EPITAXIAL GROWTH OF SiC BY CHEMICAL VAPOR DEPOSITION AND APPLICATION TO ELECTRONIC DEVICES

by

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PREFACE

This thesis describes the investigation on the CVD growth and the characterization of a widegap semiconductor silicon carbide(SiC) and its application to fundamental electronic devices. The author investigated these subjects as a graduate student at Matsunami Laboratory, Department of Electrical Engineering, Kyoto University. SiC, especially 3C-SiC, is the most hopeful candidate for the material of electronic devices which operate under harsh circumstances because of its wide bandgap and physical and chemical stability. SiC is, in truth, an old and well known material. However, dimensions of crystals obtained by a conventional growth method are too small and some other problems in crystal growth exist as a barrier to the investigation as a semiconductor material. Although many investigators tried to grow 3C-SiC on Si, a large lattice mismatch of 20% between them prevented successful single crystal growth. "A carbonized buffer layer" introduced to overcome the large lattice mismatch by the senior workers of the author opened the way to use 3C-SiC as a "new" semiconductor material. The author took over the work to bring up 3C-SiC.

This thesis consists of seven chapters. In Chapter I, features and properties of SiC and its history are introduced, and purposes of this investigation are explained. 3C-SiC grown on a Si substrate is treated in Chapter II to Chapter V. The crystal growth of 3C-SiC on Si is discussed in Chapter II. The structure of "a carbonized buffer layer" and influences exerted by the lattice mismatch were studied. Through the characterization of the grown layers, a growth technique was optimized to improve their crystallinity. In Chapter III, the antiphase disorder which is peculiar to heteroepitaxial growth and its elimination by the introduction of off-orientation into substrates are described. Electrical properties of undoped and doped crystals are mentioned in Chapter IV. Some problems due to the introduction of off-orientation and doping are also

discussed. Properties of ion implanted layers were investigated as a preparation of device fabrication and results are explained in Chapter V. Successful fabrication of MOSFET's as a compilation of studies is presented also in Chapter V. In Chapter VI, growth on 6H-SiC attempted to seek a new direction is mentioned. An innovation was achieved in homoepitaxial growth of 6H-SiC by the introduction of off-orientation into the substrate. Chapter VII summarizes conclusions of this investigation.

New materials must experience many seasons before ripe. SiC just spent a few seasons as a semiconductor material. The author hopes that this thesis serves as a seedbed for successors and the season of good harvest will come around.

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