

ELECTROPLATING PROCESSOR WITH THIN MEMBRANE SUPPORT

BACKGROUND OF THE INVENTION

[0001] Microelectronic devices such as semiconductor devices are generally fabricated on and/or in substrates or wafers. In a typical fabrication process, one or more layers of metal or other conductive materials are formed on a wafer in an electroplating processor. The processor may have a bath of electrolyte held in a bowl, with one or more anodes in the bowl. The wafer itself may be held in a rotor in a head movable into the bowl for processing and away from the bowl for loading and unloading. A contact ring on the rotor generally has a large number of contact fingers that make electrical contact with the wafer. A membrane may be positioned in the bowl between the anodes and the wafer. The membrane allows certain ions to pass through, while blocking passage of other molecules, which can provide improved electroplating results and performance.

[0002] In many electroplating processors, the membrane is supported on the top and the bottom via mechanical supports. However, certain newer processors are designed to be much shorter, so that the processors may be stacked on two levels of a processing system, effectively doubling processing capacity. Gas bubbles which collect and adhere to the membrane support cause electroplating defects. Avoiding gas bubbles, especially in short processors presents a significant engineering challenge.

[0003] The membrane material can significantly expand when wetted. It may also stretch due to liquid pressure forces in the bowl. The membrane, if not supported, may therefore tend to sag or wrinkle, which contributes to gas bubble trapping and

interference with fluid flow within the chamber. Accordingly, improved processors are needed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] In the drawings, the same element number indicates the same element in each of the views.

[0005] Fig. 1 is a perspective view of a compact electroplating processor designed for stacking in two levels in a processing system.

[0006] Fig. 2 is a section view of the processor shown in Fig. 1.

[0007] Fig. 3A is a bottom view looking up of a membrane and membrane support for use in the processor shown in Figs. 1 and 2.

[0008] Fig. 3B is a partial perspective view of the cup shown in Figs. 2 and 3A.

[0009] Fig. 4 is a plan view of the membrane support shown in Fig. 3.

[0010] Figs. 5-11 are plan views of alternative membrane supports.

DETAILED DESCRIPTION OF THE DRAWINGS

[0011] As shown in Figs. 1 and 2, a processor for electroplating a wafer 30 includes a head 22 and a bowl 24. A membrane 40 divides the bowl 24 into a lower chamber or section 44 containing one or more anodes, and a first electrolyte or anolyte, below the membrane 40, and an upper chamber or section 42 containing a second electrolyte or a catholyte. A membrane support 50 in the form of a thin plastic film supports the membrane from below. A rigid cup or field shaping element 46 supports the membrane from above. The edges of the membrane 40 and the membrane support 50 may be clamped via a perimeter seal 52 and/or clamping element.

[0012] The membrane support 50 may be a thin plastic film which supports the membrane, even though the membrane support 50 may be very thin, so that it does not significantly contribute to the height requirements of the processor 20.

[0013] The membrane support 50 may be easily cut and shaped to form open areas necessary to provide a desired electrical current distribution in the processor. The support 50 may be provided as a flat sheet cut into a pattern via laser cutting, water jet or die-stamping, or other techniques. In this case when clamped in place under the membrane 40, the support 50 and the membrane 40 both may conform to a three dimensional partially conical shape of the bottom surfaces of the rigid cup 46. Alternatively the support 50 may be formed as a three dimensional component, optionally matching the geometry of the bottom surfaces of the cup 46, rather than formed as a flat component.

[0014] The support 50 may be made of various plastics such as PEEK or Teflon fluorine resins, with a sheet thickness of 0.2 mm to 4 mm. Generally, the thickness of the support 50 is less than 20, 10, 5 or 1% of the minimum thickness DD of the cup 46. The cup 46 typically has a minimum thickness of 5 or 8 mm or more. As shown in Fig. 3B, the cup may have segments or spokes 62 extending radially outwardly and joining one or more rings 66. The segments 62 and rings 66 may have straight and parallel sidewalls, forming the through openings 64 between them.

[0015] Fig. 4 is a plan view of the support 50 shown in Fig. 3A. Fig. 3B is a perspective view of a representative cup or upper membrane support. The pattern of the solid areas or segments 54 and openings 56 of the support 50 may be designed to match or align with the solid areas or segments 62 and openings 64 of the cup 46, so

that they substantially completely overlap with the membrane between them. Aligning the solid areas 54 of the support in this way may minimize the effect of the support 50 on the electric field.

[0016] Alternatively, as shown in Fig. 3A, the solid areas 54 of the support may be largely offset from the bottom surfaces of the cup 46 shown in dotted lines in Fig. 3A. By offsetting the solid areas 54, the maximum dimension of any point on the membrane to any upper or lower support surface is reduced, allowing the membrane to more closely and uniformly conform to its desired shape and position.

[0017] In Fig. 3A the dotted line 60 schematically shows a membrane position with no lower membrane support. With the membrane support 50, the membrane 40 is held in position between the upper and lower supports 46 and 50, and cannot significantly sag or wrinkle.

CLAIMS:

1. An electroplating processor comprising:
a bowl;
a membrane in the bowl;
an upper membrane support in the bowl above the membrane; and
a lower membrane support in the bowl below the membrane, with the lower membrane support comprising a flexible sheet having a pattern of through openings.
2. The processor of claim 1 with a perimeter of the membrane overlying a perimeter of the lower membrane support, and with both perimeters clamped together at a perimeter seal of the bowl.
3. The processor of claim 1 with the lower membrane support having a thickness less than 10% of the thickness of the upper membrane support.
4. The processor of claim 3 with the upper membrane support comprising a rigid non-metal element.
5. The processor of claim 4 with the upper membrane support having through-openings substantially aligned with the through-openings of the lower membrane support.
6. The processor of claim 1 with the membrane held into up-facing conical shape between the upper and lower membrane supports.
7. The processor of claim 1 further including a head having a rotor for holding a wafer, with the head movable to position the wafer into the bowl, and with the processor having a height of less than 450 mm.

8. The processor of claim 1 with the lower membrane support having a thickness of less than 10 mm.

9. The processor of claim 8 with the lower membrane support having a plurality of spaced apart radial arms and wedge shaped through-openings between the arms.

10. An electroplating processor comprising:
a membrane in a bowl;
a rigid cup in the bowl above the membrane, with the rigid cup having a plurality of radial segments and through-openings between the segments;
a lower membrane support in the bowl below the membrane, with the lower membrane support comprising a flexible sheet having a pattern of through openings; and a perimeter of the membrane overlying a perimeter of the lower membrane support, and with both perimeters clamped together at a perimeter of the bowl.

11. The processor of claim 10 with the lower membrane support having a thickness less than 10% of the thickness of a minimum thickness of the rigid cup.