EXHIBIT

DSS-2009

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METHOD TO INCORPORATE THREE SETS OF PATTERN INFORMATION IN TWO PHOTO-MASKING STEPS

Fig. 1

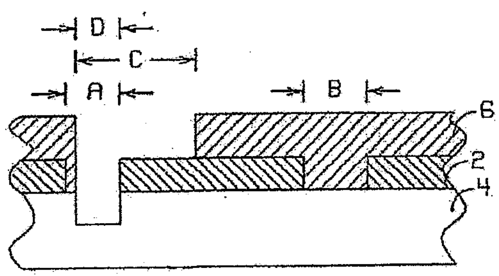


Fig. 2

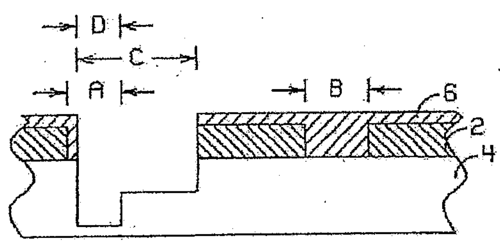
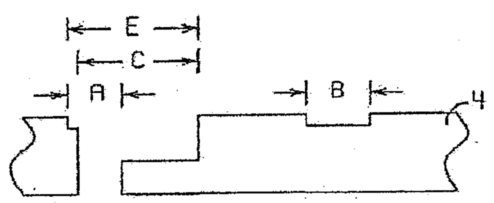


Fig. 3



By hardening a first image in a first photoresist (PR) layer and just developing a second image in a thicker second PR layer, coincident openings in the two PR layers provide a first pattern. Oxygen ion etching is then used to remove portions of the first layer of photoresist which are unprotected by the second photoresist layer, thus

Blanchard

METHOD TO INCORPORATE THREE SETS OF PATTERN INFORMATION IN TWO PHOTO-MASKING STEPS - Continued

providing a second pattern. Blanket exposing and developing away all of the remaining second photoresist provides a third pattern. Thus, three patterns are created having an overlay tolerance of a single alignment. Useful applications include creating three different thicknesses of metallized patterns within one level of dielectric material.

Referring to Fig. 1, a first photoresist layer 2 is deposited on substrate 4. Openings having width A and width B are formed in photoresist 2 by exposure to a first mask and development. Remaining photoresist 2 is then hardened, e.g., by a heat treatment. Next, photoresist 6 is applied and exposed to a second mask whereupon an opening having width C is created by exposure and development. A pattern defined by coincidence of openings having width A and C (D) can then be etched in substrate 4. The pattern having width D could be a via hole in a dielectric substrate 4 for a level-to-level interconnection.

Referring to Fig. 2, a reactive oxygen ion etching process is used to remove all of photoresist 2 which is not covered by photoresist 6 while an inconsequential amount of photoresist 6 is also removed. There is then an unprotected pattern of substrate 4 having width C which can be etched to define a part of an upper level of wiring connecting to an interlevel connector in the region having width D.

Referring to Fig. 3, all remaining photoresist 6 is removed by a blanket exposure and development. A pattern comprised of openings having width A + C = E and B in photoresist 2 may now be etched into substrate 4. Remaining photoresist is removed to complete the cross section shown in Fig. 3. The pattern having width B could be used to construct a thin fuse link which can be electrically blown. Another application of the pattern having width B is for monitoring planarizing processes. Either planarization end point or planarization uniformity may be detected by appropriate design of the shape of the region having width B.

Conformal deposition of a conductor and planarization complete the applications described.

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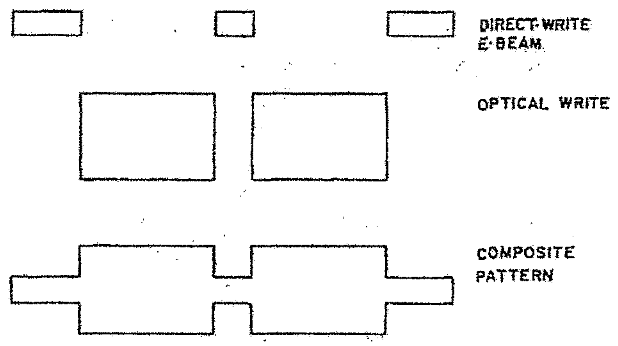
COMPLEMENTARY SELECTIVE WRITING BY DIRECT-WRITE E-BEAM/OPTICAL LITHOGRAPHY USING MIXED POSITIVE AND NEGATIVE RESIST

FIG. 1



By selectively writing complex patterns on semiconductor wafers utilizing both optical and E-beam technologies, line capacity can be increased over that which is achievable with direct-write E-beam (DWEB) considering throughput restrictions without selective writing.

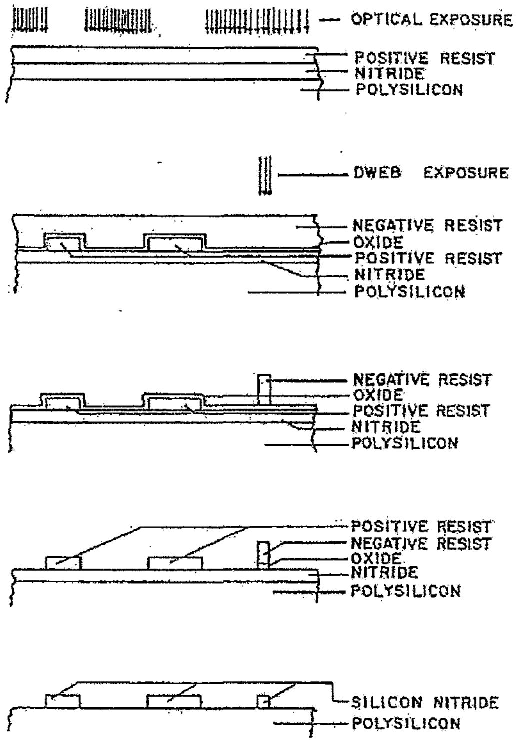
A DWEB tool is capable of 0.25 µm lithography, while current excimer laser lithographic tools are limited to images larger than 0.5 µm. For this reason the DWEB is required for printing sub-0.5 µm levels. Since the DWEB throughput is gated by pattern complexity and area to be written, it can be increased by writing only selected patterns on each wafer level.

By splitting the critical levels into two complementary patterns, the first consisting of sub-0.5-micron images to be exposed by DWEB and the second (less critical) to be exposed optically, a composite pattern can be generated, as shown in Fig. 1.

The process implementation depends on the tone of resist to be used. For the majority of levels of interest, DWEB requires a negative resist and optical tools utilize a positive resist. Referring to Fig. 2, the first resist is coated on the wafer, optically exposed, developed and hard-baked to prevent reflow or cracking during subsequent deposition of a barrier layer. (For the polysilicon level, a barrier layer of oxide is used.) Next, a layer of 1000-angstrom oxide or ni-

COMPLEMENTARY SELECTIVE WRITING BY DIRECT-WRITE E-BEAM/OPTICAL LITHOGRAPHY USING MIXED POSITIVE AND NEGATIVE RESIST - Continued

FIG. 2



tride, depending on the previous and subsequent processing, is deposited. The second resist is applied, DWEB exposed, developed and the pattern is etched into the barrier layer, simultaneously removing the barrier layer from the previously patterned positive resist, leaving resist pedestals and barrier layer pedestals. Next, the nitride is etched followed by the stripping of resist and oxide utilizing normal processing techniques. If adhesion of the first resist is not a problem while developing the second resist, the barrier layer may be omitted.

Although either exposure can be made first, there is an advantage to printing the optical pattern first. The DWEB has more accurate image placement than the optical tools and will therefore align to the optical exposure more accurately.

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