Topographie des spezifischen Widerstands semi-isolierender SiC-Substrate

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Übersicht

- Motivation
- COntactless REsistivity MApping (COREMA)
- Bewertung von lokal inhomogenem Material
- Widerstandstopogramme von SiC Substraten
- Zusammenfassung

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Motivation

- Weltweit wird an der Entwicklung von (SI) SiC Wafern mit Durchmesser bis zu 100 mm gearbeitet
- Kontaktfreie, ortsaufgelöste Widerstandsmessung an SiC Substraten ist aus mehrfachen Gründen erwünscht
- COntactless REsistivity MApping (COREMA) wird industriell zur Charakterisierung von SI GaAs und InP Substraten eingesetzt
- Weiterentwicklung des COREMA - Systems für die Bewertung von SiC Substraten erscheint aussichtsreich

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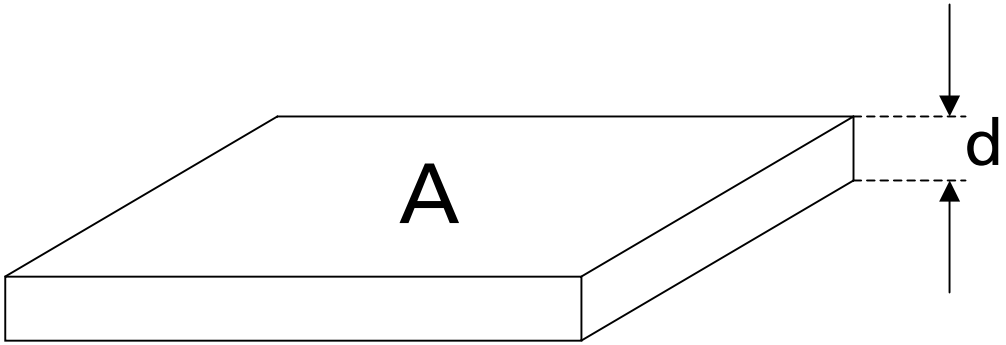
Neue Anforderungen

- **Erweiterung des Messbereiches auf $1x10^5$ – $1x10^{12}$ Ωcm**
- **Automatisierte Messung von lateral inhomogenem Material**
- **Bewertung von *lokal* inhomogenem Material**

Capacitive Resistivity Evaluation (I)



$$R_s = \rho\, d/A$$

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

$$R_s C_s = \rho\, \varepsilon = \tau$$

Semi-insulating semiconductor

$$\rho = \tau / \varepsilon$$

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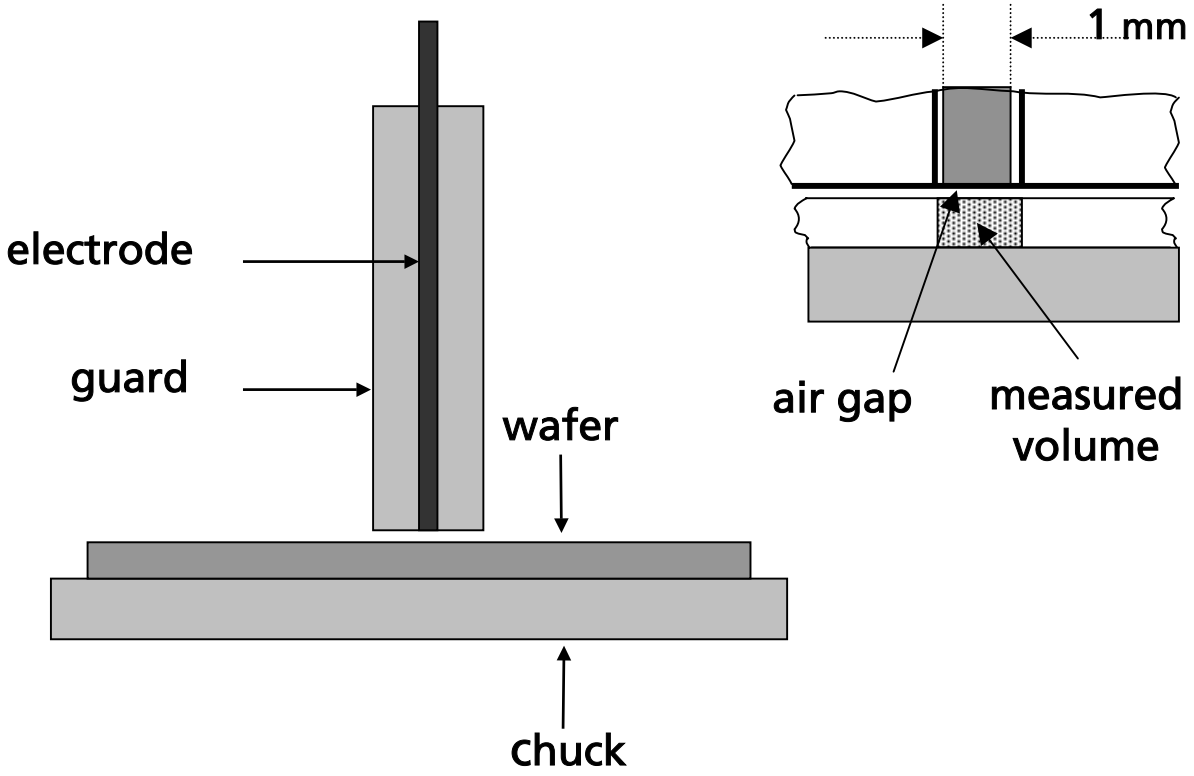
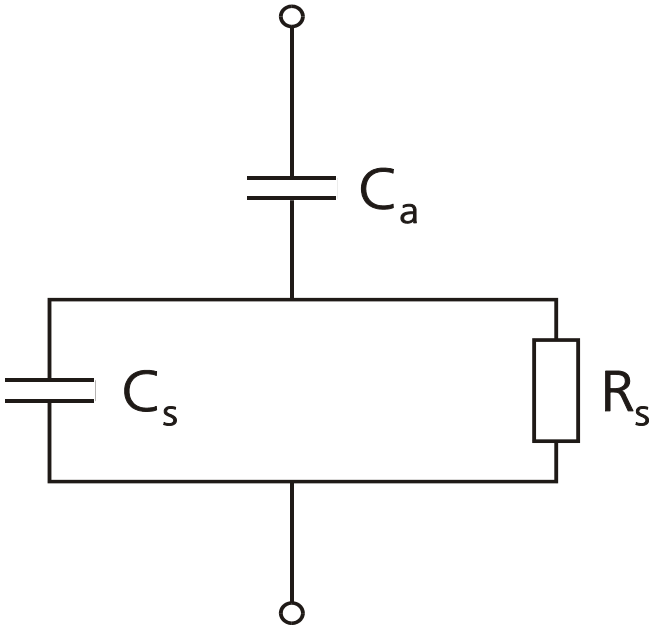
Capacitive Resistivity Evaluation (II)

Capacitive Probe



Equivalent Circuit



$$\tau = R_s(C_s+C_a)$$

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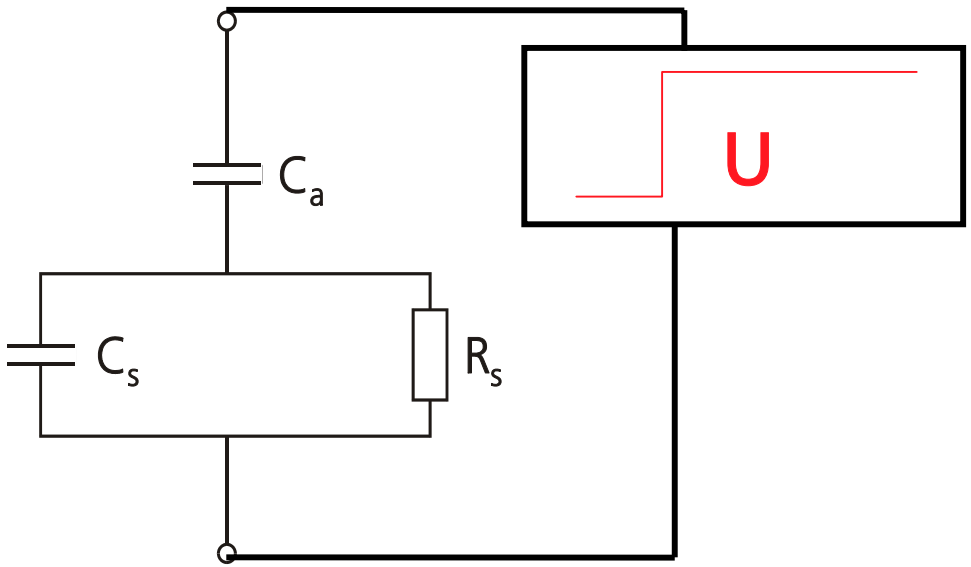
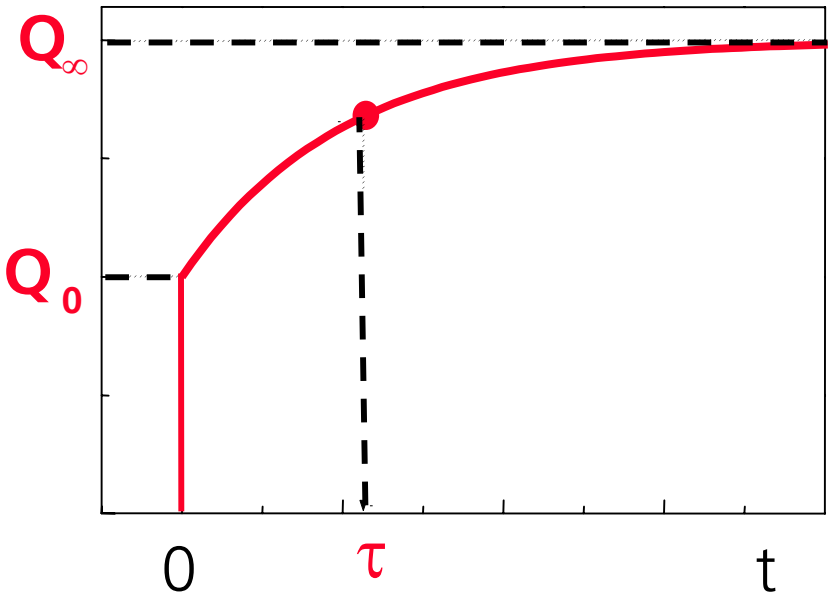
Capacitive Resistivity Evaluation (III)

Equivalent Circuit



Charge Transient after Voltage Step Application



$$\tau = R_s(C_s+C_a)$$

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

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IAF - COREMA - 2000

Specifications

Range $1x10^5 – 1x10^{12}$ Ωcm

Wafer ∅ ≤ 200 mm

Probe ∅ ≤ 1 mm

Repeatability 1%

Speed 100 ms @ 1E7 Ωcm

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SiC SUBSTRATE RESISTIVITY TOPOGRAPHY (I)

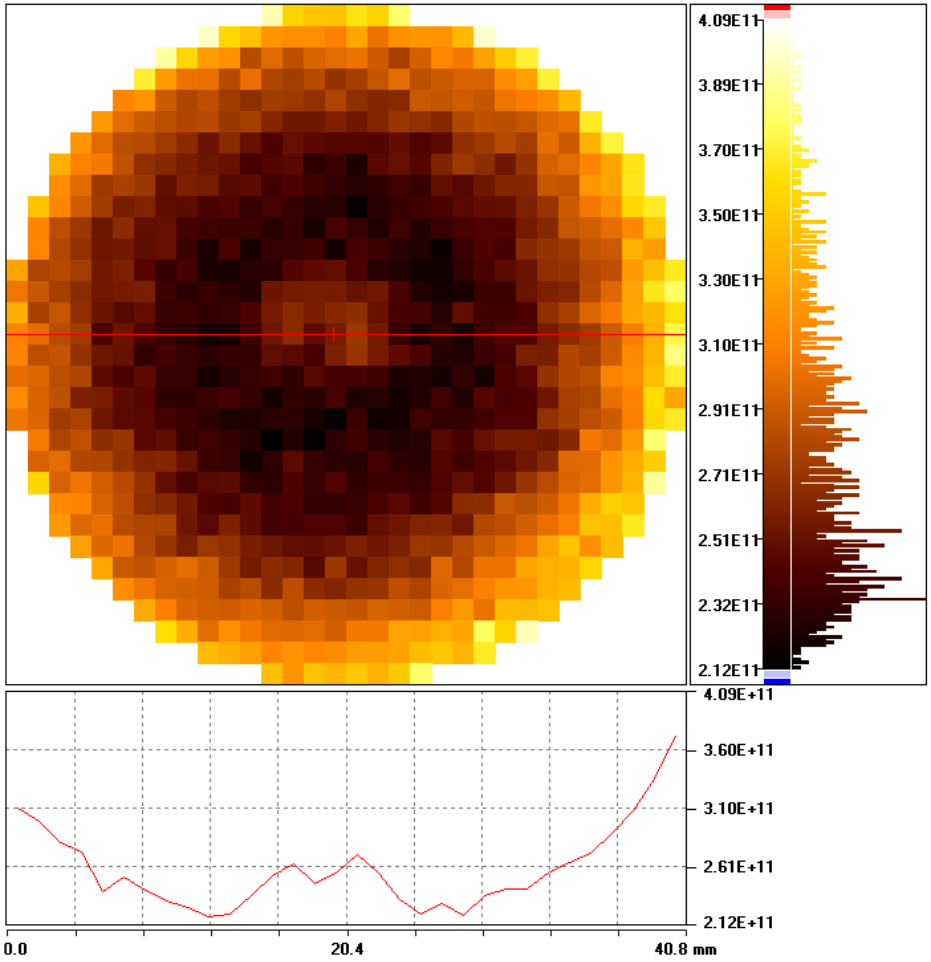
2" Wafer

ρ: 2.12 x10^{11} - 4.09 x10^{11} Ωcm

Mean: 2.75 x10^{11} Ωcm

Stdv: 14.7%

Very homogeneous Material



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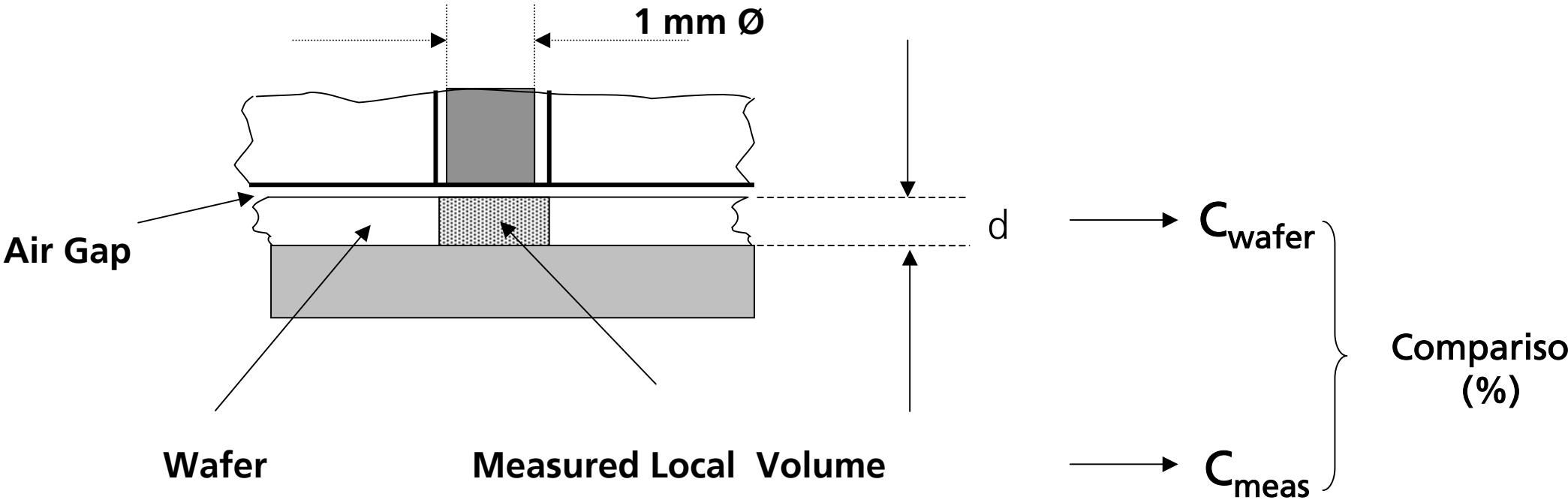
Evaluation of local Homogeneity (I)



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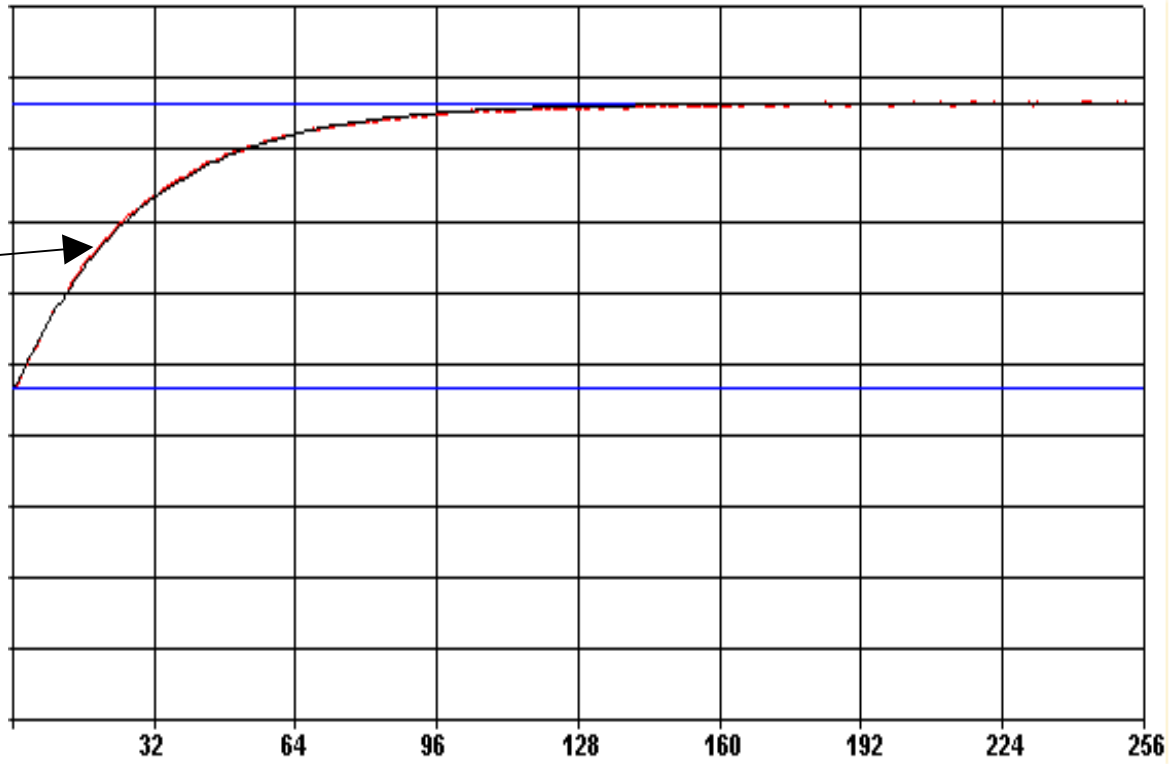
Evaluation of local Homogeneity (II)

Measured values

Q_∞

Fit

Q_0



Datapoints

Resistivity Topogram

Theoretical values

Q_∞^*

Q_0^*

Expected Transient

$Q_0 = Q_0^*$

Volume of resistive Material = 100% (homogeneous)

Volume Topogram

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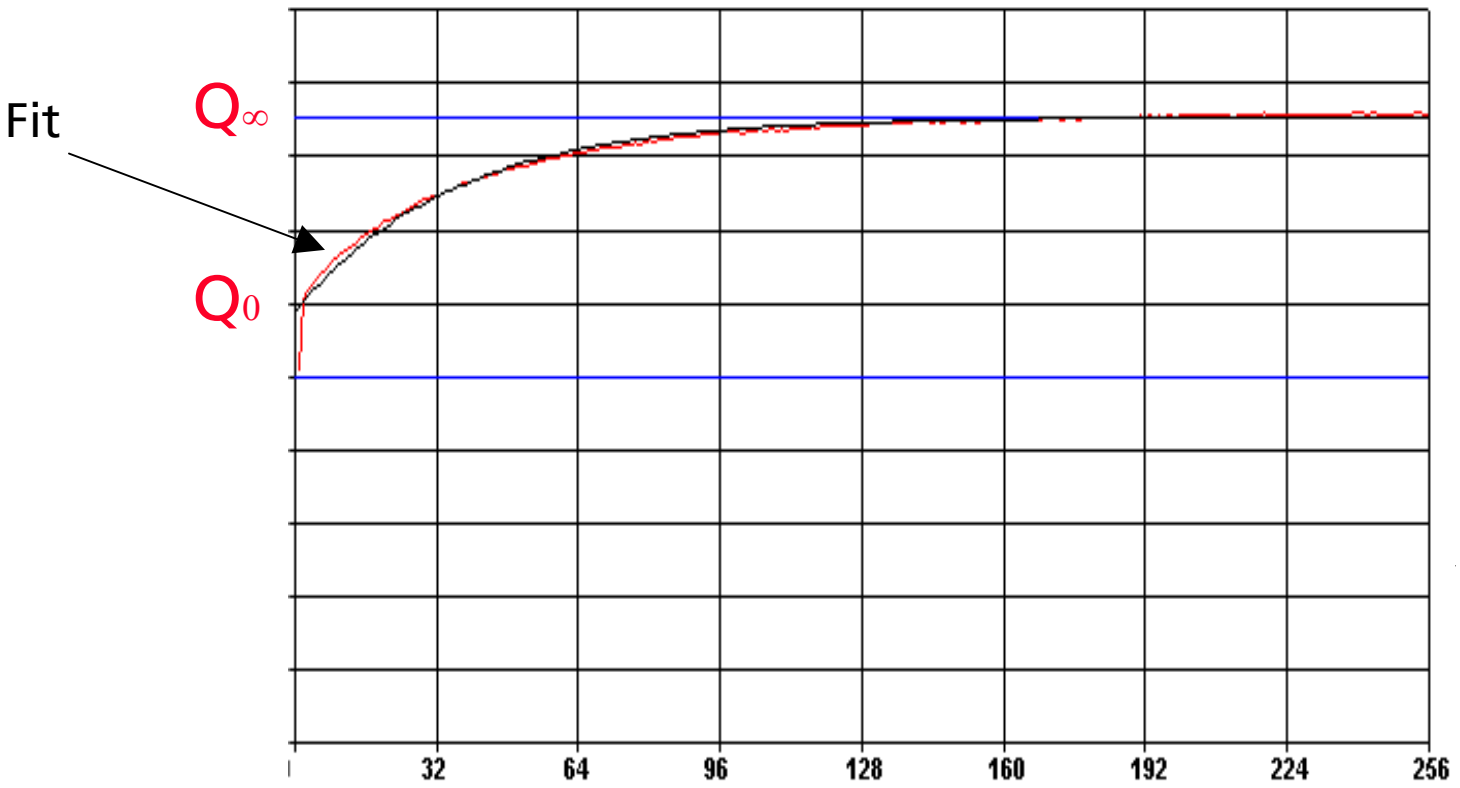
Evaluation of local Homogeneity (III)

Measured values

Theoretical values



Q_∞^*

Q_0^*

Expected Transient

$Q_0 > Q_0^*$

Volume of resistive Material < 100% (inhomogeneous)

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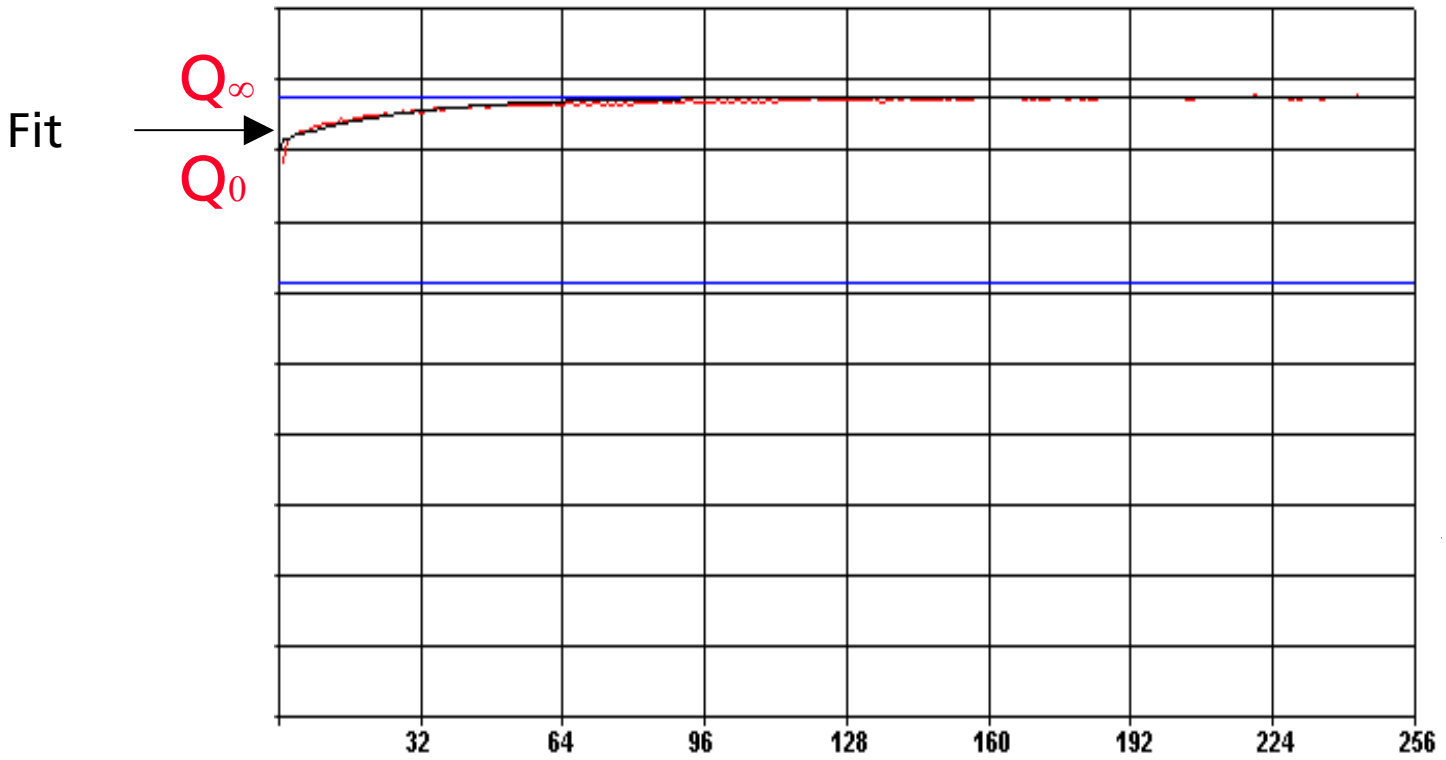
Evaluation of local Homogeneity (IV)

Measured values

Theoretical values



$Q_0 >> Q_0^*$

Volume of resistive Material < < 100% (inhomogeneous)

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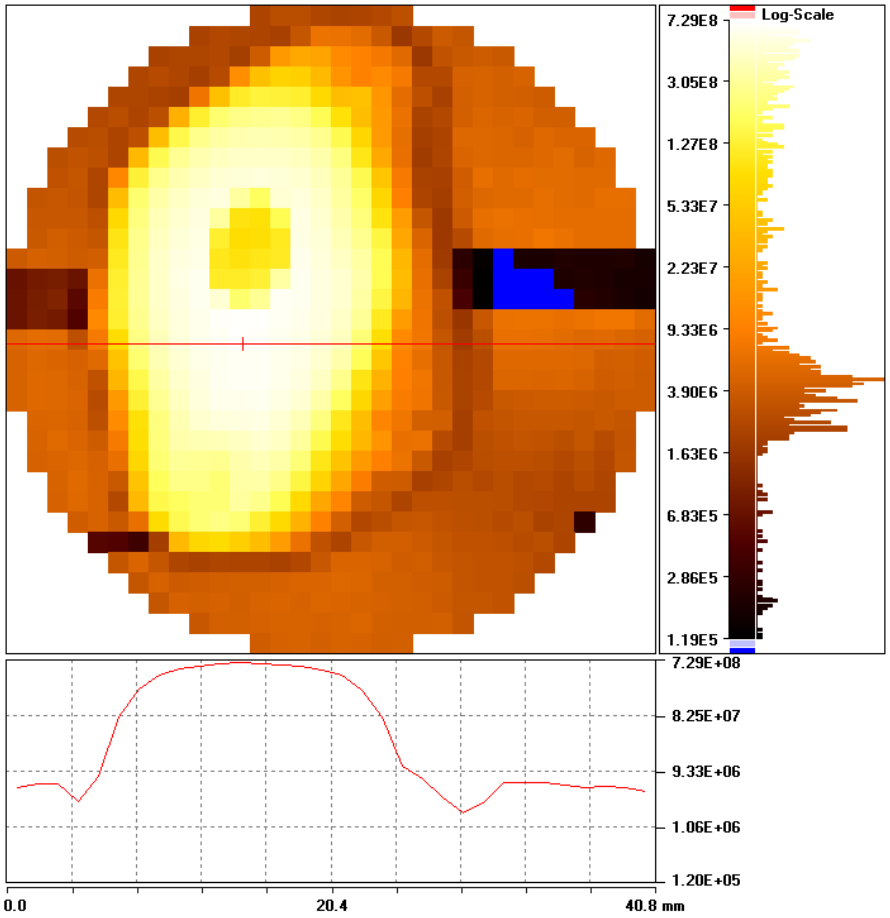
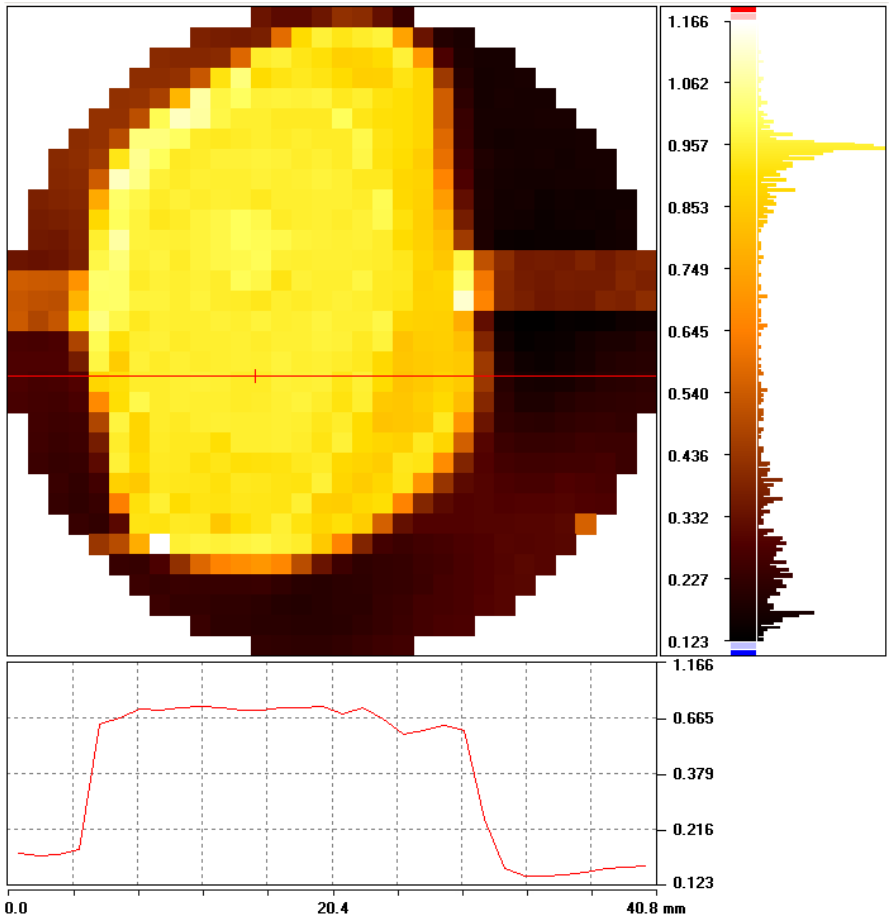
SiC SUBSTRATE RESISTIVITY TOPOGRAPHY (II)

Resistivity



Mean: 1.13 x10^8 Ωcm
Stdv: 168 %

Volume



Mean: 62%
Stdv: 54%

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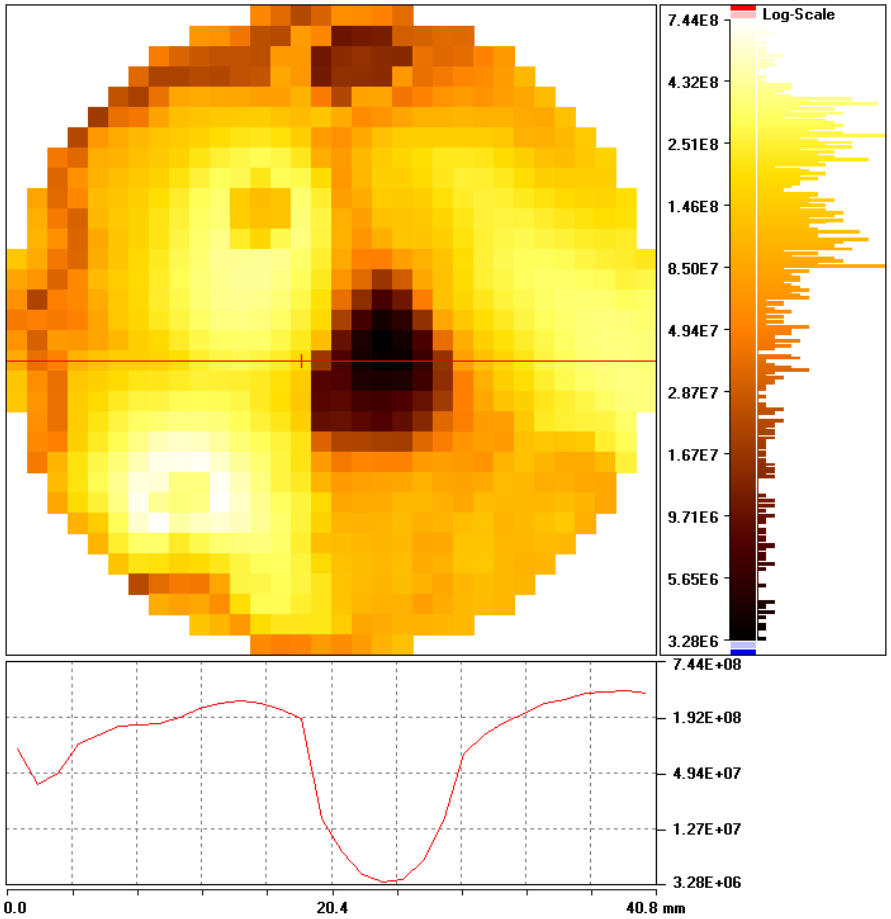
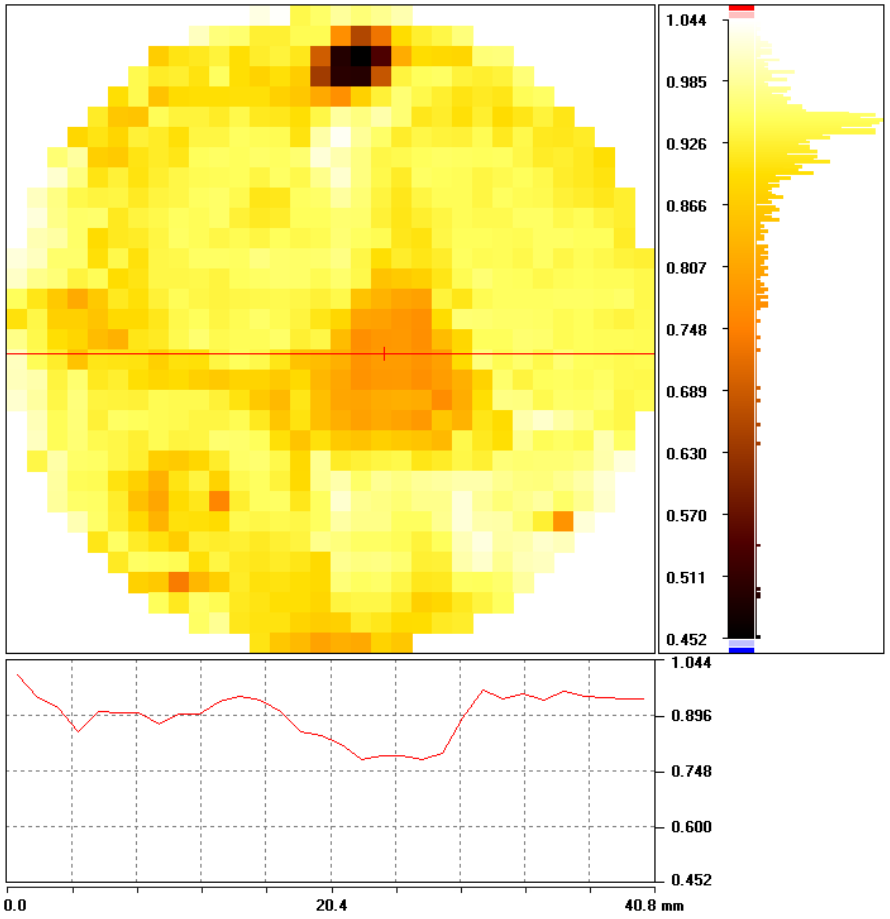
SiC SUBSTRATE RESISTIVITY TOPOGRAPHY (III)

Resistivity



Mean: 1.72 x10^8 Ωcm
Stdv: 75 %

Volume



Mean: 92.4%
Stdv: 6.76%

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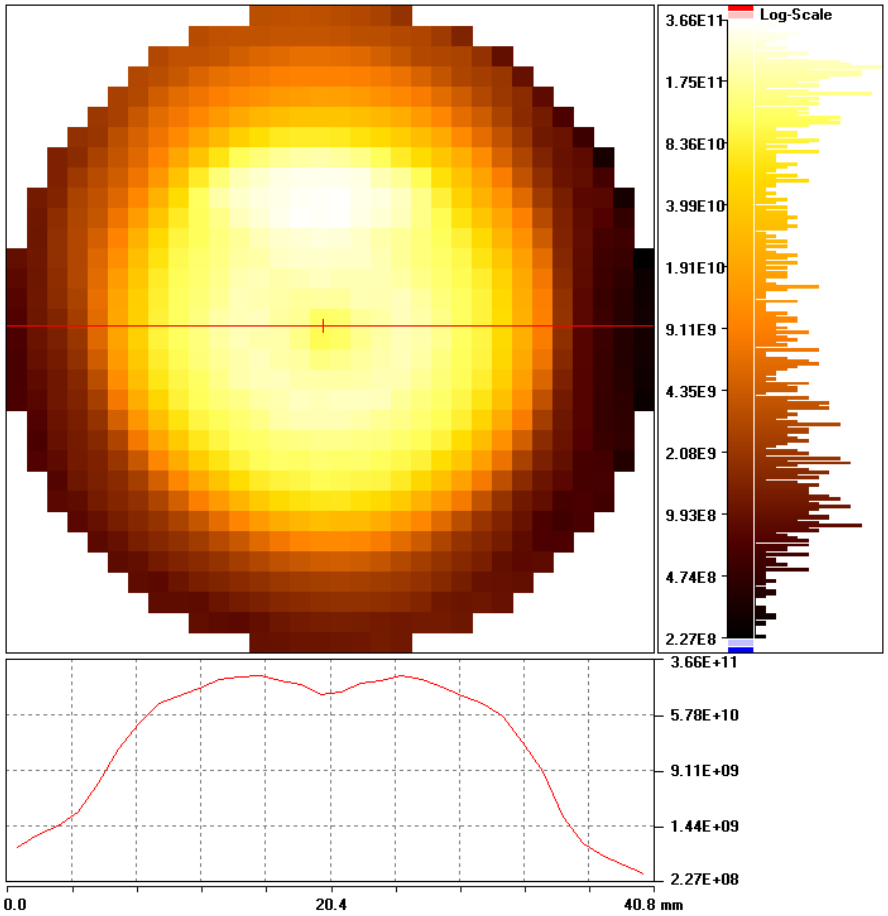
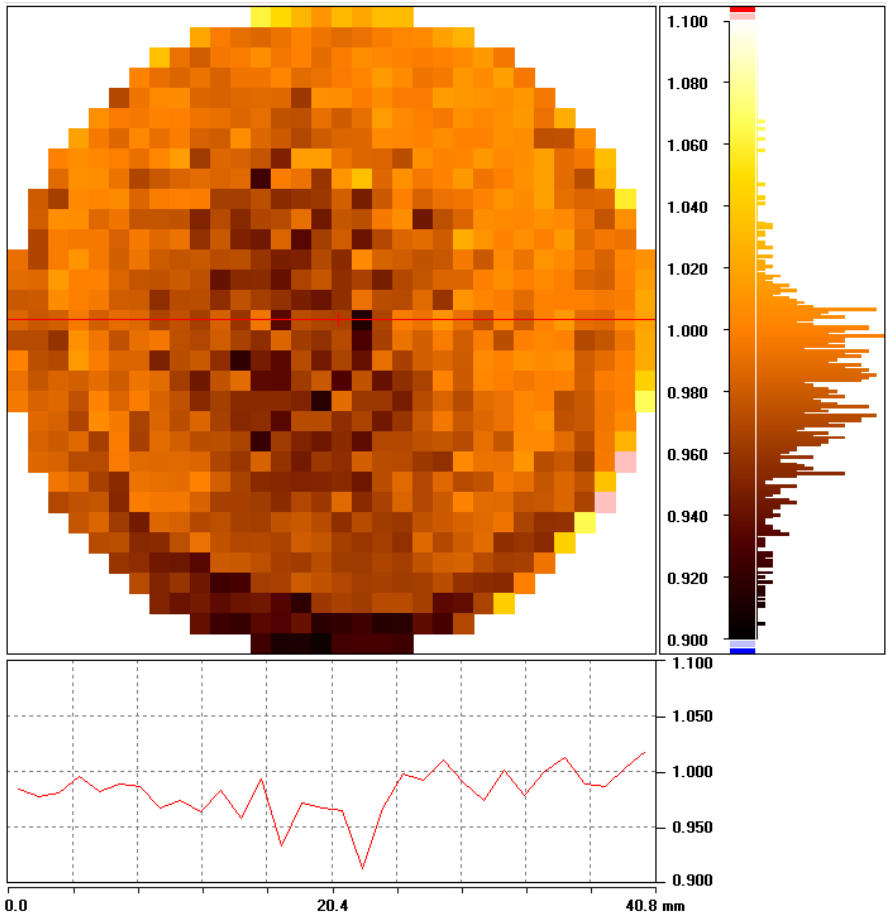
SiC SUBSTRATE RESISTIVITY TOPOGRAPHY (IV)

Resistivity



Mean: 5.82 x10^{10} Ωcm
Stdv: 143 %

Volume



Mean: 98.2%
Stdv: 2.54%

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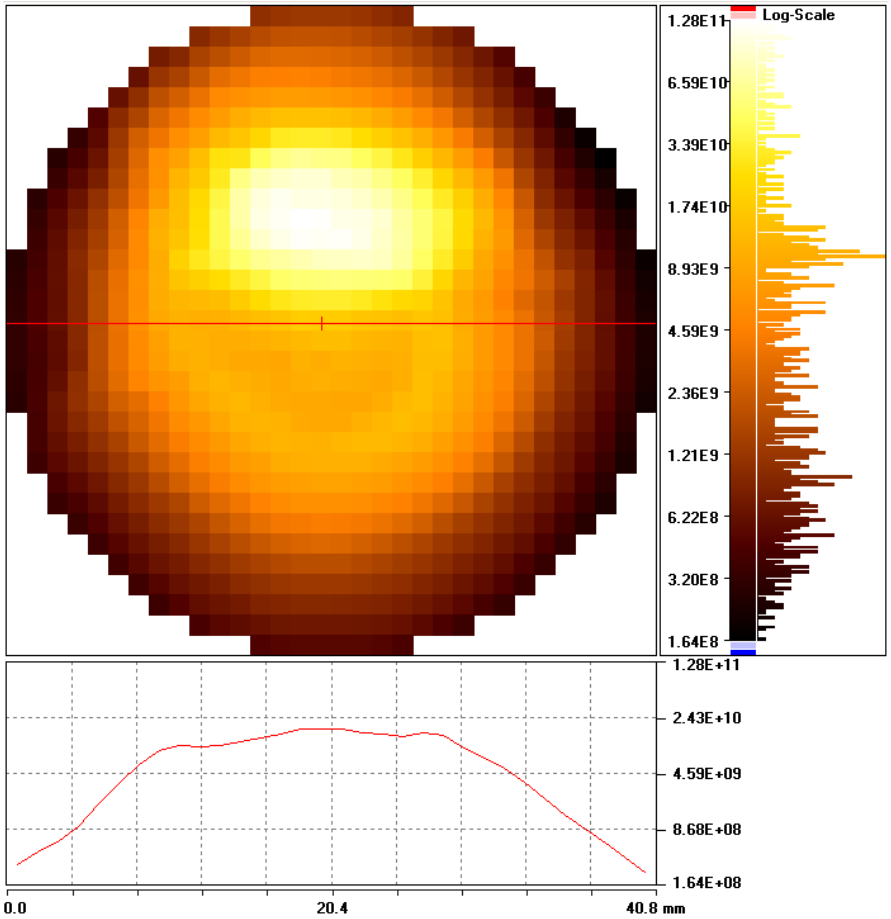
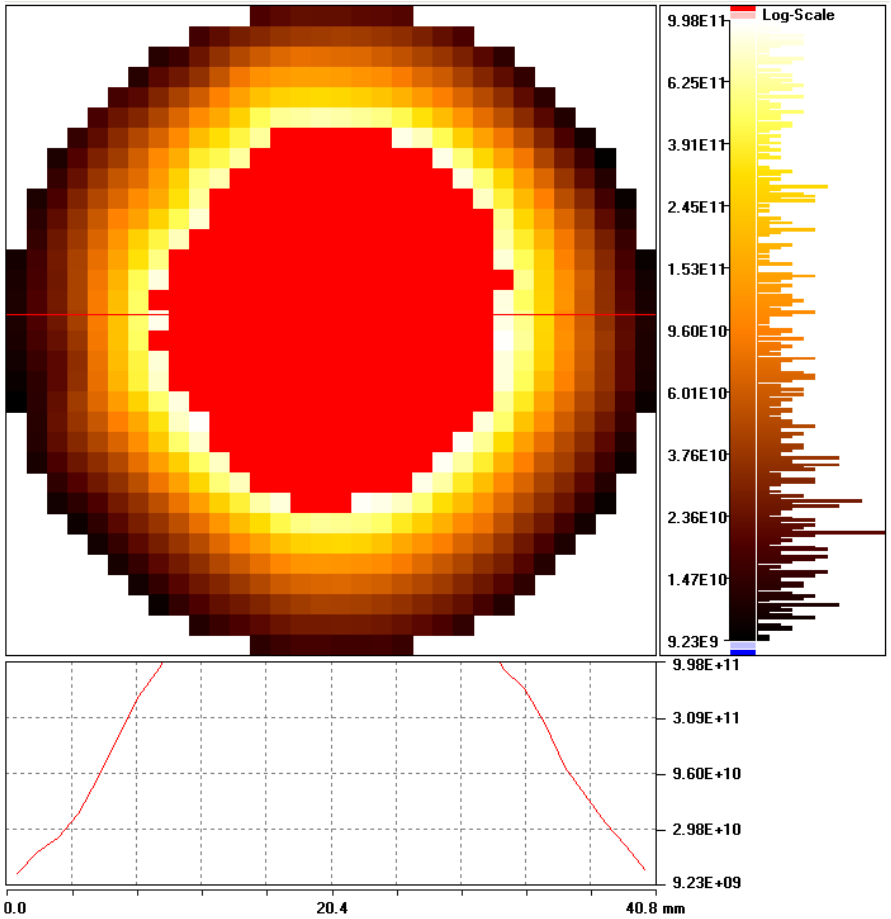
SiC SUBSTRATE RESISTIVITY TOPOGRAPHY (V)

Resistivity (3 h darkness)



Mean: 1.12 x10^{10} Ωcm

Resistivity (>48 h darkness)



Mean: 1.65 x10^{11} Ωcm

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Zusammenfassung

- Kapazitive Widerstandsmessung im Bereich $1x10^5$ bis $1x10^{12}$ Ωcm
- Topografie semi-isolierender SiC Substrate
- Bestimmung des Volumen-Anteils bei lokal inhomogenen Material

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