Digest of Tech. Papers The 7th Conf. on Solid State Devices, Tokyo, Sep. 1975

A-1-3 Microfabrication of Anti-Reflective Chromium Mask by Gas Plasmas

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There is a clear trend toward increasing packing density on a smaller single chip and wafer diameter in the integrated circuit technology. This trend requires the uniform formation of the finer patterns of the higher qualities and accuracies. Especially, recent super-LSI idea requires the formation of the high quality fine patterns of a few micron to submicron. These requirements for the high quality pattern generation result in the use of the chromium or chromium oxide film masks instead of the conventional emulsion mask.

It is not easy, however to form fine patterns of the chromium or chromium oxide films of high accuracies and manufacture high quality masks using a conventional wet chemical etching techniques because of uncontrollable variation of pattern sizes due to an undercutting effect, uncontrollable edge qualities of the patterns due to the unexpected deformation of the photoresist pattern at the high temperature baking process, and also mask defects such as opaque spots, pinholes, intrusions, adhesion of dusts on the plate, and so on. Another disadvantage of the conventional wet-chemical etching process is that the unform pattern accuracy is not easily obtained for all ranges of pattern size and all over the surface of the large mask plate.

In order to eliminate these disadvantages of the conventional wet-chemical process, new gas plasma etching and photoresist removal techniques are applied to the fabrication of the chromium and anti-reflective chromium (Cr_2O_3/Cr structure) masks. The Cr or Cr_2O_3 films are deposited by RF sputtering or evaporation methods. Four kinds of gas plasmas, which are generated by high frequency discharge, are examined to etch the films. They are the mixed gas plasmas of No. (1); Ar, Cl_2 and O_2, No. (2); He, Cl_2 and O_2, No. (3); Ar and CCl_4 and No. (4); Ar and CCl_4.

The Cr films can be etched by No. (1), No. (2) and No. (4) gas plasmas, although their etch rate depends on the deposition methods. No. (1) and (3) gas plasmas can etch Cr_2O_3 film deposited by the evaporation method. On the other hand, Cr_2O_3 film deposited by sputtering method can not be easily etched by No. (2) gas plasma. These results seems to show that the reaction rate or mechanisms between these gas plasmas and Cr or Cr_2O_3 films are very sensitive to the c crystallographical structure of the surface of these films.

In our dried process with gas plasmas, the photoresist which is not post-baked is used as an etching mask is also removed sequentially using wet air gas plasma after etching of the films.

The advantage of our dried process with gas plasmas are identified as follows;

a) The etched pattern sizes with high accuracies are easily obtained for all ranges of pattern sizes because of little undercutting during gas plasma etching. This result is shown in Fig. 1 for positive and negative images formed by gas plasma and wet-chemical process.

b) A better spatial uniformity of the accuracies of the etched pattern sizes all over the surface of 2.5" and 4" plate is obtained.

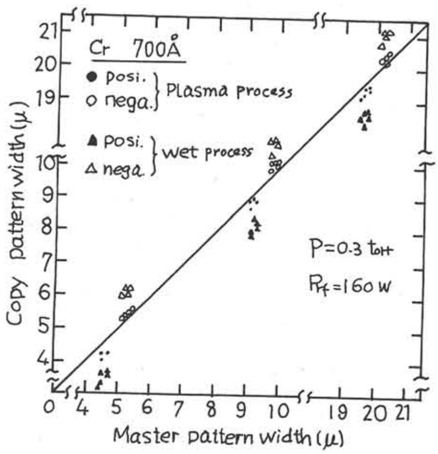
c) A sharper edge or corner of fine patterns can be easily obtained because of the elimination of the high temperature post-baking treatment of the photoresist.

d) The finer patterns are easily obtained comparing with wet process. In photo 1, the positive and negative patterns of the Cr_2O_3/Cr film are shown. Their widths are in 0.90 µm to 1.05 µm. Both patterns whose widths are less than 1.0 µm are also easily obtained by choosing an optimum condition of the exposure and development.

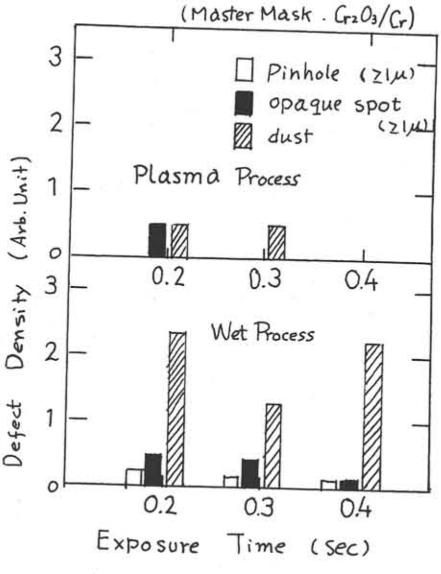
e) The pattern defects due to pinhole, opaque spot and dust are remarkably reduced and mask quality and yield is increased, as shown in Fig. 2.

f) Mask fabrication process is simplified because of the elimination of post-baking, cooling and sequential treatment of plasma etching and photoresist removal.

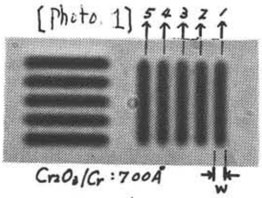
[Fig. 1]



[Fig. 2]

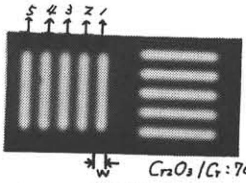


[Photo. 1]



Cr_2O_3/Cr : 700Å

	W (µm)
1 :	1.05
2 :	1.10
3 :	1.10
4 :	1.15
5 :	1.10



Cr_2O_3/Cr : 700Å

	W (µm)
1 :	0.90
2 :	1.00
3 :	0.95
4 :	0.95
5 :	0.95

(measured by Nikon digital micro meter)