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

Fig. 1

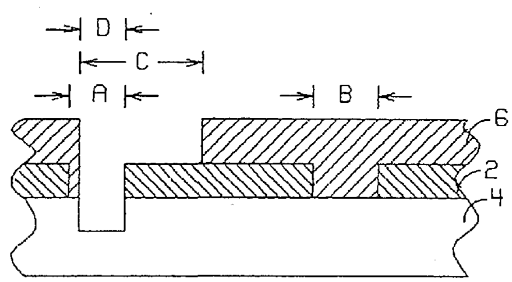


Fig. 2

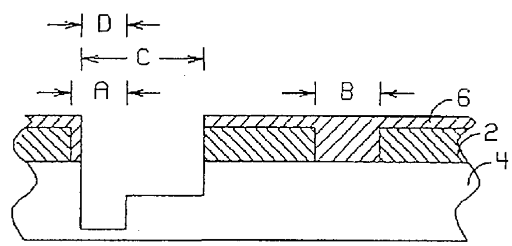
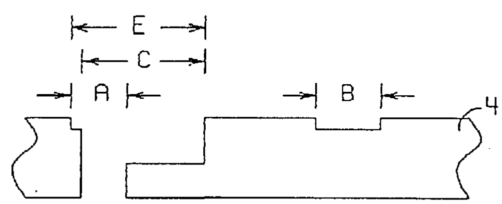


Fig. 3



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 photo-resist which are unprotected by the second photoresist layer, thus

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.

DUAL-IMAGE RESIST FOR SINGLE-EXPOSURE SELF-ALIGNED PROCESSING

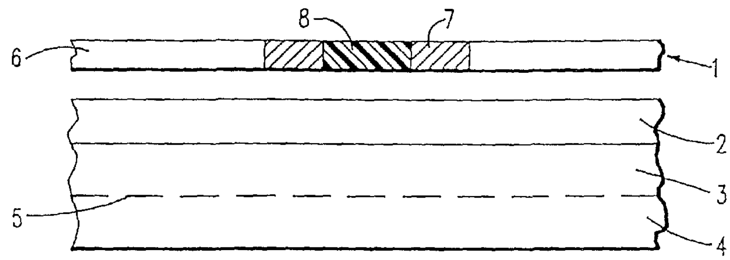


FIG. 1

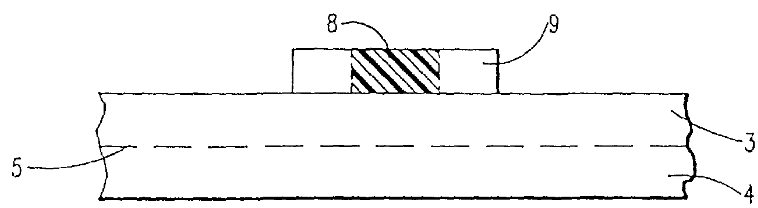


FIG. 2

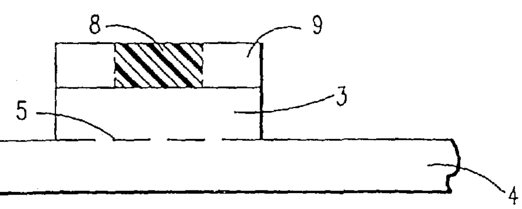


FIG. 3

This article describes a resist system having a wet developable first image and a dry developable second image (based on silicon incorporation through a silylation step). A novel material/process approach is described which simplifies device fabrication through self-aligned dual-image lithography.

DUAL-IMAGE RESIST FOR SINGLE-EXPOSURE SELF-ALIGNED PROCESSING - Continued

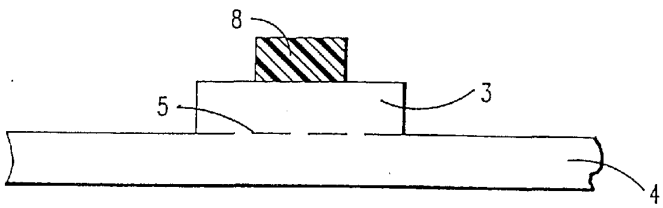


FIG. 4

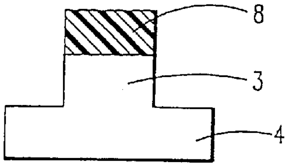


FIG. 5

Dual-tone resists (positive or negative working depending upon the choice of wavelength and developer) are useful to a degree for self-aligned processes where elements of two separate patterns are to be placed on a substrate in a single masking step and developed out separately. They are limited in use, however, since the resist must survive the first process unaffected in order to allow the subsequent development of the second latent image and completion of the second process. Where the first process is a harsh one, such as metal RIE (reactive ion etch), the effects of ion and electron bombardment, UV radiation, heat, polymer deposition, etc., act to prevent proper delineation of the second image, i.e., development of the second latent image. The technique here disclosed is capable of high resolution imaging, successfully overcoming the prior noted difficulties while achieving the objective of sequentially delineating, on a wafer, two separate self-aligned patterns from a single mask exposure.

The material used for resist is one which, when exposed to radiation of wavelength $\lambda 1$, acts as a positive working, wet developing resist and, when exposed to radiation of wavelength $\lambda 2$, acts as a positive working, dry developing (developed by oxygen plasma) resist. One mask containing the elements of two patterns is used, where a first pattern (p1) is defined by areas which transmit the wavelength $\lambda 1$, and the second, (p2), is defined by areas which transmit the wavelength 2, or some combination of $\lambda 1$ and $\lambda 2$. The disclosed dual-imaging technique is illustrated by Figs. 1 - 5, where it is applied to a self-aligned 1st metal and 1st to 2nd stud definition process.

DUAL-IMAGE RESIST FOR SINGLE-EXPOSURE SELF-ALIGNED PROCESSING - Continued

Fig. 1 shows a mask 1, a dual-image resist layer 2, and Al-Cu metallization layers 3 and 4 (deposited 1 um each), separated by an intermediate layer 5 of chromium or titanium/tungsten (~200-300 angstroms) as a metal RIE stop (optional). These three depositions can be done in sequence using a single metal deposition tool. The mask 1 will be noted to contain the elements of two patterns, the first 6 transmissive to wavelength λ1, and the second 7 transmissive to wavelength λ2. A central section 8 is opaque to both λ1 and λ2.

Following exposure to λ1 and wet development, the structure shown in Fig. 2 is presented. Only silylites remain in the unexposed area 8 of the remaining resist 9.

One um of metal is removed by RIE to obtain the structure shown in Fig. 3, the metal etch stop layer 5 acting to maintain a smooth surface on 4 during the etch process.

A dry etch (oxygen plasma) is next performed to remove resist 9, resulting in the structure shown in Fig. 4. This is followed with an RIE to remove another um of metal 3 in order to obtain the self-aligned 1st metal and 1st to 2nd stud structure shown in Fig. 5.

The process illustrated proves useful for the simultaneous definition of two levels of metallization, offering a capability for tighter ground rules and improved performance in a broad range of applications. Obvious modifications of the disclosed technique include the employment of a variable dose mask instead of the variable wavelengths of transmission used. Multiple layer resist materials composed of layers sensitive to differing wavelengths of transmission could also be used, as could resist layers containing silicon or capable of being silylated, to further simplify device fabrication.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.