A－2－5 A New Self-Aligned Framed Mask Method for Selective Oxidation

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A selective oxidation process using a new structure mask has been developed for suppression of the bird's beak extent. The oxidation mask has a directly deposited Si_3N_4 frame around a conventional mask structure with pad SiO_2 and Si_3N_4. The framed mask is formed by self-aligned method.

Selective oxidation process steps in the framed mask method are shown in Figs. 1(a)~(d). First, a conventional mask consisting of a pad SiO_2 film 50~100 nm thick and a Si_3N_4 film 100~150 nm thick is photoetched. Second, the conventional mask is covered with a second Si_3N_4 film by CVD method. Third, the frame is formed by reactive sputter etching of the second Si_3N_4 film. Reactive sputter etching realizes anisotropic etching and no lateral etching is recognized. Therefore, the second Si_3N_4 at the perimeter of the first Si_3N_4 film pattern is left when the second Si_3N_4 in the other region is fully etched off. Finally, selective oxidation is carried out in wet O_2 at 900~1100°C. The grown SiO_2 films are 600~800 nm thick.

SEM photographs of oxide structures formed by the conventional mask method and the framed method are shown in Figs. 2(a) and (b), respectively. The bird's beak in the conventional mask method is widely extended. On the other hand, in the framed mask method, it is suppressed by the Si_3N_4 frame and is shorter than the frame width. For 750 nm thick isolation oxide films, the bird's beak extent dependence on Si_3N_4 frame width is shown in Fig. 3. The bird's beak extent decreases as the frame width increases.

When a thick Si_3N_4 mask without pad SiO_2 is used, the bird's beak can be suppressed to a point as narrow as the framed mask. However, the thick Si_3N_4 mask method generates dislocations. Figure 4 shows SEM photographs of a cross section of a silicon wafer etched with Wright etchant after the selective oxidation. No dislocations are observed in the framed mask method. The presence of the pad SiO_2 under the Si_3N_4 film releases the stress and effectively suppresses dislocations.

Figure 5 shows the reverse current-voltage characteristics of a pn junction surrounded by isolation oxide. The reverse current in the framed mask method is as small as in the convetional mask method.

The framed mask method realizes fine width isolation and is applicable to high-density MOS LSIs.

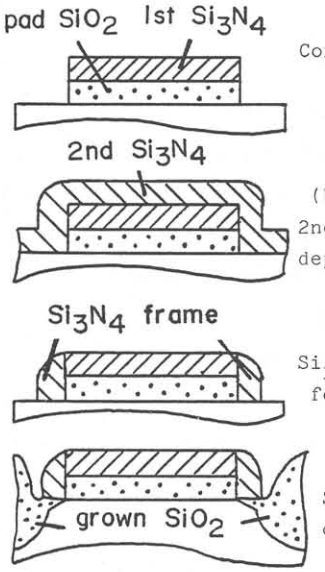

Fig.1 Selective oxidation process steps using the framed mask method.

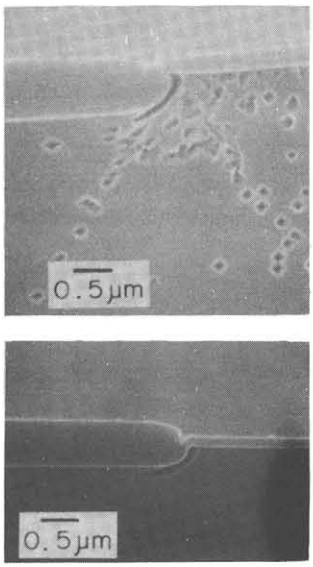

Fig.4 SEM cross sectional view of a silicon wafer etched with Wright etchant after selective oxidation.

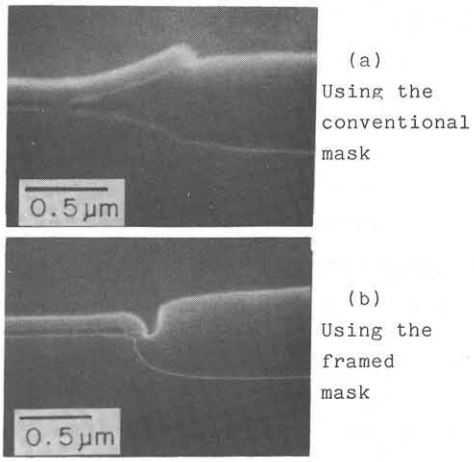

Fig.2 Oxide structures using conventional mask method (a) and framed mask method (b).

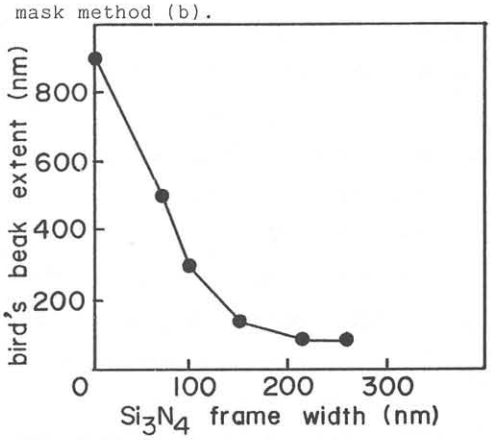

Fig.3 Bird's beak extent dependence on Si_3N_4 frame width.

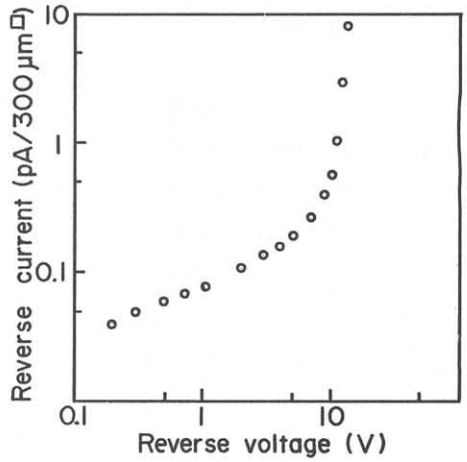

Fig.5 Reverse I-V characteristics of pn junction.