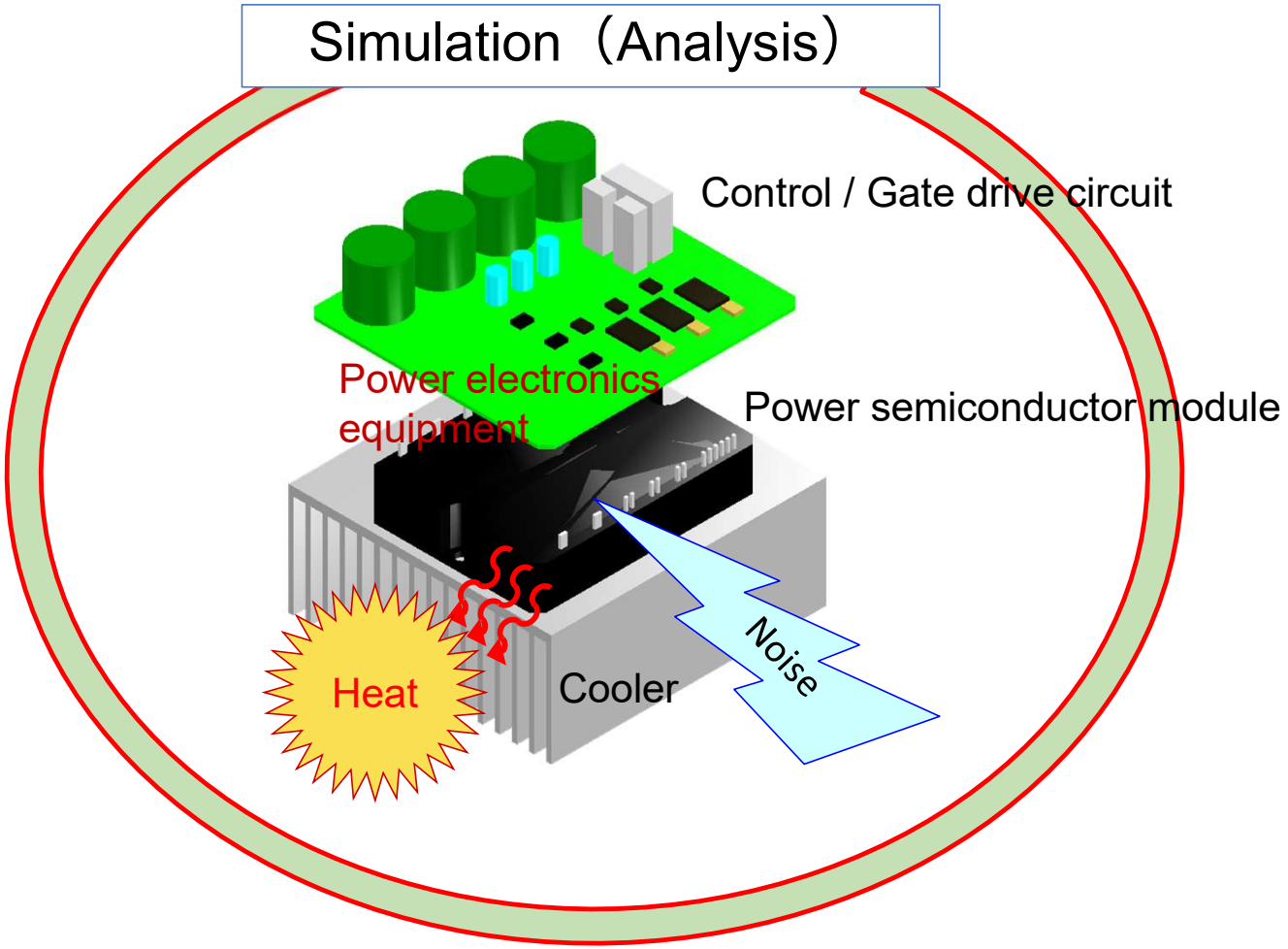
Purpose: Construction of an accurate and easy-to-use power semiconductor model for virtual production and verification of power electronics equipment utilizing simulation technology



Research summary: Build a modeling method for power semiconductor devices

Modeling method（@MATLAB）

Step.1
Import the actual measurement data (I_D vs. V_{DS}).
Extract the values of the variables Func1, Func2, and Func3 in the basic model formula for each V_{GS} data.

↓

Step.2
Model the extracted Func1, Func2, Func3 data with a Gaussian function as a function of V_{GS}.

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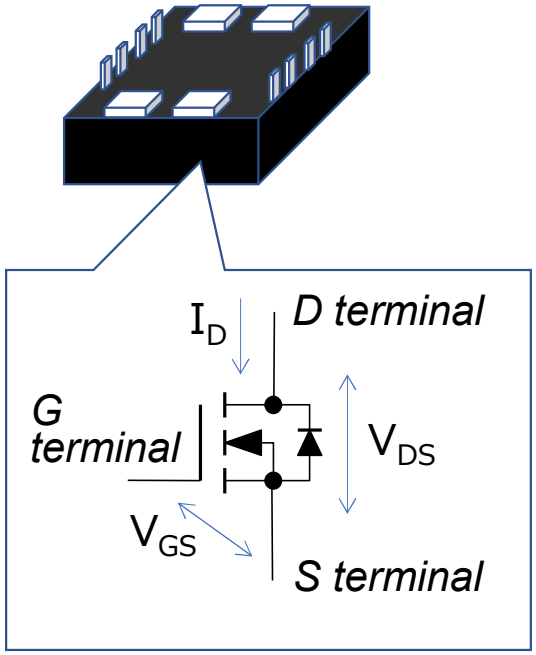
Step.3
Replace Func1 ~ 3 model with basic model formula.

↓

Power semiconductor model is completed

Target : 1.2kV-Full SiC module

Power semiconductor module



Power semiconductor device

Step.1

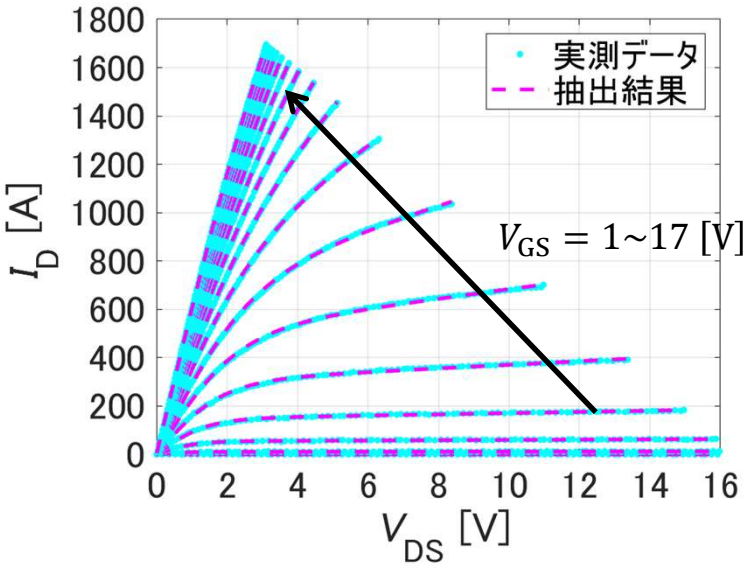
Import the actual measurement data (I_D vs. V_{DS}). Extract the values of the variables Func1, Func2, and Func3 in the basic model formula for each V_{GS} data.

∗ *Fitting measured data with Func1,2,3.*

Basic model formula :

$$I_{\mathrm{D}(V_{\mathrm{DS}})} = f_{(\mathbf{Func1},\mathbf{Func2},\mathbf{Func3},V_{\mathrm{DS}})}$$

$$= \mathbf{Func1} \times tanh(\mathbf{Func2} \times V_{\mathrm{DS}} \cdots) + \cdots$$



Target : 1.2kV-Full SiC module

Step.2

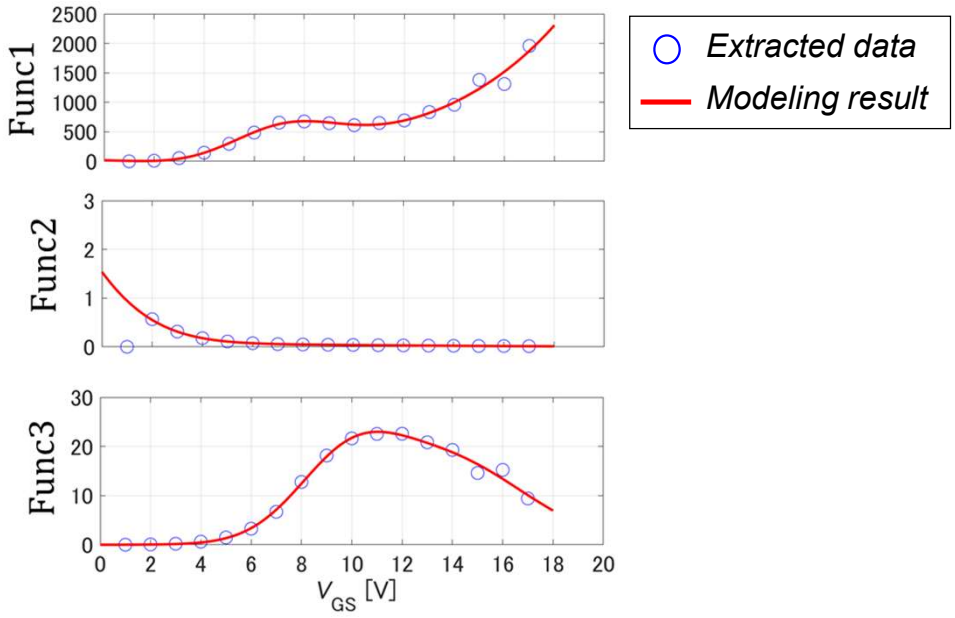
Model the extracted Func1, Func2, Func3 data with a Gaussian function as a function of V_{GS} .

$$\mathrm{Func1}_{(V_{\mathrm{GS}})} = \sum_{i=1}^{n} \mathbf{A1}_i \times e^{-\left(\frac{V_{\mathrm{GS}}-\mathbf{B1}_i}{\mathbf{C1}_i}\right)^2}$$

$$\mathrm{Func2}_{(V_{\mathrm{GS}})} = \sum_{i=1}^{n} \mathbf{A2}_i \times e^{-\left(\frac{V_{\mathrm{GS}}-\mathbf{B2}_i}{\mathbf{C2}_i}\right)^2}$$

$$\mathrm{Func3}_{(V_{\mathrm{GS}})} = \sum_{i=1}^{n} \mathbf{A3}_i \times e^{-\left(\frac{V_{\mathrm{GS}}-\mathbf{B3}_i}{\mathbf{C3}_i}\right)^2}$$

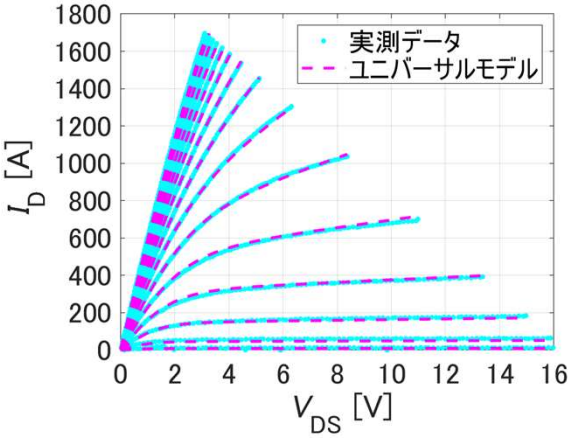
$\mathbf{A1}_i \sim \mathbf{C3}_i$: Constant parameter



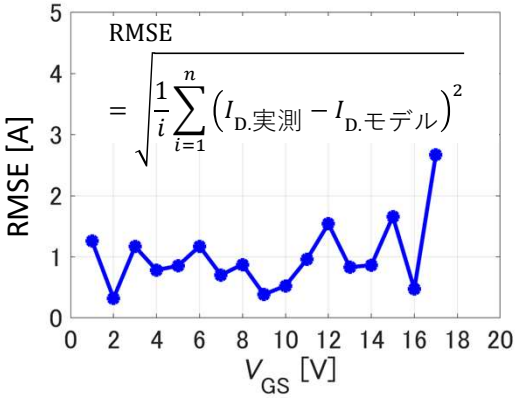
Step.3
Replace Func1 ~ 3 model with basic model formula.

＊*Power semiconductor model is completed*

$$I_{\mathrm{D}(V_{\mathrm{DS}},V_{\mathrm{GS}})} = f_{\left(\mathrm{Func1}_{(V_{\mathrm{GS}})},\mathrm{Fun}\ \ _{(V_{\mathrm{GS}})},\mathrm{Fun}\ \ _{(V_{\mathrm{GS}})},V_{\mathrm{DS}}\right)}$$



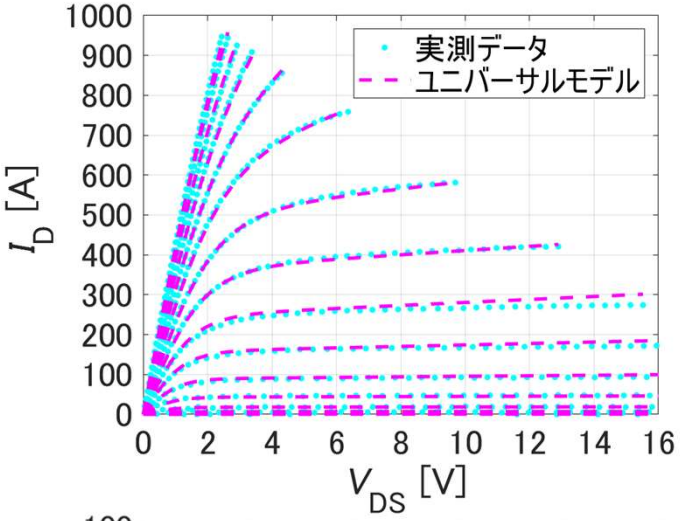
Compare the measured data with the model



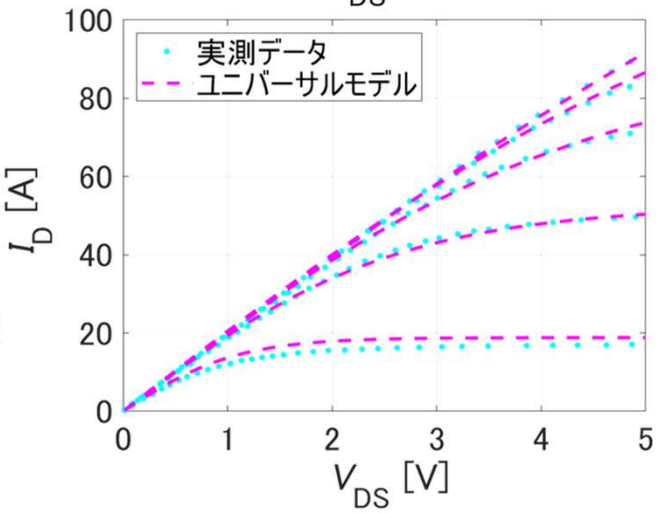
Mean square error between measured data and model

Target : 1.2kV-Full SiC module

Verify other power semiconductor devices.



3.3kV full SiC module



650V GaN-HEMT