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In situ analysis of carrier lifetime and barrier capacitance variations in silicon during 1.5 MeV protons implantation

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Ion implantation technology is commonly employed for modification of material properties, device structures, as well as for introducing fast recombination centers in microelectronic, nanoelectronic and optoelectronic devices. Despite beneficial recombination centers, detrimental defects that affect the device operation are introduced during implantation as well. Therefore, it is essential to analyze the characteristics of these defects. Usually, combined analysis of current-voltage (I-V), capacitance-voltage (C-V), deep level transient spectroscopy (DLTS), transient current technique (TCT) characteristics is employed for investigation of radiation induced defects. However, these techniques are applied in the post irradiated state and do not provide direct information of defects creation processes. Therefore, in situ techniques, capable to reveal the peculiarities of defects creation during ion implantation, are desirable.

In this work, results of the in situ analysis of recombination lifetime and barrier capacitance variations in Si substrates and pin diodes, respectively, during 1.5 MeV protons implantation are presented. Carrier recombination lifetime has been measured by employing microwave probed photoconductivity method (MW-PCD), while parameters of barrier capacitance changes have been extracted by transient technique of barrier capacitance charging current measurements using linearly increasing voltage pulses. Sub-linear decrease of carrier lifetime as a function of fluence has been revealed and peculiarities of such characteristic are explained in terms of formation of two layered structure within implanted Si material. Barrier capacitance variations in pin diode structures during 1.5 MeV protons implantation are discussed.

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