depositing a layer of electrophoretic resist 320 onto the seed layer 310 using known plating techniques or other techniques. This embodiment also includes patterning the resist layer 320 to form openings 330 aligned with corresponding conductive elements 24 (only one opening 330 and one conductive element are shown).

[0034] This stage continues with a two-phase etching process to form the second opening 40. Referring to Figure 3C, the first phase of the etching process selectively removes the silicon of the substrate to an oxide formation (not shown) on the contact surface 26. Referring to Figure 3D, the second phase of the etching process selectively removes the oxide from the contact surface 26. The two-phase etching process illustrated in Figures 3C and 3D is advantageous because the oxide formation on the contact surface 26 provides an etch stop for the first phase of the process, and the metal contact surface 26 provides an etch stop for the second phase of the process. As such, this embodiment of the fine removal stage can precisely end-point the second opening 40 at the contact surface 26.

[0035] Figure 4 illustrates another embodiment of the fine removal stage for forming the second opening 40. In this embodiment, the electrophoretic resist layer 320 is deposited and patterned to form the opening 330 as described above with reference to Figure 3B. The second opening 40, however, is formed using a single-phase etching process that etches through the seed layer 310 and the workpiece 10 from the end-surface 32 to the contact surface 26.

D. Embodiments of Methods for Filling the Second Openings

[0036] After forming the second openings 40 to expose the contact surfaces 26 of the conductive elements 24, the second openings 40 are filled with a conductive material and the workpiece is thinned to construct the interconnects as described above with reference to Figures 1D and 1E. Figures 5A-7C illustrate several embodiments of filling the second openings 40 and thinning the workpiece 10.

[0037] Figures 5A-5E illustrate an embodiment of filling the second openings 40 using a plating process. Referring to Figure 5A, this embodiment of the filling stage includes depositing an oxide layer 500 on the workpiece 10 to form a dielectric liner in the second opening 40. As shown in Figure 5B, the method continues by spacer etching the workpiece 10 to selectively etch the oxide 500 from surfaces that are transverse to the direction of the etchant. For example, when the back side 14 of the workpiece 10 is perpendicular to the direction of the etchant, the spacer etch removes the oxide layer 500 from the back side 14, the end-surface 32, and an interface region 28 of the contact surface 26. The portions of the oxide layer 500 on the sidewall of the second opening 40 and the sidewall 34 of the first opening 30 remain on the workpiece 10. As such, the sidewall of the second opening 40 is lined with a dielectric layer to electrically insulate the substrate 12.

[0038] Figures 5C and 5D illustrate one embodiment for plating conductive material into the second opening 40. Referring to Figure 5C, this embodiment of the filling stage includes depositing a seed layer 510 onto the workpiece 10. The seed layer 510 can be deposited using vapor deposition techniques, such as chemical vapor deposition, physical vapor deposition and/or atomic layer deposition. Suitable materials for the seed layer 510 include copper, tungsten, cobalt, aluminum and other materials used in the semiconductor industry. In some applications (e.g., plating copper), a barrier layer (e.g., tantalum) is generally deposited onto the

workpiece before depositing the seed layer 510. Referring to Figure 5D, this stage can continue by applying an electrical potential to the seed layer 510 at one polarity and to an electrode in a plating bath (not shown) at an opposite polarity to plate a conductive layer 520 onto the seed layer 510. In other embodiments, electroless plating processes can be used to plate the conductive layer 520 onto the seed layer 510. The conductive layer 520 can fill the second openings 40 without voids because the aspect ratio of the second openings 40 can be low enough to avoid pinch-off. The conductive layer 520 typically does not completely fill the first openings 30 such that the first openings 30 have the unoccupied void 60 after filling the second openings 40. The conductive layer 520 can include copper, gold, nickel or other suitable materials or alloys of materials having the desired conductivity.

[0039] Figure 5E illustrates an embodiment of the thinning stage after the workpiece 10 has been thinned to electrically isolate the conductive material 520 in the second opening 40. An interconnect 530 formed by this embodiment is defined by the portions of the seed layer 510 and conductive layer 520 remaining in the second opening 40. The portion of the oxide layer 500 remaining in the second opening 40 electrically isolates the interconnect 530 from the substrate 12. The workpiece 10 can be thinned in a manner described above with reference to Figure 1E.

[0040] Figures 6A-6C illustrate another embodiment of the filling stage in which conductive material is plated into the second opening 40 to form an interconnect. Figure 6A illustrates the workpiece 10 after lining the sidewall of the second opening 40 with the oxide 500 in a manner similar to the embodiment described above with reference to Figure 5B. The embodiment shown in Figure 6A further includes removing material from the second side 16 of the workpiece 10 to expose a bond-pad surface 29 of the conductive element 24. Figure 6B illustrates the workpiece 10 in a bottom-up plating process that selectively fills the second opening 40 with a plug of conductive material 600. In this embodiment, a conductive member 610 engages the workpiece 10 such that the bond-pad surface 29 presses against the conductive member 610. This embodiment continues by placing the workpiece 10 in a plating solution 620 and applying an electrical potential to the electrical member 610 and an electrode 630. An electrical current accordingly passes through the conductive element 24 such that the ions in the plating solution 620 plate onto the contact

surface 26 and progressively plate onto each other toward the end-surface 32. The plating process can be terminated when the second opening 40 is either fully or partially filled with the conductive material 600. Figure 6C illustrates the workpiece 10 after it has been thinned to form an interconnect 610 in the second opening 40.

[0041] Figures 7A-7C illustrate still another embodiment of the filling stage for depositing a conductive material into the second opening 40. Referring to Figure 7A, the contact surface 26 is cleaned using a wash to remove any oxide from the contact surface 26 and to form a thin layer 700 of conductive material on the contact surface 26. Referring to Figure 7B, this embodiment continues by plating a conductive material 710 into the second opening 40 using an electroless plating process. In one embodiment, the electroless plating process can be a nickel "bottom-up" plating process that fills the remainder of the second opening 40 with nickel. In other embodiments, the electroless plating process can plate only a thin layer of nickel (e.g., five microns), and the remainder of the second opening 40 can be filled using a solder deposit to form plugs, posts or other structures in the second opening. Figure 7C illustrates the workpiece 10 after it has been thinned to form an interconnect 720 defined by the layer 700 and the conductive material 710.

[0042] From the foregoing, it will be appreciated that specific embodiments of the invention have been described herein for purposes of illustration, but that various modifications may be made without deviating from the spirit and scope of the invention. Accordingly, the invention is not limited except as by the appended claims.

CLAIMS

I/We claim:

1. A method of forming an interconnect engaged with a blind contact surface of a conductive element of a microelectronic workpiece, the method comprising:

forming a cavity in the workpiece, the cavity having a first width at a first exterior side of the workpiece and a depth extending to an intermediate level in the workpiece;

constructing a blind via from the intermediate level in the cavity to the contact surface, the blind via having a second width less than the first width;

filling the blind via with a conductive material; and

thinning the workpiece from the first exterior side until the cavity is eliminated.

2. The method of claim 1 wherein forming the cavity comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element.

3. The method of claim 1 wherein forming the cavity comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element.

4. The method of claim 1 wherein the microelectronic workpiece includes a plurality of dies having a plurality of conductive elements with contact surfaces, and wherein forming the cavity comprises forming a plurality of depressions in the exterior side of the workpiece such that portions of the depressions are aligned with one or more of the contact surfaces.

5. The method of claim 4 wherein the depressions are trenches and/or holes having a depth from the exterior side to the intermediate level within the workpiece.

6. The method of claim 4 wherein forming the depressions comprises laser cutting trenches and/or holes into the workpiece.

7. The method of claim 4 wherein forming the depressions comprises cutting trenches into the workpiece using an abrasive disk.

8. The method of claim 4 wherein forming the depressions comprises cutting trenches and/or holes into the workpiece using an abrasive tipped router.

9. The method of claim 4 wherein forming the depressions comprises etching trenches and/or holes into the workpiece.

10. The method of claim 9 wherein etching trenches and/or holes into the workpiece comprises patterning a layer of resist on the exterior side of the workpiece and isotropically etching the workpiece.

11. The method of claim 1 wherein constructing the blind via comprises etching a hole having the second width and a second depth from the intermediate level in the cavity to the contact surface.

12. The method of claim 11 wherein etching the hole comprises a single-phase etching procedure.

13. The method of claim 11 wherein etching the hole comprises a two-phase etching procedure including a first phase in which a first etchant etches from the intermediate level in the cavity to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface.

14. The method of claim 1 wherein constructing the blind via comprises laser drilling a hole having the second width from the intermediate level in the cavity to the contact surface.

15. The method of claim 1 wherein filling the blind via with a conductive material comprises plating the conductive material into the blind via.

16. The method of claim 15 wherein plating the conductive material into the blind via comprises:

depositing a seed layer onto the workpiece and into the blind via; and

applying an electrical potential to the seed layer in the presence of a plating solution.

17. The method of claim 15 wherein the conductive element is exposed on an opposing exterior side of the workpiece, and wherein plating the conductive material into the blind via comprises:

engaging the conductive element with an electrical contact from the opposing exterior side of the workpiece; and

applying an electrical potential to the conductive element via the electrical contact in the presence of a plating solution to cause bottom-up plating onto the contact surface of the conductive element within the blind via.

18. The method of claim 15 wherein plating the conductive material into the blind via comprises electrolessly plating material onto the contact surface of the conductive element within the blind via.

19. The method of claim 15 wherein plating the conductive material into the blind via comprises washing the contact surface with a zinc solution that forms a layer of zinc on the contact surface and electrolessly plating nickel onto the layer of zinc within the blind via.

20. A method of forming an interconnect engaged with a blind contact surface of a conductive element of a microelectronic workpiece, the method comprising:

forming a first opening in the workpiece, the first opening having a first width and extending from an exterior face of the workpiece to an intermediate depth within the workpiece;

forming a second opening extending from the intermediate depth in the first opening to the contact surface, wherein the second opening has a second width less than the first width;

filling the second opening with a conductive material; and

removing material from the exterior face of the workpiece to form a surface at least at the intermediate depth of the first opening.

21. The method of claim 20 wherein forming the first opening comprises forming a cavity into the exterior face and forming the second opening comprises constructing a blind via.

22. The method of claim 21 wherein:

forming the cavity comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

constructing the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via.

23. The method of claim 21 wherein:

forming the cavity comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

constructing the blind via comprises etching from the trench to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via using a bottom-up plating process.

24. The method of claim 21 wherein:

forming the cavity comprises cutting a trench into the workpiece using a laser and/or an abrasive tool such that a portion of the trench is aligned with the conductive element;

constructing the blind via comprises etching from the trench to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via.

25. The method of claim 21 wherein:

forming the cavity comprises cutting a trench into the workpiece using a laser and/or an abrasive such that a portion of the trench is aligned with the conductive element;

constructing the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via using a bottom-up plating process.

26. The method of claim 21 wherein:

forming the cavity comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

constructing the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via.

27. The method of claim 21 wherein:

forming the cavity comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

constructing the blind via comprises etching from the hole to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via using a bottom-up plating process.

28. The method of claim 21 wherein:

forming the cavity comprises cutting a hole into the workpiece using a laser and/or an abrasive tool such that a portion of the hole is aligned with the conductive element;

constructing the blind via comprises etching from the hole to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via.

29. The method of claim 21 wherein:

forming the cavity comprises cutting a hole into the workpiece using a laser and/or an abrasive such that a portion of the hole is aligned with the conductive element;

constructing the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the blind via using a bottom-up plating process.

30. A method of forming an interconnect engaged with a contact surface embedded within a microelectronic workpiece having a backside, a front side, and a plurality of microelectronic dies at the front side, the method comprising:

forming a first opening in the workpiece, the first opening having (a) a first orifice with a first width at the backside of the workpiece and (b) a first depth extending from the backside of the workpiece to an intermediate level in the workpiece, wherein the intermediate level is spaced apart from the contact surface;

forming a second opening in the workpiece, the second opening having (a) a second orifice with a second width at the intermediate level and (b) a second depth extending to the contact surface such that the contact surface is exposed through the second opening, wherein the second width is less than the first width;

filling the second opening with a conductive material; and

removing material from the backside of the workpiece until a back surface is formed between the contact surface and the intermediate level.

31. The method of claim 30 wherein:

forming the first opening comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

32. The method of claim 30 wherein:

forming the first opening comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises etching from the trench to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

33. The method of claim 30 wherein:

forming the first opening comprises cutting a trench into the workpiece using a laser and/or an abrasive tool such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises etching from the trench to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

34. The method of claim 30 wherein:

forming the first opening comprises cutting a trench into the workpiece using a laser and/or an abrasive such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

35. The method of claim 30 wherein:

forming the first opening comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

36. The method of claim 30 wherein:

forming the first opening comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises etching from the hole to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

37. The method of claim 30 wherein:

forming the first opening comprises cutting a hole into the workpiece using a laser and/or an abrasive tool such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises etching from the hole to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

38. The method of claim 30 wherein:

forming the first opening comprises cutting a hole into the workpiece using a laser and/or an abrasive such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

39. A method of forming an interconnect engaged with a contact surface embedded a microelectronic workpiece, the method comprising:

forming a first opening in the workpiece, the first opening having a first width and extending from an exterior surface of the workpiece to an intermediate depth within the workpiece;

forming a second opening in the workpiece aligned with the first opening, the second opening extending from the intermediate depth to the contact surface, wherein the second opening has a second width less than the first width;

filling the second opening with a conductive material; and

eliminating the first opening to form a back surface in a region between the intermediate depth and the contact surface.

40. The method of claim 39 wherein:

forming the first opening comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

41. The method of claim 39 wherein:

forming the first opening comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises etching from the trench to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

42. The method of claim 39 wherein:

forming the first opening comprises cutting a trench into the workpiece using a laser and/or an abrasive tool such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises etching from the trench to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

43. The method of claim 39 wherein:

forming the first opening comprises cutting a trench into the workpiece using a laser and/or an abrasive such that a portion of the trench is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

44. The method of claim 39 wherein:

forming the first opening comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

45. The method of claim 39 wherein:

forming the first opening comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises etching from the hole to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

46. The method of claim 39 wherein:

forming the first opening comprises cutting a hole into the workpiece using a laser and/or an abrasive tool such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises etching from the hole to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening.

47. The method of claim 39 wherein:

forming the first opening comprises cutting a hole into the workpiece using a laser and/or an abrasive such that a portion of the hole is aligned with the conductive element;

forming the second opening comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

filling the second opening with a conductive material comprises plating the conductive material into the second opening using a bottom-up plating process.

48. A method of forming an interconnect engaged with a contact surface embedded in a microelectronic workpiece, the method comprising:

removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface at a first depth within the workpiece, wherein the end-surface is spaced apart from the contact surface;

forming a blind via extending from the end-surface of the depression to the contact surface, wherein the blind via has a second width less than the first width of the depression;

depositing a conductive material into the blind via until the blind via is filled with the conductive material; and

terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material;

wherein removing the selected region of the workpiece comprises cutting a trench into the workpiece such that a portion of the trench is aligned with the conductive element;

wherein forming the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

wherein depositing the conductive material comprises plating the conductive material into the blind via.

49. A method of forming an interconnect engaged with a contact surface embedded in a microelectronic workpiece, the method comprising:

removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface at a first

depth within the workpiece, wherein the end-surface is spaced apart from the contact surface;

forming a blind via extending from the end-surface of the depression to the contact surface, wherein the blind via has a second width less than the first width of the depression;

depositing a conductive material into the blind via until the blind via is filled with the conductive material; and

terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material;

wherein removing the selected region of the workpiece comprises cutting a trench into the workpiece using a laser and/or an abrasive tool such that a portion of the trench is aligned with the conductive element;

wherein forming the blind via comprises etching from the trench to the contact surface; and

wherein depositing the conductive material comprises plating the conductive material into the blind via.

50. A method of forming an interconnect engaged with a contact surface embedded in a microelectronic workpiece, the method comprising:

removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface at a first depth within the workpiece, wherein the end-surface is spaced apart from the contact surface;

forming a blind via extending from the end-surface of the depression to the contact surface, wherein the blind via has a second width less than the first width of the depression;

depositing a conductive material into the blind via until the blind via is filled with the conductive material; and

terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material;

wherein removing the selected region of the workpiece comprises cutting a trench into the workpiece using a laser and/or an abrasive such that a portion of the trench is aligned with the conductive element;

wherein forming the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the trench to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

wherein depositing the conductive material comprises plating the conductive material into the blind via using a bottom-up plating process.

51. A method of forming an interconnect engaged with a contact surface embedded in a microelectronic workpiece, the method comprising:

removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface at a first depth within the workpiece, wherein the end-surface is spaced apart from the contact surface;

forming a blind via extending from the end-surface of the depression to the contact surface, wherein the blind via has a second width less than the first width of the depression;

depositing a conductive material into the blind via until the blind via is filled with the conductive material; and

terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material;

wherein removing the selected region of the workpiece comprises cutting a hole into the workpiece such that a portion of the hole is aligned with the conductive element;

wherein forming the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

wherein depositing the conductive material comprises plating the conductive material into the blind via.

52. A method of forming an interconnect engaged with a contact surface embedded in a microelectronic workpiece, the method comprising:

removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface at a first depth within the workpiece, wherein the end-surface is spaced apart from the contact surface;

forming a blind via extending from the end-surface of the depression to the contact surface, wherein the blind via has a second width less than the first width of the depression;

depositing a conductive material into the blind via until the blind via is filled with the conductive material; and

terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material;

wherein removing the selected region of the workpiece comprises cutting a hole into the workpiece using a laser and/or an abrasive tool such that a portion of the hole is aligned with the conductive element;

wherein forming the blind via comprises etching from the hole to the contact surface; and

wherein depositing the conductive material comprises plating the conductive material into the blind via.

53. A method of forming an interconnect engaged with a contact surface embedded in a microelectronic workpiece, the method comprising:

removing a selected region of the workpiece to form a large area depression in the workpiece having a first width and an end-surface at a first depth within the workpiece, wherein the end-surface is spaced apart from the contact surface;

forming a blind via extending from the end-surface of the depression to the contact surface, wherein the blind via has a second width less than the first width of the depression;

depositing a conductive material into the blind via until the blind via is filled with the conductive material; and

terminating the deposition of the conductive material into the blind via before the depression is filled with the conductive material;

wherein removing the selected region of the workpiece comprises cutting a hole into the workpiece using a laser and/or an abrasive such that a portion of the hole is aligned with the conductive element;

wherein forming the blind via comprises a two-phase etching procedure including a first phase in which a first etchant etches from the hole to an oxide on the contact surface and a second phase in which a second etchant etches from the oxide to the contact surface; and

wherein depositing the conductive material comprises plating the conductive material into the blind via using a bottom-up plating process.