SNDM Observation of the Dopant Distribution in a SiC Power Device Cross-section

SHEET No. 008

Instruments: Environment control AFM AFM5300E
Scanning Nonlinear Dialectric Microscope HS-SNDM Ⅱ

Introduction

Until now, the dopant distributions in semiconductor devices was mainly evaluated with scanning spread resistance microscopy (SSRM) and scanning capacitance microscopy (SCM). Recently, the technique of scanning nonlinear dielectric microscopy (SNDM), as shown in figure 1, was developed.[1]

SNDM is a measurement mode that differentiates p-type and n-type dopants and acquires the dopant concentration from the image contrast. Similar to the SSRM, the performance of the SNDM increases further in a high vacuum surrounding. Low dopant concentrations of 10^{13}/cm^3 to 10^{14}/cm^3 as well as high accuracy C-V curves can be measured.[2, 3]

In this data sheet, the SNDM was applied to a SiC device as an application example of a wide-gap semiconductor. The observation results of its two dimensional dopant distribution are presented here.

[1] Cho, Y. *et al*., "Scanning nonlinear dielectric microscope," Rev. Sci. Instrum., **67**, 2297–2303, 1996.

[2] Yamaoka *et. al.*, "Nano-scale physical property observations by SPM: Electromagnetic measurements in vacuum and SPM/SEM observations", The 34th Annual NANO Testing Symposium, 13-18, 2014.

[3] Jing-jiang Yu *et al*., "Environmental control scanning nonlinear dielectric microscopy measurements of p-n structures, epi-Si Wafers, and SiC crystal defects", ISTFA 2015: Conference Proceedings, 341-348, 2015.

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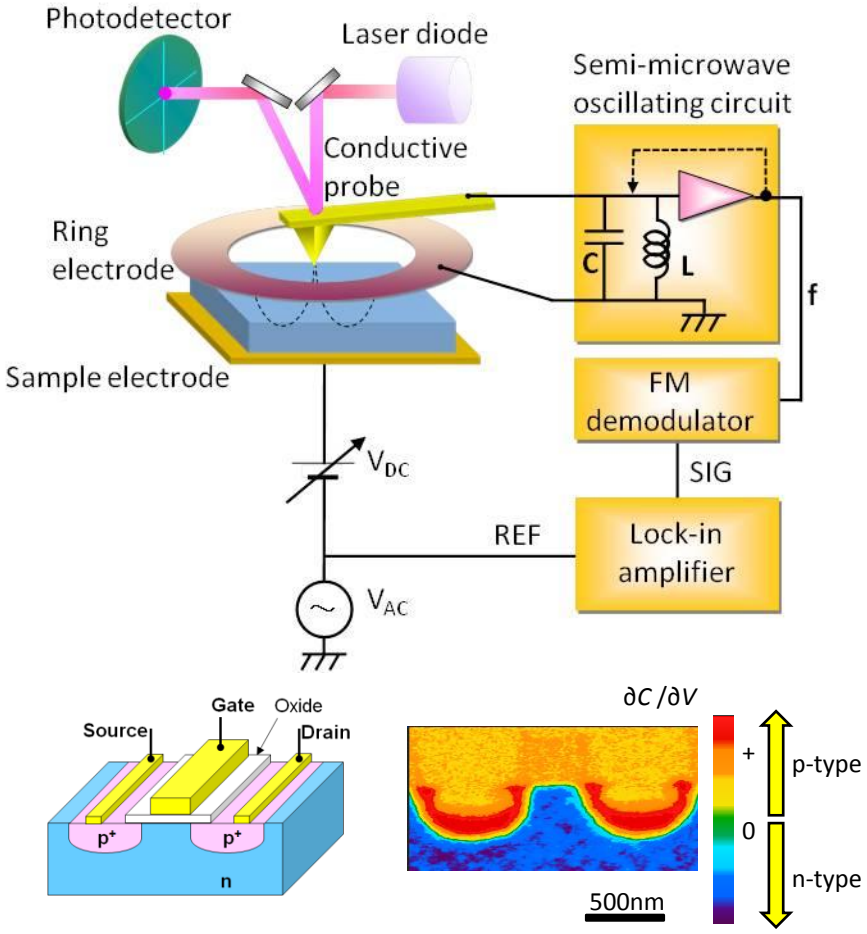

Figure 1: SNDM principle and observation result of a Si MOS FET

Results

In figure 2 the SNDM observation results of a SiC Power MOS FET in a vacuum are shown. The dopant concentration distribution corresponds to the device structure. Furthermore, the C-V curves at 10 points crossing the pn-junction from p-type area to n-type area were measured. The state of the depletion layer modulation depending on the dopant concentration and type could be clearly obtained due to the DC voltage sweep.

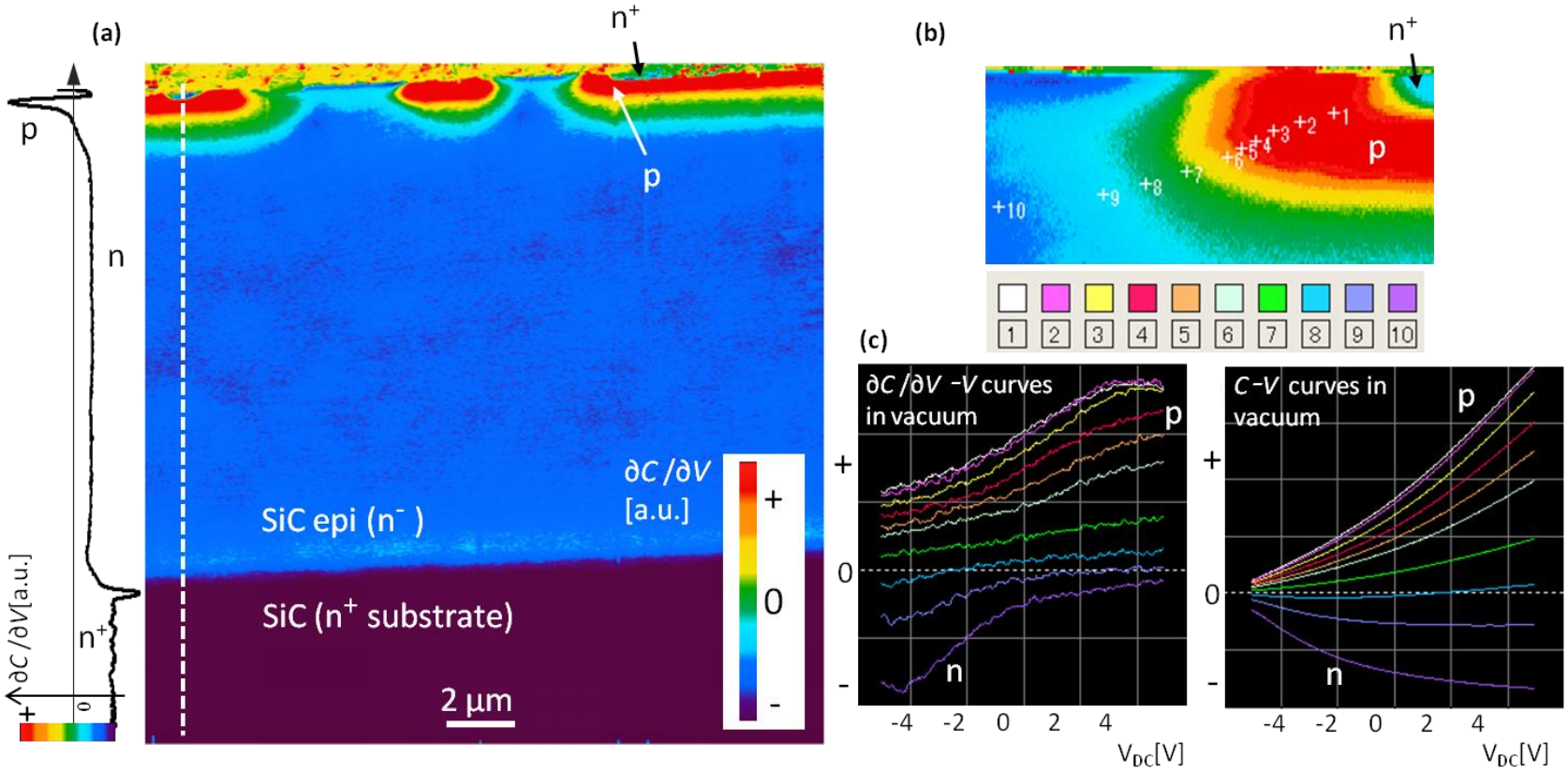

Figure 2: (a) In vacuum SNDM observation result of a SiC Power MOS FET and cross-section signal strength profile line
(b) Observation results in vicinity of the pn-junction (c) ∂C/∂V-V curves in a vacuum, measurement results of C-V curves

【Complementary information】 The C-V curves of the SNDM observation are calculated as the integral of the ∂C/∂V-V curves obtained by the DC voltage sweep. As every point shows clearly its characteristics, the typical response of a depletion layer can be identified from the shape of the curves. Furthermore, these ∂C/∂V-V curves are more stable and accurate when measured in a vacuum than in air. [2]

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