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Modeling of Dynamic Input Capacitance in Trench-Gate SiC MOSFETs via Voltage-Dependent Gate Oxide Capacitance Partitioning

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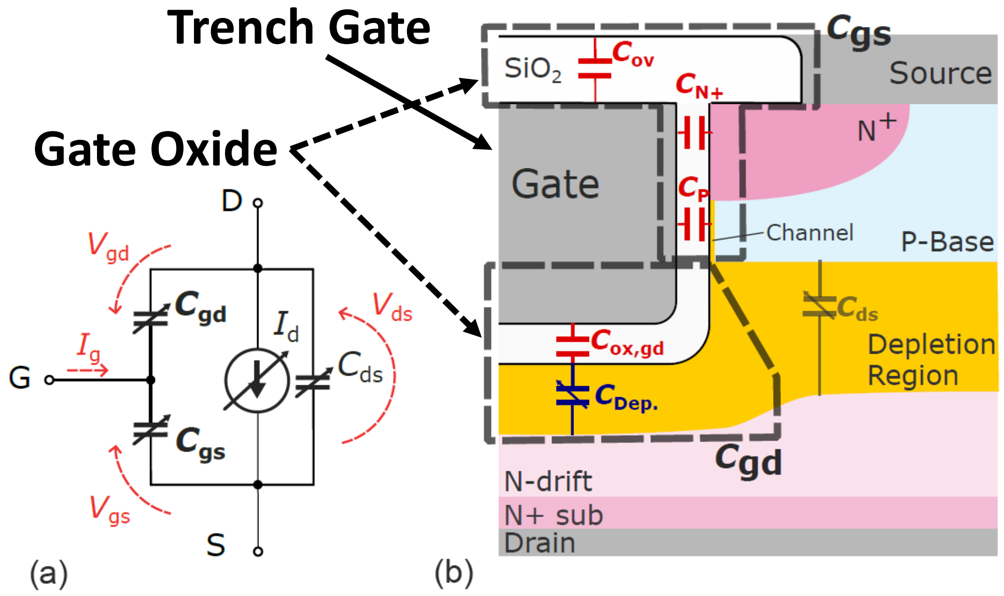
Background and approach

Problem:

- Conventional models do not accurately capture the complex gate charge mechanism of trench SiC MOSFETs.

Proposed Solution:

- TCAD analysis reveals transient charge boundary behavior.
- New model captures dynamic capacitance partitioning and voltage dependence.



Trench MOSFET cross-section

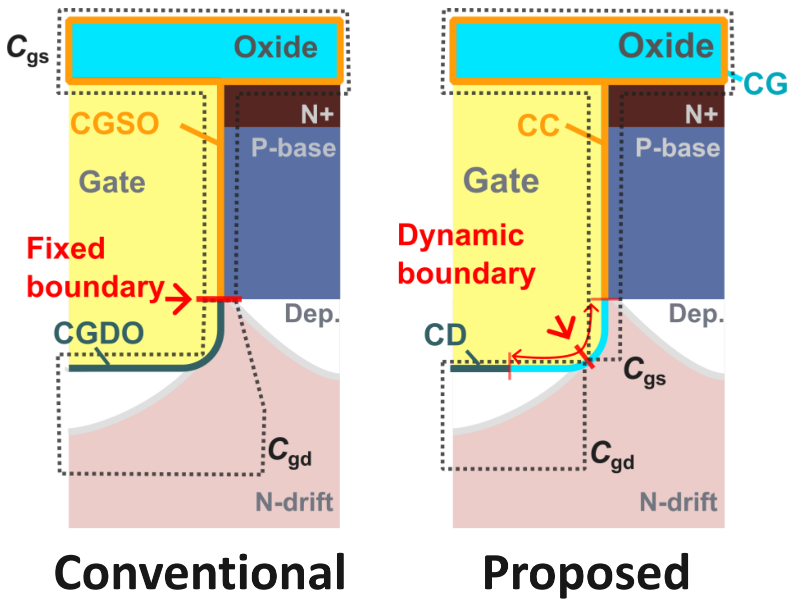


Illustration of the gate partitioning in SPICE models

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Proposed Model:

- C_{gs} and C_{gd} **both** dependent on V_{gs} and V_{gd}.

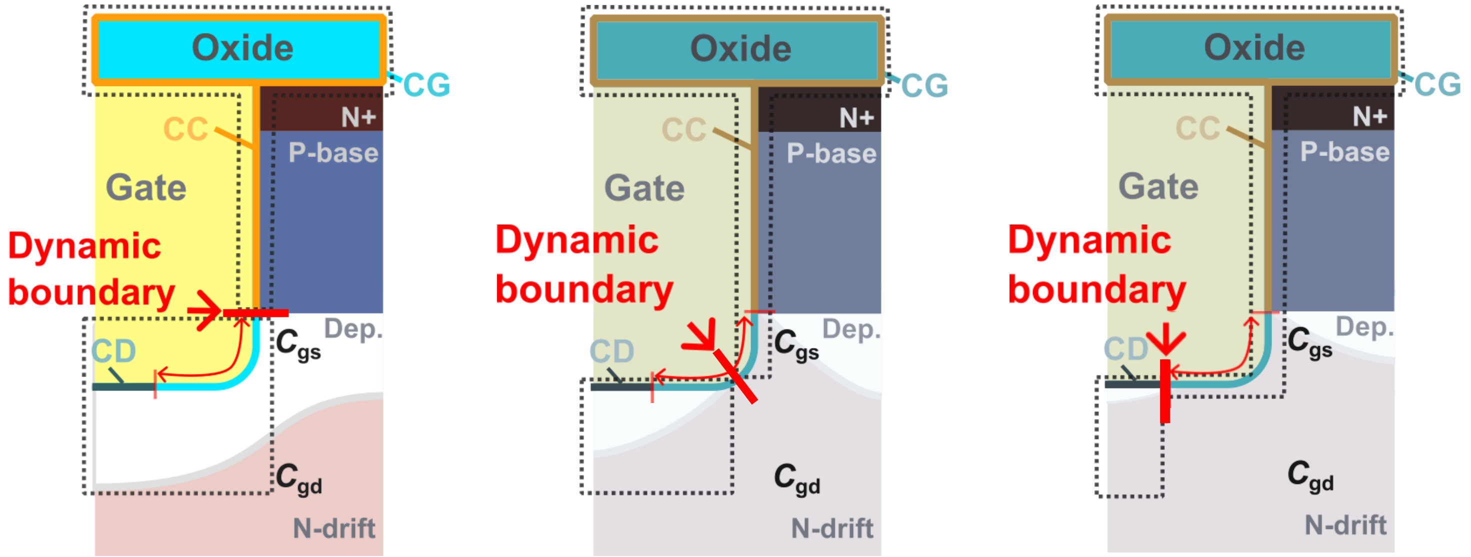
$$C_{gs}(t) = (\mathbf{CG} - \mathbf{CC} - \mathbf{CD}) \frac{|V_{gs}|}{|V_{gs}| + |V_{gd} - \mathbf{VJ}|} + \mathbf{CC}.$$

$$C_{gd}(t) = \mathbf{CG} - C_{gs}(t).$$

Bold: model parameters

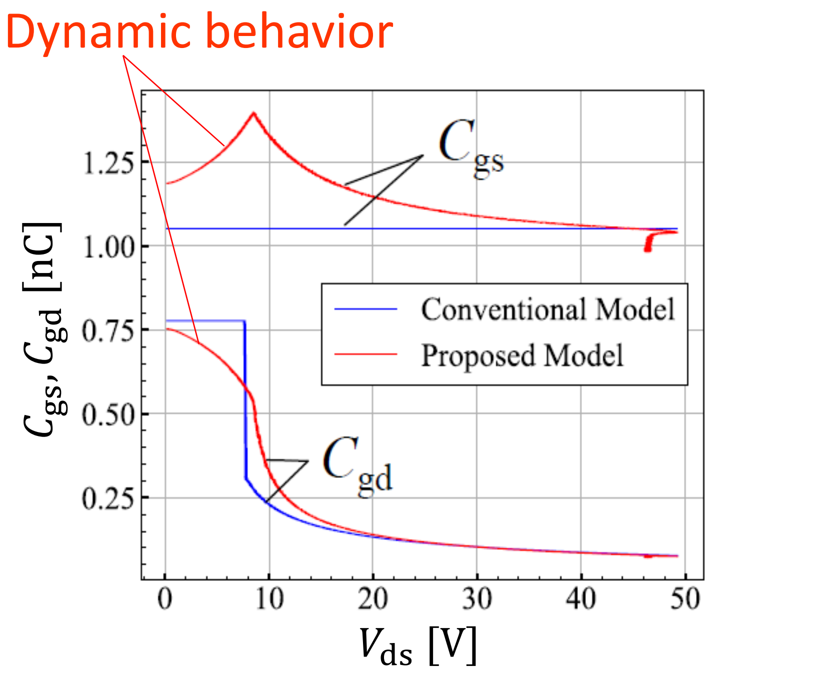
Result

- Validated on a commercial SiC UMOSFET.
- Improved accuracy (RMSE) is achieved.



OFF   Transient (init.)   Transient (mid.)

Illustration of **Proposed model** behavior during the switching transient



Modeled C_{gs} and C_{gd} as a function of V_{ds}