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Chapter 15

Enhancement of Properties of SiC Through Doping

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Modern power electronics require semiconductor devices which are capable of performing reliably within extreme conditions like high voltages and high temperature environment and also rapidly varying temperature conditions. Semiconductors having wider band gap are more suitable in comparison to the traditional semiconductor Si for such extreme conditions. Few of the wide band gap semiconductors found useful and being extensively studied are GaN, SiC and ZnO. For making them practically useful, their properties (structural, electronic, magnetic and optical) are to be studied in detail. In this thesis we have chosen one wide band gap semiconductor SiC and studied its properties theoretically.

SiC shows, excellent mechanical and electronic properties which vary slightly for different polytypes. The difference of stacking sequence affects the structural, electrical and optical properties of SiC. However, all polytypes are extremely hard, very inert and have a high thermal conductivity. The tetrahedral structured SiC has indirect band gap which varies from 2.2 eV to 3.3 eV for different polytypes. Properties such as the breakdown electric field strength, which allows the material to withstand up to certain voltage, is quite high for SiC in comparison to Si because of the wide band gap. The use of SiC, gives the possibility to increase the blocking voltages for high power devices, as well as to make devices smaller with less power losses. The high thermal conductivity, and high emissivity in the infrared, in addition to the excellent creep resistance and oxidation resistance, makes SiC a preferable choice for high temperature uses. Its high thermal conductivity enables more efficient removal of heat from the device. Heat energy radiation efficiency increases greatly with the increase in temperature difference between device and cooling ambient. The high electrical resistance of SiC has been used to advantage in resistive heating applications such as igniters for natural gas furnaces. On the whole, one can say that the outstanding material properties keep SiC devices advantageous over other available semiconductor devices in optical, high