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NEW IC PROCESS TECHNOLOGY

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It has been reported that oxygen-doped polysilicon films are useful tools[1)-5)] for surface passivation of high voltage devices and for channel stopperless structure in MOS-devices. The electronic mechanism and properties in the interface of this device structure, however, are not so far examined in detail.

This paper will concern with the physical study and consideration in Metal-CVD Silicon Dioxide-Oxygen Doped Semi-insulating Polysilicon-Silicon structure (M-O-SI-S structure) and Metal-Oxygen Doped Semi-insulating Polysilicon structure (M-SI-S structure). In addition to the basic study of Interface structure, the practical methods and electrical properties of partial oxidation technology by using oxygen doped polysilicon film will be discussed. Furthermore, some IC process applications will be proposed and discussed as applications which are used for this partial oxidation technology of polysilicon films in this paper.

BASIC CHARACTERISTICS OF METAL-CVD SILICON DIOXIDE-OXYGEN DOPED SEMI-INSULATING POLY SILICON-STRUCTURE (M-O-SI-S STRUCTURE) AND METAL-PARTIAL OXIDATION FILM-SILICON STRUCTURE (M-PO-S) STRUCTURE)

A simple model of oxygen doped semi-insulating poli-silicon-silicon and partially oxidized film-silicon is shown in Fig. 1. The total interface density in this structure of the oxygen doped semi-insulating polysilicon-silicon and the partially oxidized film of oxygen doped polysilicon-silicon will be about higher than 10^{13} cm^{-2} and 10^{11} cm^{-2} on (100) silicon surface, respectively. Constructing the partial oxidation part and oxygen doped polysilicon part in same films, high threshold voltage part and low threshold voltage part can be formed as shown in Fig. 1. Fig. 2 shows an application of MOS device by using the partial oxidation technology. In order to realize this process for practical use, the detailed studies on the partial oxidation of oxygen doped semi-insulating polysilicon in the wet oxygen ambient and electrical characteristics on MOS-FET having the partial oxidation film as a gate insulator were measured under the film thickness of 400Å to 1200Å and the oxygen concentration of 7% to 36%, respectively, as shown in Fig. 3 and Fig. 4.

APPLICATIONS

It can be considered from these experimental data that the control of high threshold voltage due to the partial oxidation will be very effective for all kinds of MOS-structure; p-channel, n-channel and C/MOS-IC, D-MOS high voltage device and others. In Fig. 5, for an example, the high voltage D-MOS transistor with the breakdown voltage higher than 500 volts is shown. Applying this process to MOS-IC, the channel stopper will be unnecessary for all of MOS-IC structure under the normal MOS voltage operation. As a result, many advantages and disadvantages may be considered: ADVANTAGE 1) simple process and device structure; 2) high packing density; 3) short oxidation time; 4) thin thickness of field oxide; 5) high field threshold voltage; 6) stable surface energy status, DISADVANTAGE 1) leakage current 2) high surface state density. In conclusion, the structure composed of the partially oxidized gate film and oxygen doped semi-insulating polysilicon film will be useful for the digital IC process and structure.

REFERENCES

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Fig.1

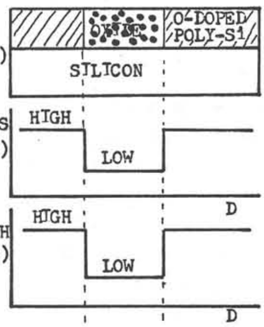


Fig.2

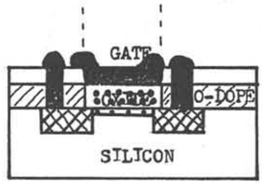
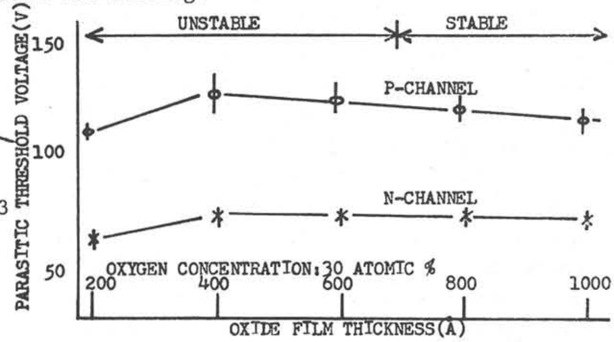


Fig.3 a)



b)

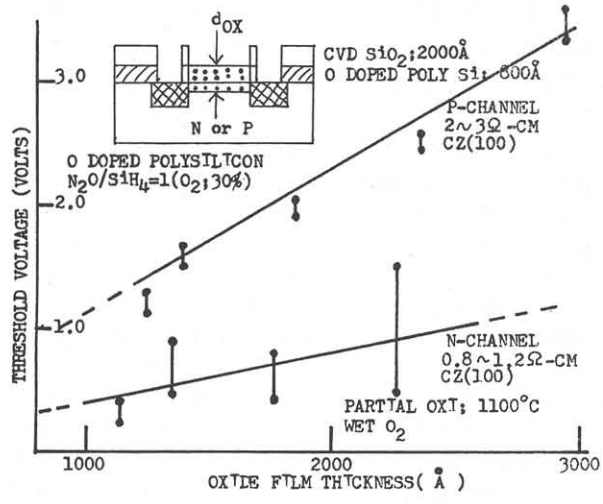


Fig.1:A Simple Model of Partial Oxidation Technology

Fig.2:MOS-FET With Partial Oxidation Structure

Fig.3:a)PV_{TH} vs. Oxide Thickness
b)V_{TH} vs. Oxide Thickness

Fig.4:Substrate Resistivity Dependence of PV_{TH}

Fig.5:High Voltage D-MOS Tr By Using Partial Oxidation Technology (BV: higher than 500V)

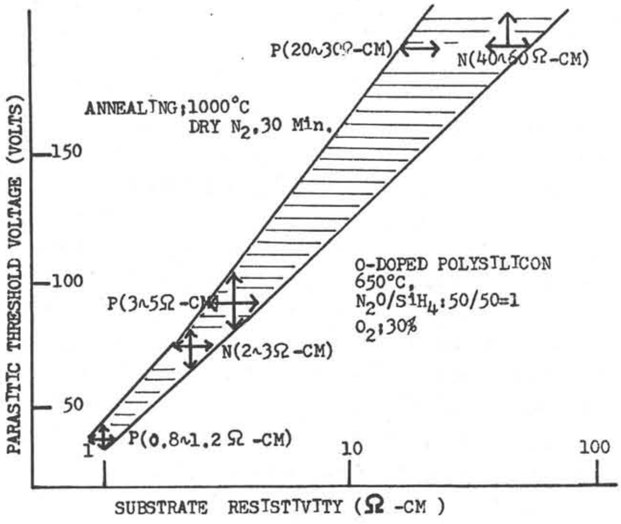


Fig.4

Fig.5