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(54) **THICK PERFORATED POLISHING PAD AND METHOD FOR MAKING SAME**

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(57) **ABSTRACT**

A thick perforated polishing pad and method for making same which includes a polishing pad having a thick polymer sheet with multiple circular openings or perforations contained therein that are produced in the pad by machining techniques such as drilling.

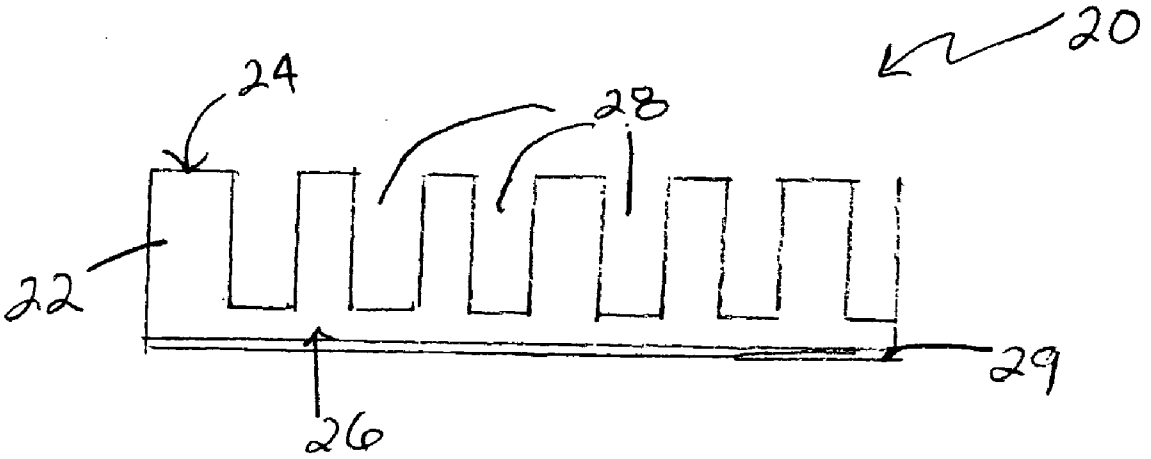


FIG. 1 (PRIOR ART)

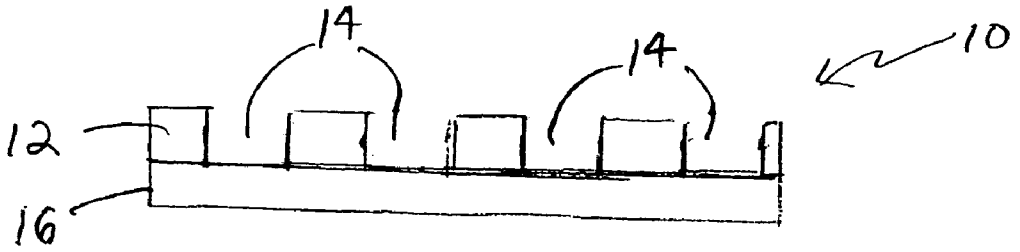


FIG. 2

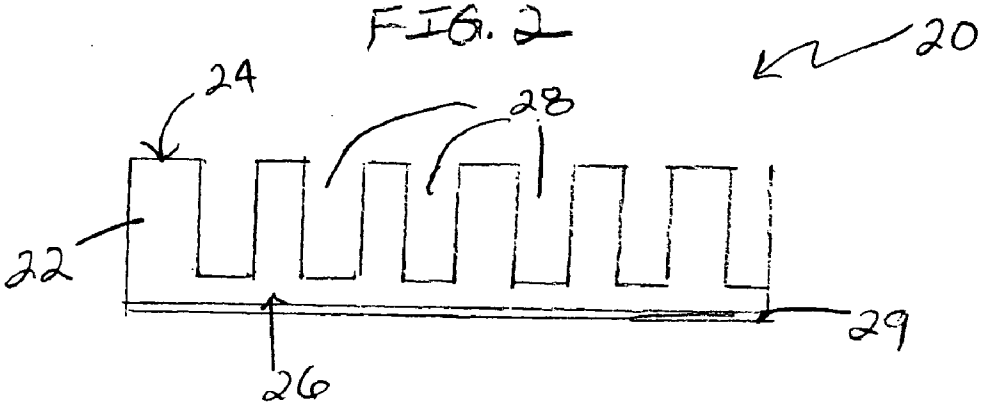
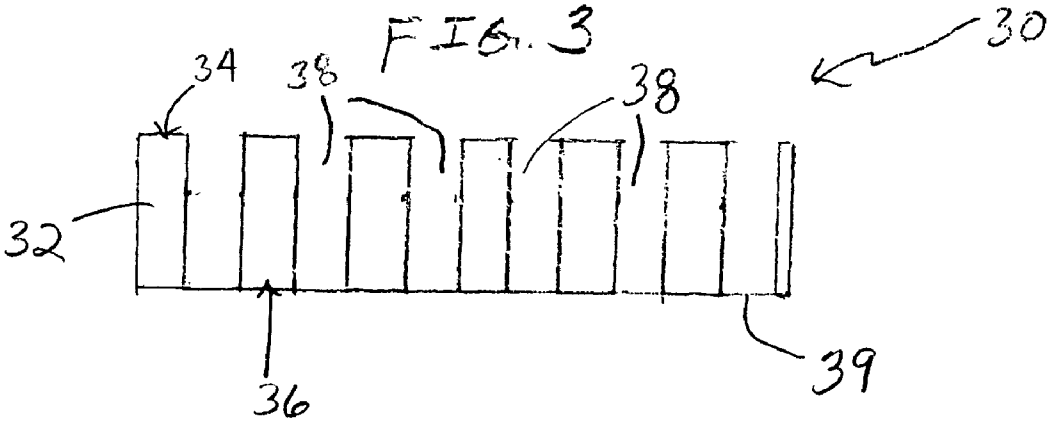


FIG. 3



Testing

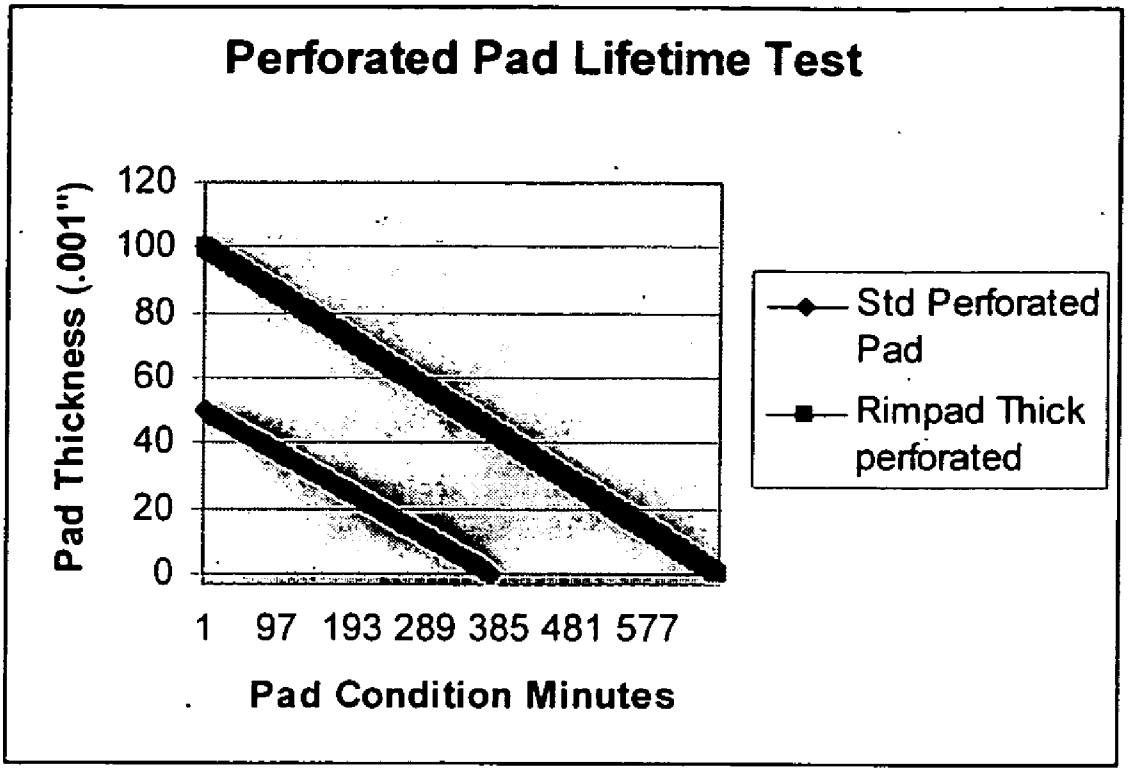


FIG. 4

THICK PERFORATED POLISHING PAD AND METHOD FOR MAKING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of an earlier filed provisional application having Ser. No. 60/596,474, filed Sep. 27, 2005, which is herein incorporated in its entirety.

FIELD OF INVENTION

[0002] The present invention relates generally to a polishing pad for use in integrated circuit device wafers, integrated circuit device substrates, hard disk drive media and magnetic resonance head planarization, and more particularly to a polishing pad having a thick polymer sheet with multiple circular openings or perforations contained therein that are produced in the pad by machining techniques such as drilling.

BACKGROUND OF THE INVENTION

[0003] Perforated polishing surfaces such as perforated polishing pads have typically been produced by punching holes in the surface or pad. The punching technique produces holes that extend through the entire thickness of the pad material.

[0004] Punching techniques are limited by a relationship between the thickness of the material to be punched and the diameter of the hole being punched. For example, the largest hole that can be punched with a controllable process in a 0.050 inch thick polishing pad is a 0.070 inch diameter hole. Beyond this thickness, the hole begins to distort such that the walls are no longer straight. Alternatively, the punches become bent and damaged.

[0005] The distortion is a result of the material bending due to the stress applied to it during the punching process. This bending pushes the material at the bottom of the perforation outward from the desired center of the hole to be punched. The punching process creates a hole and upon retraction of the punch the material being punched returns to its original dimensions. The hole that was punched under the additional stress is significantly smaller than desired. In addition, the hole diameter at the top of the perforation is the desired width thereby creating a hole that has tapered sidewalls.

[0006] Finally, the punching process is a through hole process meaning that holes are punched such that they traverse the entire thickness of the material. The punching process cannot be used to create a hole or opening in a material that does not traverse a bottom surface of the material.

[0007] Accordingly, there is a need for a perforated polishing pad that contains uniform perforations, that can be processed quickly, and that possesses a longer lifetime than existing perforated pads.

SUMMARY OF THE INVENTION

[0008] The present invention is directed to a thick perforated polishing pad that is formed by simultaneously machine drilling holes into a thick polymer layer. Machine drilling the holes or openings into the polymer layer allows for the polymer layer to be much thicker without risking distortions of the openings, such as tapered holes, when punch processing is used. In addition, the holes or openings that are drilled into the polymer layer may be terminated within the material being perforated without traversing the entire thickness of the material.

[0009] In one exemplary embodiment of the invention, the polishing pad comprises a thick polymer layer having a top surface, a bottom surface, and a plurality of openings contained therein which are drilled into the polymer layer such that the openings do not traverse the bottom surface of the polymer layer.

[0010] In one example, the perforated polishing pad of the invention may have a polymer layer made of a closed cell polyurethane having a shore D hardness within the range of 40 to 80.

[0011] In another example, the perforated polishing pad of the invention may have a thickness of 0.100 inches or greater and the openings or perforations contained in the pad may have a diameter less than or equal to 0.100 inches. Moreover, the perforated polishing pad of the present invention may generally have a thickness that is greater than or equal to the diameter of the openings or perforations contained in the pad.

[0012] The perforated polishing pad of the present invention may further include one or more grooves in a top surface of the polymer layer in yet another exemplary embodiment of the polishing pad.

[0013] The present invention is also directed to a method for making a polishing pad which includes the steps of providing a thick polymer layer having a top surface and a bottom surface and simultaneously drilling a plurality of openings into the thick polymer layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The figures illustrate various embodiments of the present invention by way of example, and not by way of limitation. Embodiments of the present invention may include part or all of the features shown in one of these figures, or may include features from two or more figures. Embodiments of the present invention may also include features described in the specification, or elements of features described in the specification.

[0015] Furthermore, embodiments of the present invention may include features that would be familiar to a person of ordinary skill in the art having studied this document. Thus, a more complete understanding of the present invention may be derived by referring to the detailed description and claims when considered in connection with the drawing figures where like reference numbers refer to similar elements throughout the figures, and

[0016] FIG. **1** is a cross sectional view of a prior art perforated polishing pad;

[0017] FIG. **2** is a cross sectional view of one exemplary embodiment of the perforated polishing pad of the present invention;

[0018] FIG. **3** is a cross sectional view of another exemplary embodiment of the perforated polishing pad of the present invention; and

[0019] FIG. **4** is a graph showing the lifetime of a prior art perforated polishing pad compared to the lifetime of a perforated polishing pad of the present invention.

DETAILED DESCRIPTION

[0020] The detailed description of exemplary embodiments herein makes reference to the accompanying drawings and pictures, which show the exemplary embodiment by way of illustration and its best mode. While these exemplary embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, it should be understood that other embodiments may be realized and that logical and mechanical changes may be made without departing from the spirit and scope of the invention. Thus, the detailed description herein is presented for purposes of illustration only and not of limitation. In addition, any reference to singular includes plural embodiments, and any reference to more than one component may include a singular embodiment.

[0021] FIG. **1** is a cross sectional view of a prior art perforated polishing pad **10**. Pad **10** includes a polymer layer **12** having a plurality of openings or perforations **14** where the polymer layer is positioned over a subpad **16**. The openings or perforations **14** in the polymer layer **12** (or top pad) are formed by punching the openings **14** through the entire polymer layer **12**. The polymer layer **12** containing the openings **14** is then secured to the subpad **16**. As previously explained, distortion of the openings **14** occurs if the diameter of the openings **14** is less than the thickness of the polymer layer **12**. The openings **14** shown in FIG. **1** have a diameter that is larger than the thickness of the polymer layer **12** and therefore are shown to be uniform without distortions. However, openings punched into the polymer layer that have diameters less than the thickness of the polymer layer will present distortions.

[0022] A cross sectional view of one exemplary embodiment of the perforated polishing pad **20** of the present invention is shown in FIG. **2**. Polishing pad **20** includes a thick polymer layer **22** having a top surface **24**, a bottom surface **26**, and a plurality of openings **28** that are machine drilled into the polymer layer **22** such that they do not traverse the bottom surface **26** of the polymer layer **22**. A tape layer **29** may be attached to the bottom surface **26** of the polymer layer so that the polishing pad **20** can be secured to a platform for polishing. Since the openings **28** are machine drilled into the polymer layer **22**, the openings **28** may have diameters that are smaller than the thickness of the polymer layer **22** without distorting the openings **28**. In addition, because the openings **28** are machine drilled, the depth of the openings **28** can be terminated prior to reaching the bottom surface **26** of the polymer layer **22**.

[0023] FIG. **3** is a cross sectional view of another exemplary embodiment of the perforated polishing pad **30** of the present invention. Polishing pad **30** includes a thick polymer layer **32** having a top surface **34**, a bottom surface **36**, and a plurality of openings **38** that are machine drilled into the polymer layer **32** such that they traverse the bottom surface **36** of the polymer layer **32**. A tape layer **39** may be attached to the bottom surface **36** of the polymer layer so that the polishing pad **30** can be secured to a platform for polishing. Since the openings **38** are machine drilled into the polymer layer **32**, the openings **38** may have diameters that are smaller than the thickness of the polymer layer **32** without distorting the openings **38**.

[0024] The thick perforated polishing pad of the present invention may be 0.100 inches thick or greater and the perforations contained within the pad may be through holes (i.e. extending through the entire thickness of the pad or material being perforated as shown in FIG. **3**) or the perforations may be terminated prior to extending through the entire thickness of the pad or material as shown in FIG. **2**. When the perforations are terminated prior to reaching a bottom surface of the pad or material, a pad is provided that offers a homogenous material on the bottom and sides of the perforations or openings and on the top polishing surface of the polishing pad.

[0025] The pad material can be any type of material suitable for polishing semiconductor wafers, semiconductor substrates, hard disk drive substrates, and magnetic resonance head substrates. The material may preferably be a closed cell polyurethane with a shore hardness of between 40 and 80 shore D.

[0026] In addition, the perforations may be combined with one or more grooves for the purpose of minimizing suction phenomena during polishing as one approaches the end of the polishing pad life. Grooves can also be added for the purpose of providing slurry drainage effects at isolated areas on the pad.

[0027] The polishing process creates pad wear. In some applications, the polishing pad is nearly totally consumed before it needs to be replaced with a new pad. In this situation, the lifetime of the polishing pad is dependent on the thickness of the pad. The perforated polishing pad of the present invention provides the benefit of a longer lifetime than those perforated polishing pads that are perforated using punch techniques.

[0028] A lifetime estimate test was conducted with a perforated polishing pad of the present invention and a prior art perforated polishing pad. The test consisted of pad conditioning with a commercially available 100 grit diamond pad conditioner. A downforce of 67 lbs was applied to the pad and the pad was rotated at 30 RMP with water supplied to the pad during conditioning. Pad thickness measurements were taken at time intervals of 15 minutes and 30 minutes using a dial indicator configured on a beam (referencing the polishing table) extending across the outer diameter of the pad.

[0029] FIG. **4** is a graph showing the lifetime of a prior art perforated polishing pad compared to the lifetime of a perforated polishing pad of the present invention. The results clearly show the lifetime benefit of perforating thicker material by machine drilling rather than punch pressing thinner material. The lifetime test showed that the prior art perforated polishing pad would be consumed in 476 minutes while the perforated polishing pad of the present invention would be consumed in 667 minutes. The perforated polishing pad of the present invention possesses a 140% increase in lifetime over the prior art perforated polishing pads.

[0030] In practice, the chemical mechanical planarization (CMP) user typically changes a polishing pad with 0.020 pad material left. In this case, the prior art perforated polishing pad would be changed in 226 minutes of conditioning and the perforated polishing pad of the present invention would be changed in 535 minutes of conditioning. This results in the perforated polishing pad of the present

invention possessing a 230% increase in lifetime over the prior art perforated polishing pads.

[0031] The foregoing description is of exemplary embodiments of the subject invention. It will be appreciated that the foregoing description is not intended to be limiting; rather, the exemplary embodiments set forth herein merely set forth some exemplary applications of the subject invention. It will be appreciated that various changes, deletions, and additions may be made to the components and steps discussed herein without departing from the scope of the invention as set forth in the appended claims.

1. A polishing pad comprising a thick polymer layer having a top surface, a bottom surface, and a plurality of openings contained therein which are drilled into the polymer layer.

2. The polishing pad of claim 1 wherein the plurality of openings do not traverse the bottom surface of the polymer layer.

3. The polishing pad of claim 1 wherein the thick polymer layer is comprised of a closed cell polyurethane.

4. The polishing pad of claim 1 wherein the polymer layer has a shore hardness within a range of 40 to 80 shore D.

5. The polishing pad of claim 1 having a thickness of 0.100 inches or greater.

6. The polishing pad of claim 5 wherein the openings have a diameter less than or equal to 0.100 inches.

7. The polishing pad of claim 1 further comprising one or more grooves in the top surface of the polishing pad.

8. The polishing pad of claim 1 wherein a diameter of the openings is less than or equal to a thickness of the pad.

9. A method for making a polishing pad comprising the steps of:

a. providing a thick polymer layer having a top surface and a bottom surface; and

b. simultaneously drilling a plurality of openings into the thick polymer layer.

10. The method of claim 9 wherein the step of simultaneously drilling a plurality of openings comprises the step of simultaneously drilling a plurality of openings into the thick polymer layer without traversing the bottom surface of the layer.

11. The method of claim 9 wherein the step of providing a thick polymer layer comprises the step of providing a thick layer of a closed cell polyurethane.

12. The method of claim 9 wherein the step of providing a thick polymer layer comprises the step of providing a polymer layer having a shore hardness within a range of 40 to 80 shore D.

13. The method of claim 9 wherein the step of providing a thick polymer layer comprises the step of providing a polymer layer having a thickness of 0.100 inches or greater.

14. The method of claim 13 wherein the step of simultaneously drilling a plurality of openings comprises the step of simultaneously drilling a plurality of openings having a diameter less than or equal to 0.100 inches.

15. The method of claim 9 further comprising the step of cutting one or more grooves in the top surface of the thick polymer layer.

16. The polishing pad of claim 9 wherein the step of simultaneously drilling a plurality of openings comprises the step of simultaneously drilling a plurality of openings having a diameter less than or equal to a thickness of the thick polymer layer.

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