Advanced Topographic Resistivity Analysis Of Semi-insulating SiC Substrates

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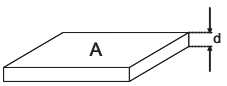
Outline

The growing complexity and maturity of SiC based high frequency, high power microelectronic devices and modules continually tightens the demand on the electrical quality of semi-insulating SiC substrates.

The topographic measurement system COREMA-WT and the temperature dependent measurement system COREMA-VT are used to characterize exploratory 40 mm diameter SiC wafers. We demonstrate that the combined analytic capabilities of these tools allow a very detailed assessment of the resistivity distribution across the entire wafer area. Both macroscopic variations, resulting from the growth process, as well as local intermixtures of material phases with different resistivities, resulting from incomplete compensation, are assessed with respect to absolute resistivity values and the respective volume contributions. We show that local inhomogeneity results in a temperature dependent activation energy.

Basics of COntactless REsistivity MApping

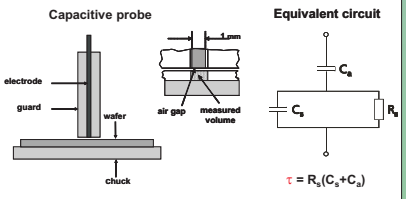


Semi-insulating semiconductor

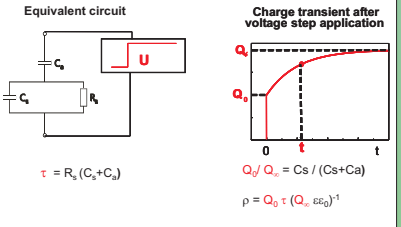
$R_s = \rho\ d/A$

$C_s = \varepsilon\ \varepsilon_0\ A/d$

$R_sC_s = \rho\ \varepsilon\ \varepsilon_0$



$\tau = R_s(C_s+C_a)$



$\tau = R_s(C_s+C_a)$

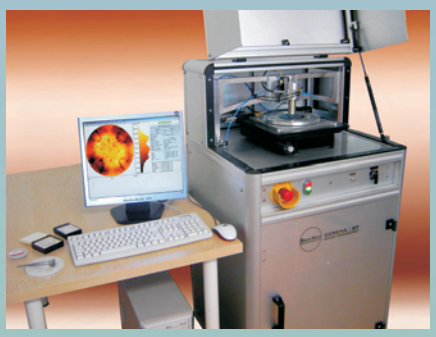
$Q_0/Q_\infty = Cs / (Cs+Ca)$

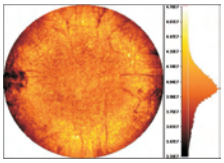
$\rho = Q_0\ \tau\ (Q_\infty\ \varepsilon\varepsilon_0)^{-1}$

Evaluation of electrical material properties

Resistivity	$\rho = Q_0\ \tau\ (Q_\infty\ \varepsilon\ \varepsilon_0)^{-1}$
Mobility	$\mu = 1/B\ [\ \rho(B) / \rho(0) - 1]^{1/2}$
Activation energy	$E_a = (kT_1T_2)/(T_2-T_1) * \ln [\rho(T_1) / \rho(T_2)]$

COREMA System





Resistivity Measurement

150 mm GaAs wafer

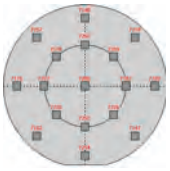
Mean: 3.96×10^7 Ohm*cm

Stdv: 4.3 %

Radial variation

Fourfold symmetry

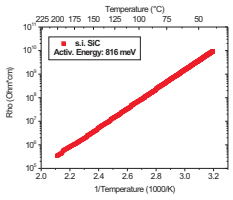
Dislocation network



Mobility Measurement

Mobility measurement

150 mm GaAs wafer



Activation Energy

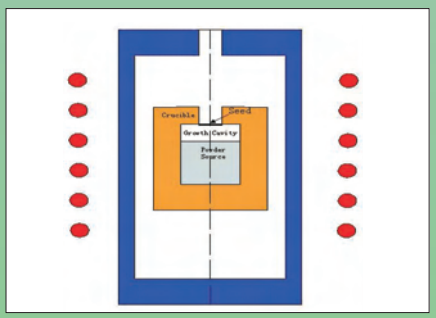
2" SiC wafer

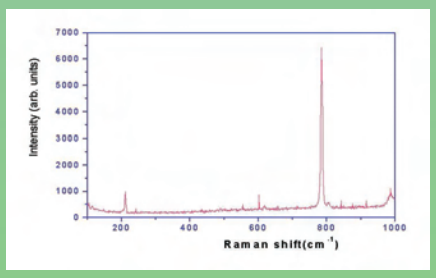
Temperature range
40 – 200°C

Resistivity range
3×10^5 – 1×10^{10} Ohm*cm

Not semi-insulating at 300°C

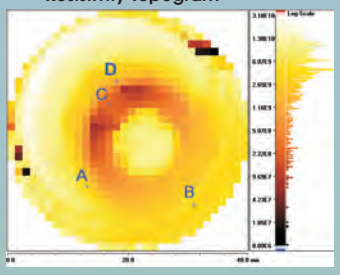
S.i. SiC Crystal Growth



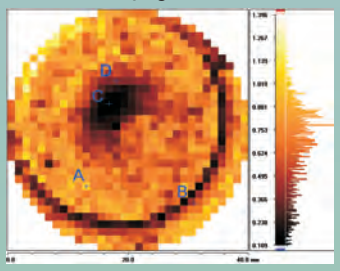


Resistivity

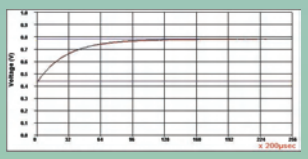
Resistivity Topogram



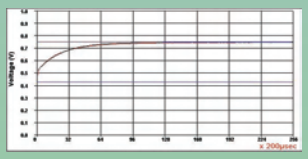
Volume Topogram



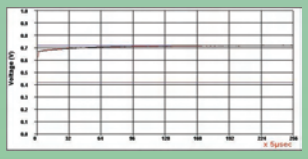
Position A, Volume = 100%



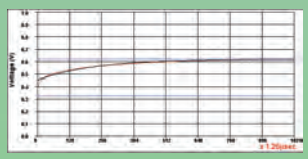
Position B, Volume = 58%



Position C, Volume = 10%



Position D, Volume = 50%



Activation Energy