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CHARACTERIZATION OF FLUORINE UPON IMPLANT SEQUENCE ON P-METAL OXIDE SEMICONDUCTOR (PMOS) AND P+/N-JUNCTION SCHOTTKY DIODE IN BiCMOS TECHNOLOGY

SITI ZUBAIDAH MD SAAD

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ABSTRACT

Fluorine (F) is known as a reactive species that capable to form a variety of complex defects. It beneficial effect as well as the detrimental effect to the electrical and physical characterization of devices have been studied by many researchers. The effect of F to the electrical results such as resistance and leakage current has created controversy discussions among researchers. F used as the co-implantation of boron (B) was found to reduce the resistance and leakage current but some researchers revealed an opposite findings. Due to this, it is crucial to understand the phenomenon behind these controversies. This study was done on BiCMOS product. BiCMOS is the integration of CMOS and Bipolar devices. In this work, we study the effect of F co-implant with BF_2 as well as F with B by varying the dose and implant energy in the *p*+-region of *p*+/*n*-junction Schottky diode and PMOS as these are the basic and important devices in the BiCMOS technology. Besides that, the most important condition in this experiment was the implant sequence of boron fluoride (BF_2) and F co-implant. Instead of implanting F followed by BF_2 (F-BF_2 sequence), we have reversed the implant sequence to BF_2 followed by F (BF_2-F sequence). We found that for the same dose and implant energy of F co-implant and BF_2, the leakage current of *p*+/*n*-junction was improved by one decade in BF_2-F sequence. Further variation of dose and implant energy had shown that implant sequence affected the electrical characterization such as leakage current, breakdown voltage and resistance in *p*+/*n*-junction. As implant sequence changes, the pre-amorphization layer will be different according to the dopant, dose and implant energy. These will significantly affect the subsequent implant profile and depth. By implanting B and F as close as possible helps to reduce the leakage current as F acts as a sinker for the defects from End-of-Range (EOR) region to get into the B doped region. While in PMOS, very minor effect of BF_2 dose and implant energy variation upon implant sequence to the SiO_2 electrical thickness and capacitance were seen as well as to the Negative Bias Temperature Instability (NBTI) degradation except for F variation effect. With these understandings, integrated circuit (IC) design engineer is able to define the optimum implant conditions in order to get the desired electrical results such as low leakage current, high breakdown voltage and low NBTI degradation.

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