- Original Article
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Machine learning approach for sorting SiC MOSFET devices for paralleling

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- Zhibin Zhao[2]

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Abstract

This paper presents the development of a machine learning model for sorting SiC MOSFET devices for paralleling. A multivariate linear regression model is developed and trained with device parameter data (as input) and current imbalance data (as label). Each of the training devices is successively paralleled with one reference device to generate the current imbalance (label) data. Devices with close values of current imbalance when individually paralleled with the reference device are expected to have relatively balanced current sharing when paralleled among themselves. This model is trained with 40 devices and tested with 20 devices. The model shows accuracies of 87.93% and 97.48% in predicting transient and steady state current imbalances, respectively. These accuracy values are obtained by comparing the model's prediction for the 20 testing devices with the actual current imbalance values when these devices are paralleled with a reference device. Based on current imbalance predictions made by these models, the devices are grouped into classes for paralleling applications. The selection of devices for paralleling based on predictions from these models result in a satisfactorily balanced current distribution. The model's performance at higher temperatures is also satisfactory.

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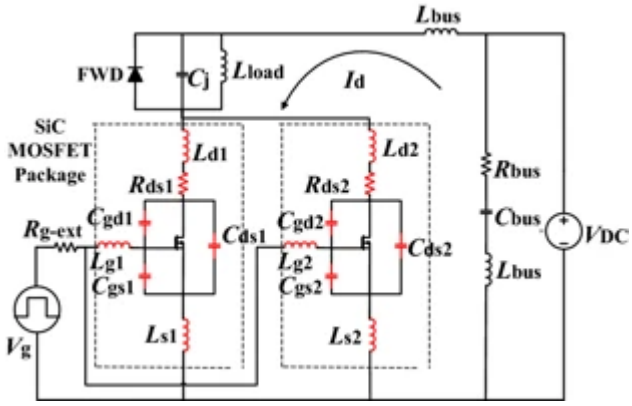
Fig. 1



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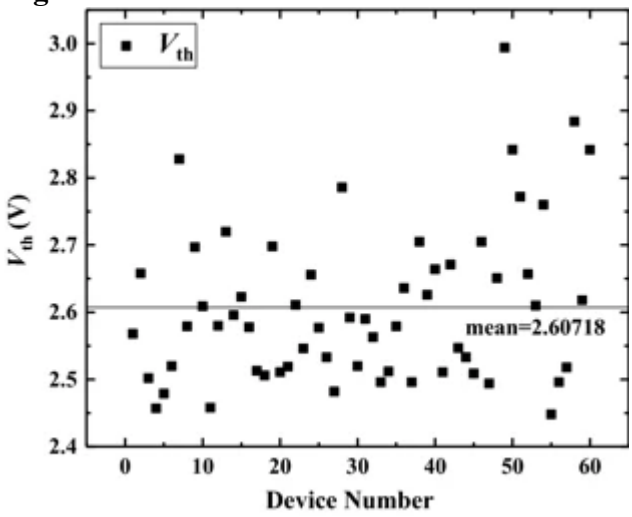

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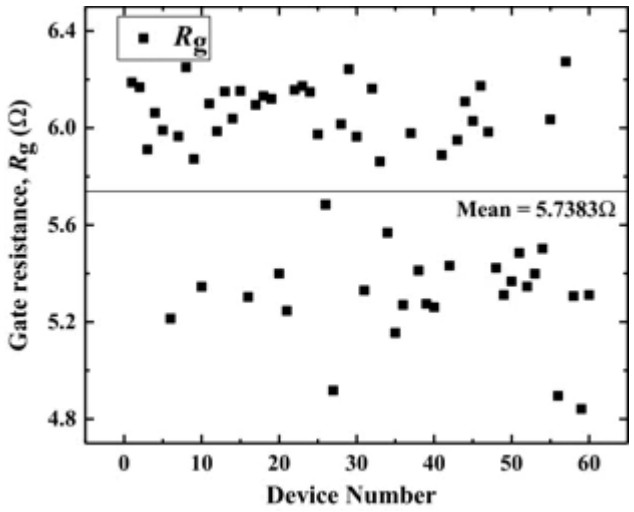

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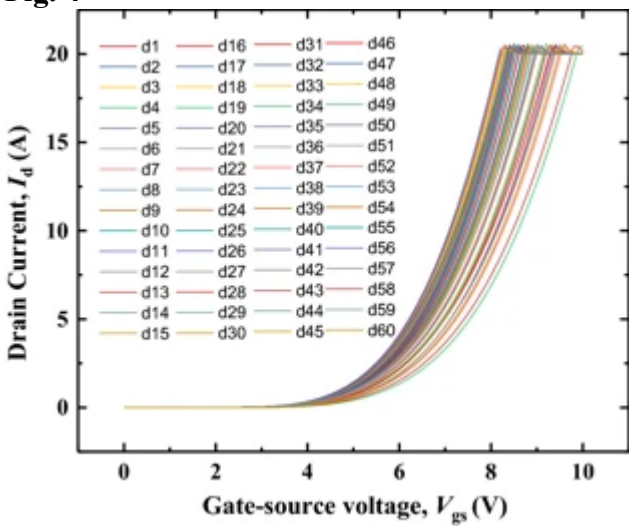

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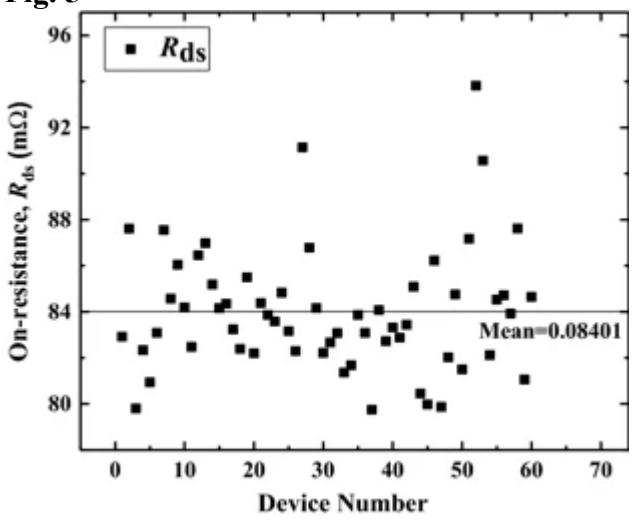

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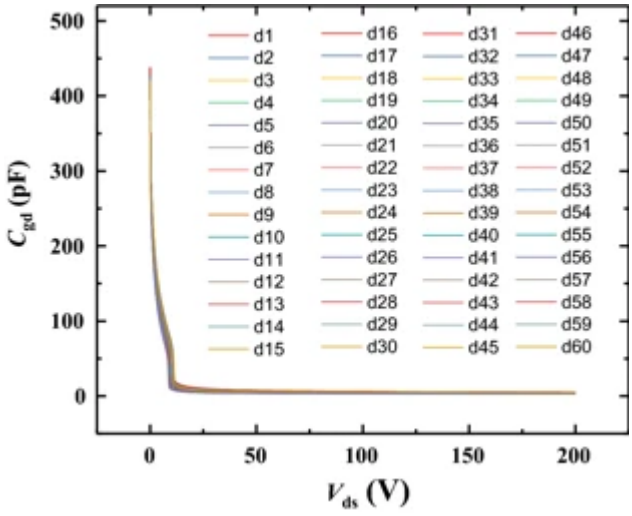

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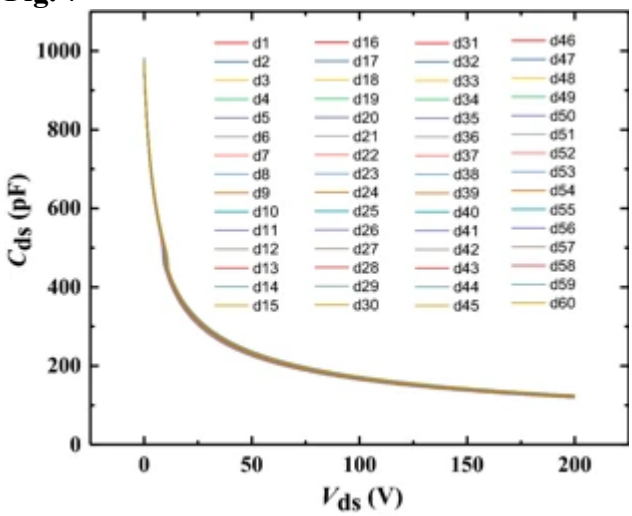

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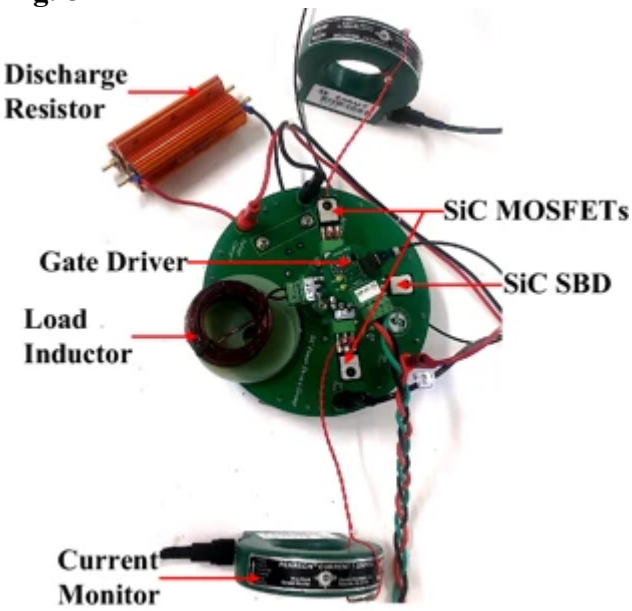


Fig. 9

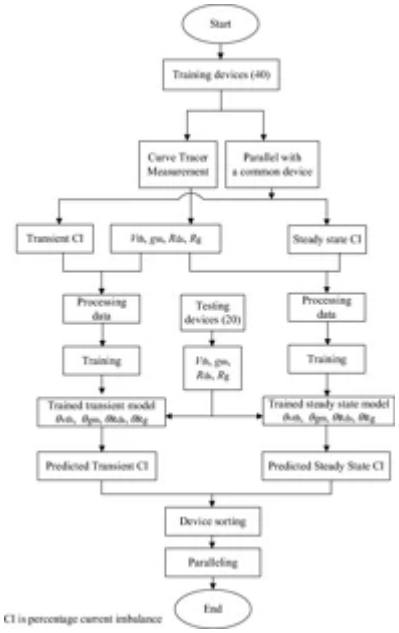

Start
Training devices (40)
Curve Tracer Measurement
Parallel with a common device
Transient CI
Ith, gm, Rth, Rg
Steady state CI
Processing data
Testing devices (20)
Processing data
Training
Ith, gm, Rth, Rg
Training
Trained transient model
Trained steady state model
Predicted Transient CI
Predicted Steady State CI
Device sorting
Paralleling
End
CI is percentage current imbalance

Fig. 10

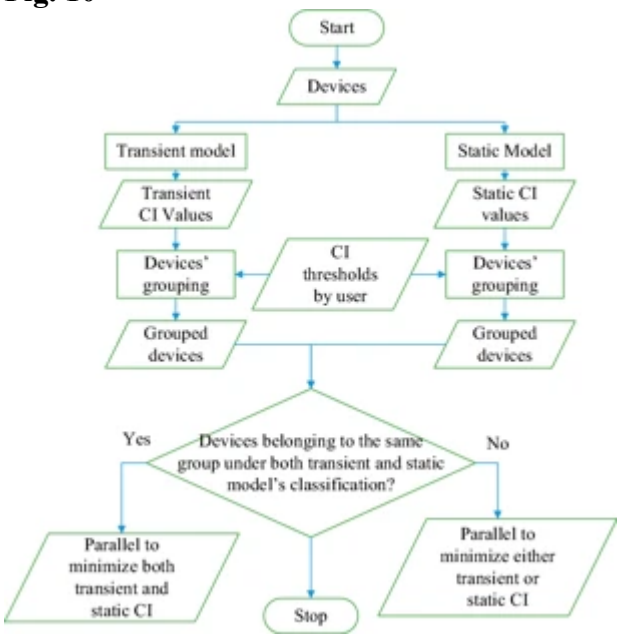

Start
Devices
Transient model
Static Model
Transient CI Values
Static CI values
Devices' grouping
CI thresholds by user
Devices' grouping
Grouped devices
Grouped devices
Yes
Devices belonging to the same group under both transient and static model's classification?
No
Parallel to minimize both transient and static CI
Stop
Parallel to minimize either transient or static CI

Fig. 11

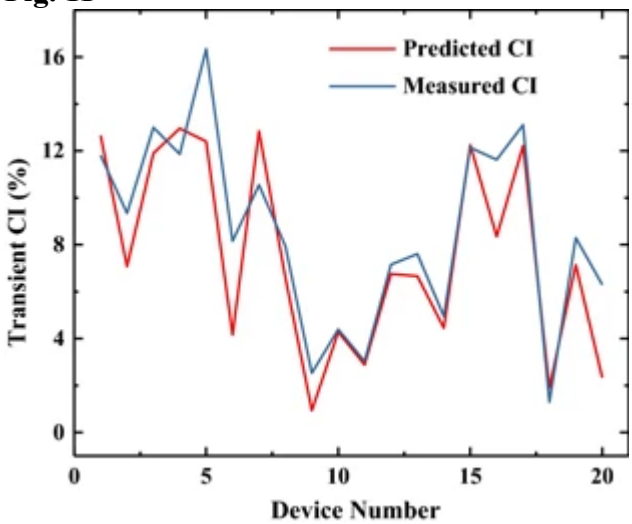

Predicted CI
Measured CI
Transient CI (%)
Device Number
0
4
8
12
16
0
5
10
15
20

Fig. 12

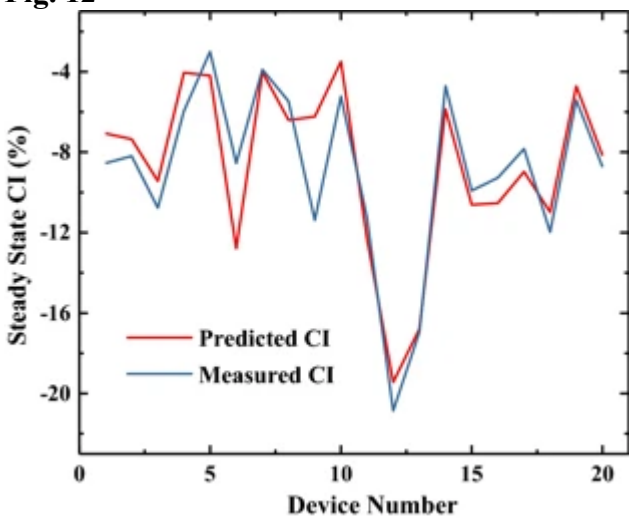


Fig. 13

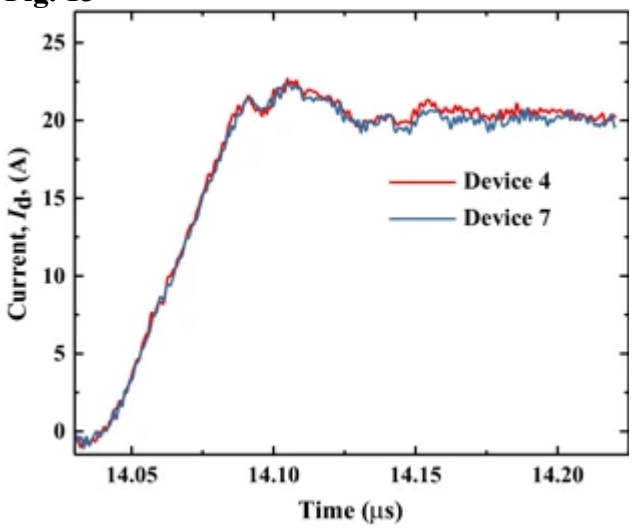


Fig. 14

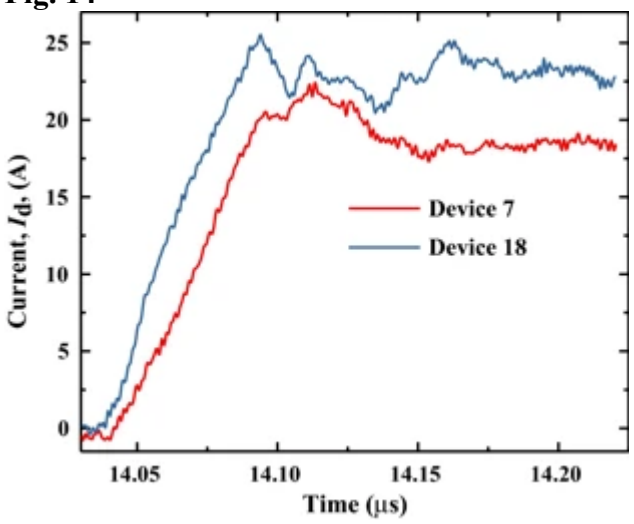


Fig. 15

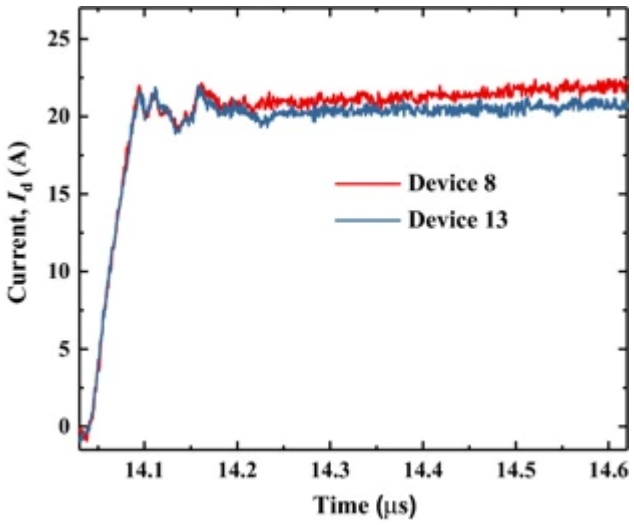


Fig. 16

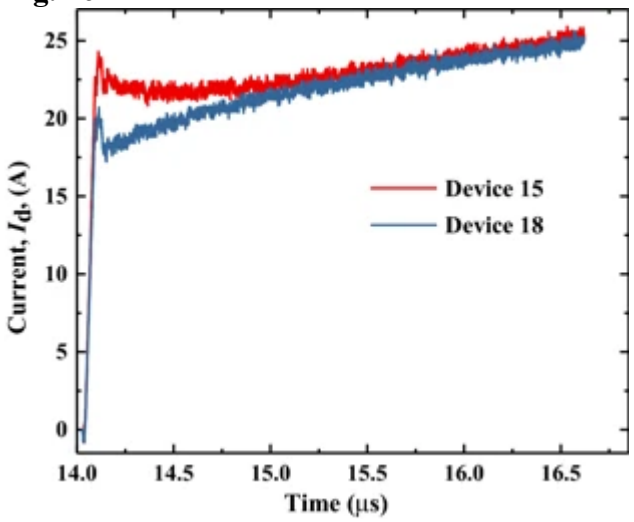


Fig. 17

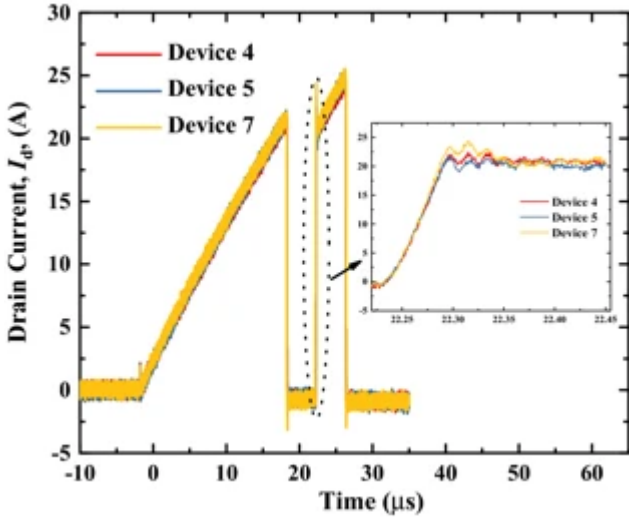


Fig. 18

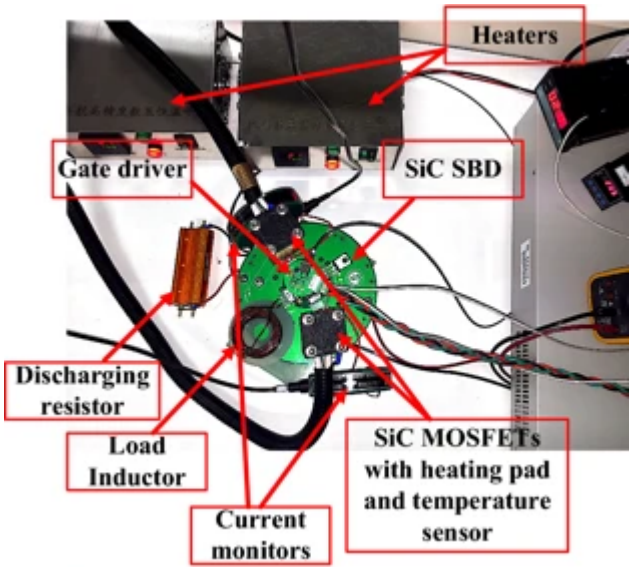
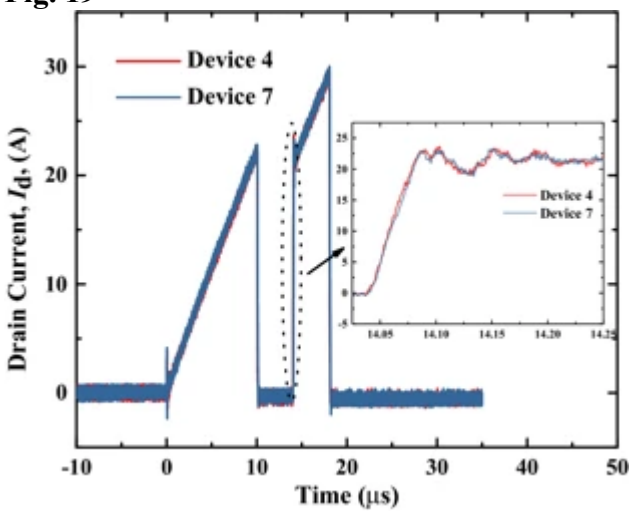


Fig. 19



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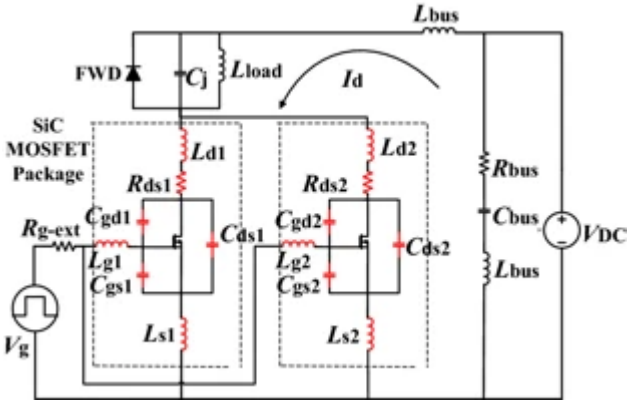
Keywords

- SiC MOSFET
- Current imbalance
- Sorting
- Paralleling
- Machine learning
- Multivariate linear regression

- **Fig. 1**



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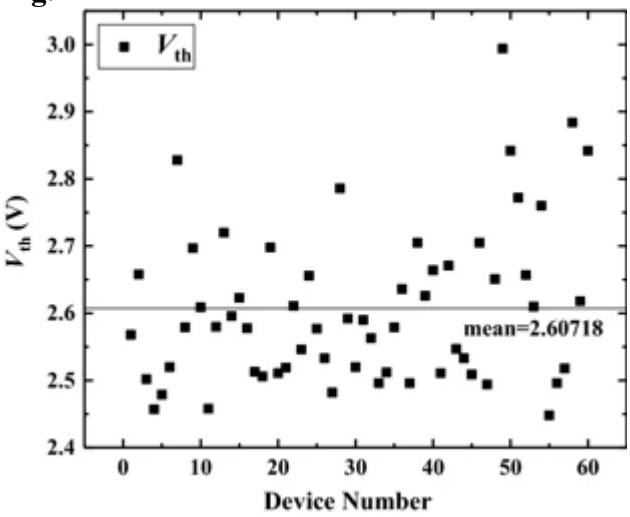

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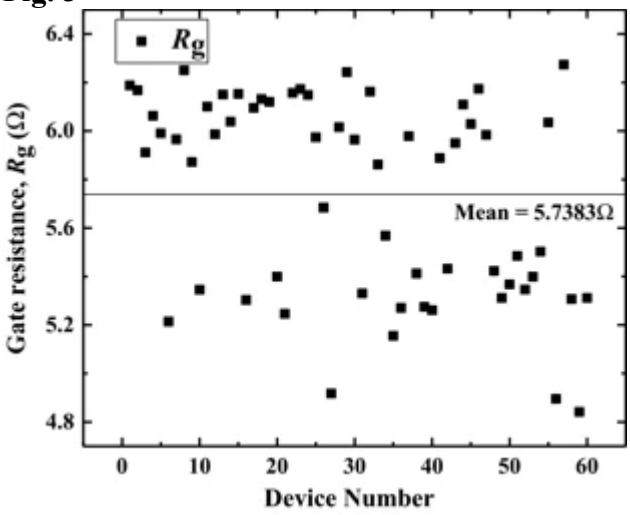

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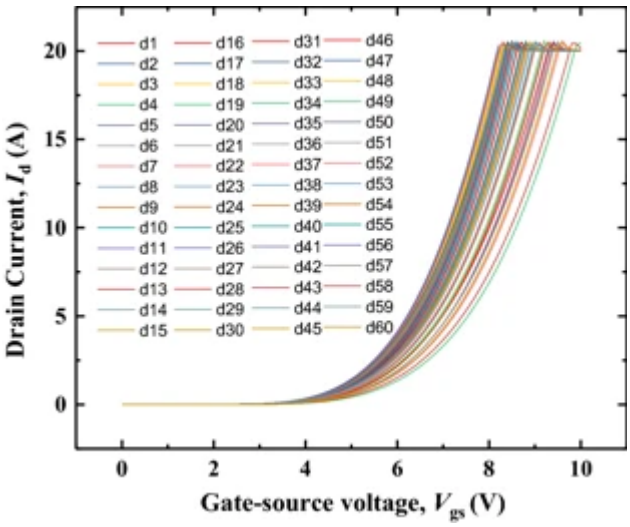

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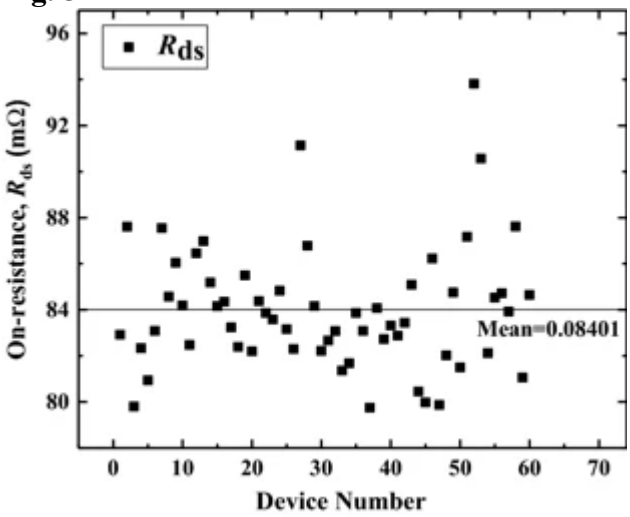

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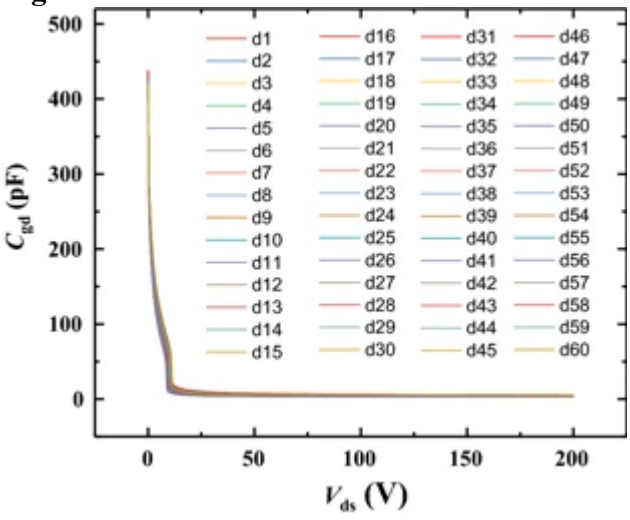

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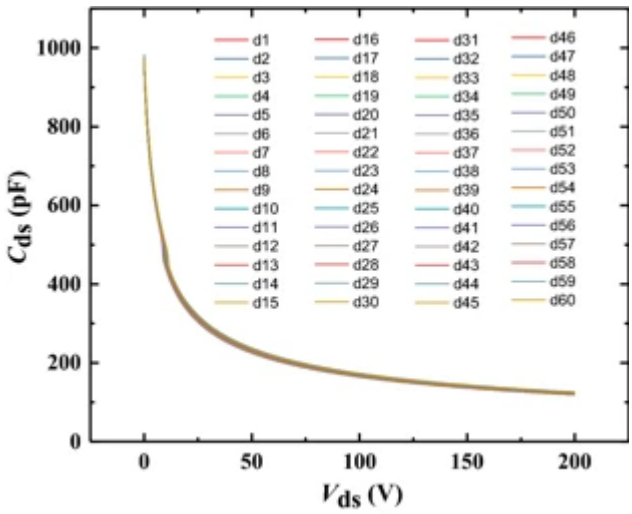
1000
800
600
400
200
0
C_{ds} (pF)
0
50
100
150
200
V_{ds} (V)
d1 d2 d3 d4 d5 d6 d7 d8 d9 d10 d11 d12 d13 d14 d15
d16 d17 d18 d19 d20 d21 d22 d23 d24 d25 d26 d27 d28 d29 d30
d31 d32 d33 d34 d35 d36 d37 d38 d39 d40 d41 d42 d43 d44 d45
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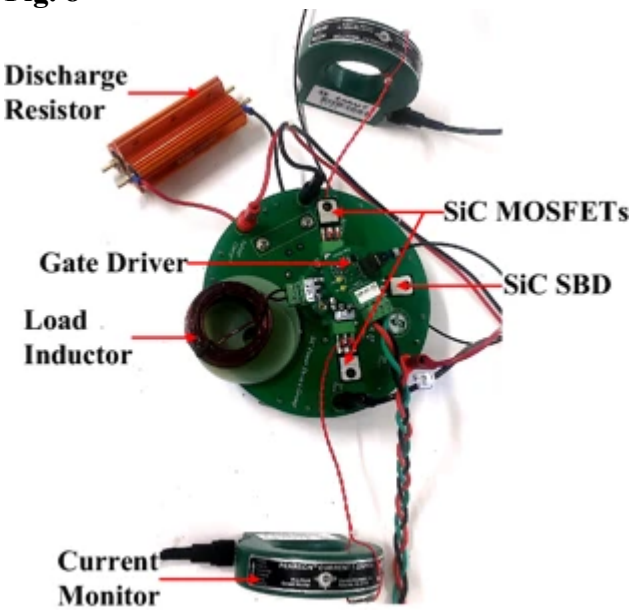
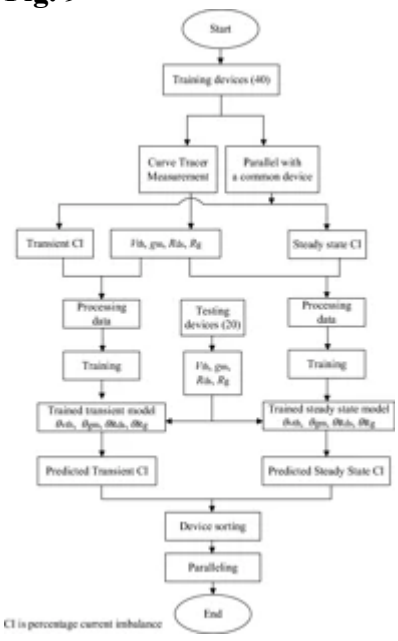
- **Fig. 8**


Discharge Resistor
SiC MOSFETs
Gate Driver
SiC SBD
Load Inductor
Current Monitor

- **Fig. 9**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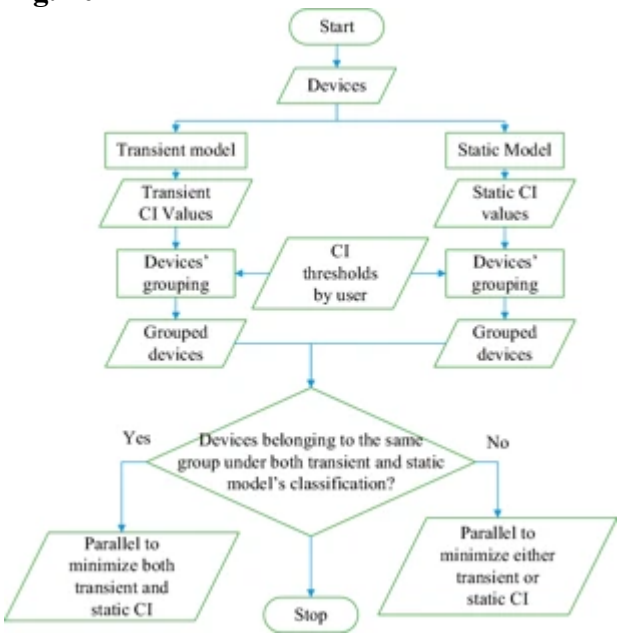

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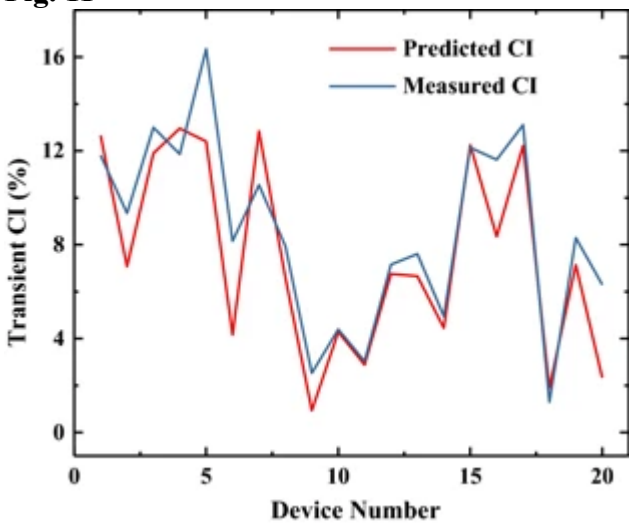
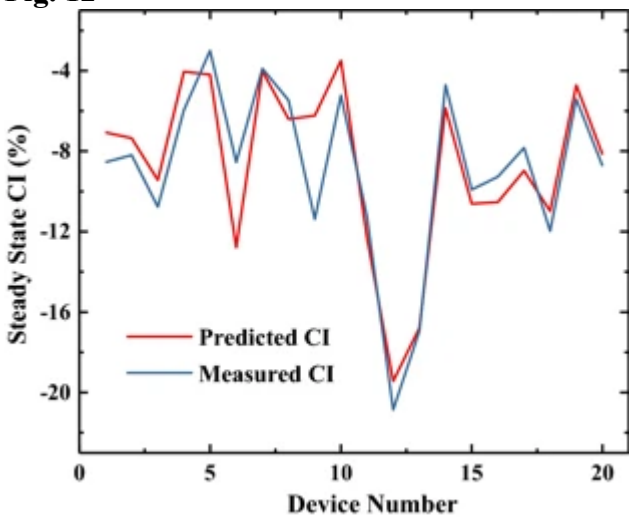
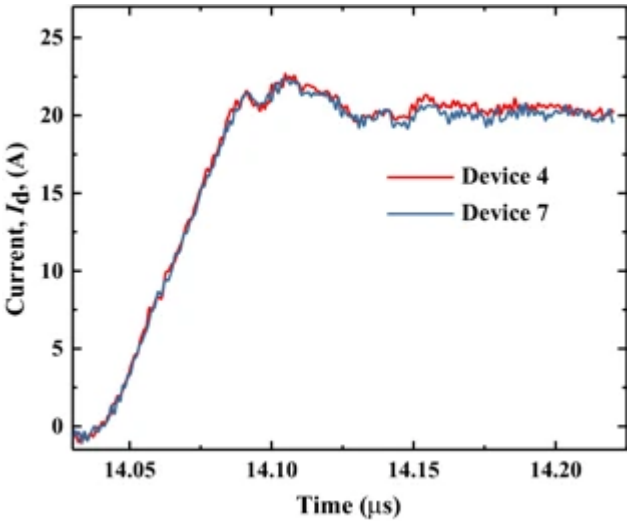


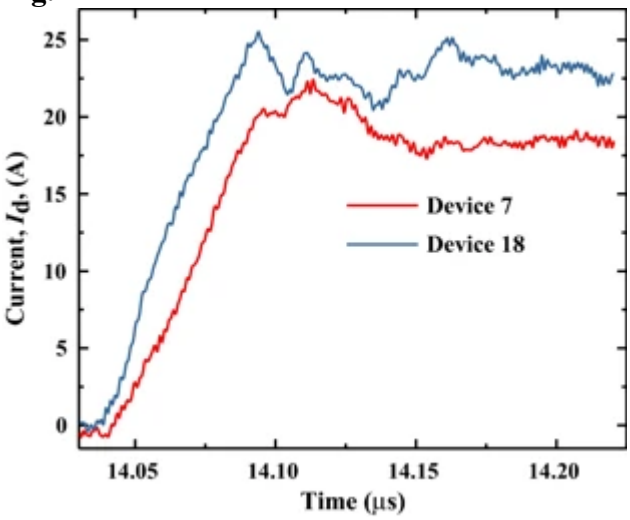
- **Fig. 12**



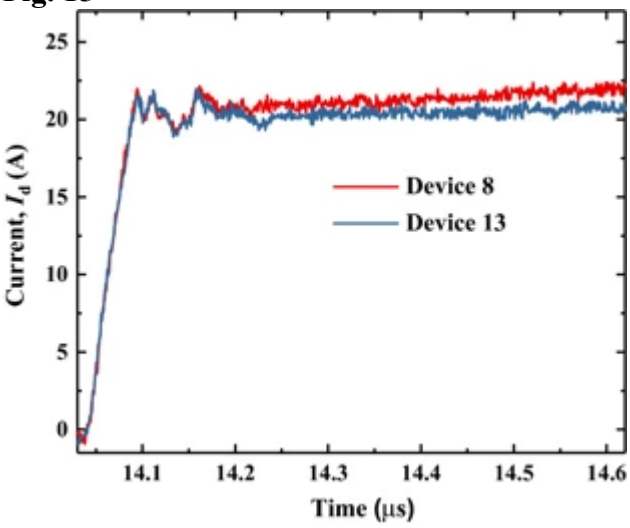
- **Fig. 13**



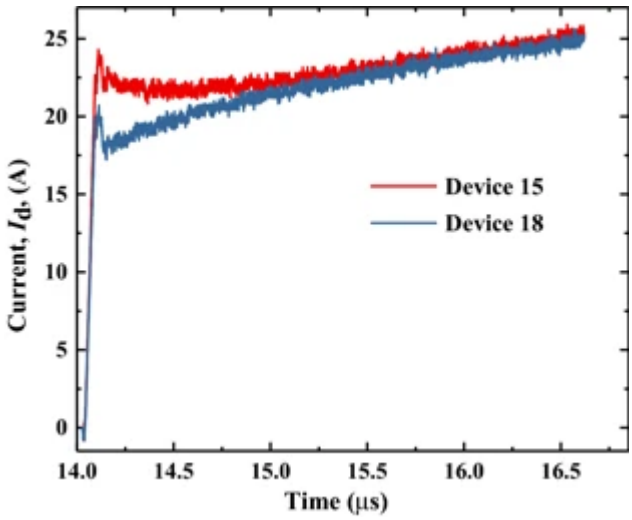
- **Fig. 14**



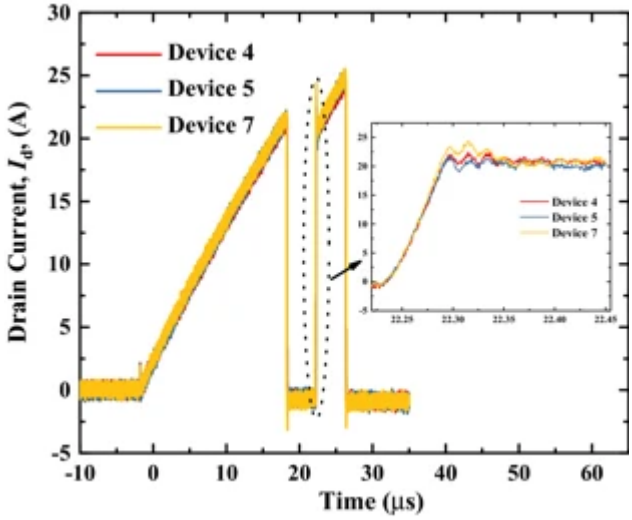
- **Fig. 15**



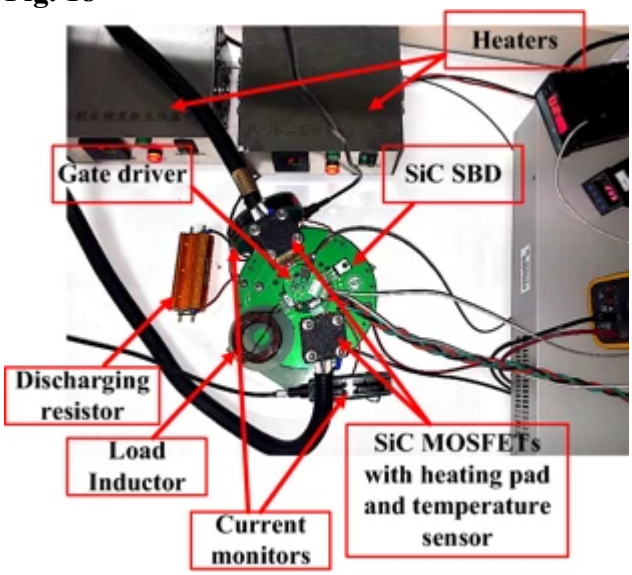
- **Fig. 16**



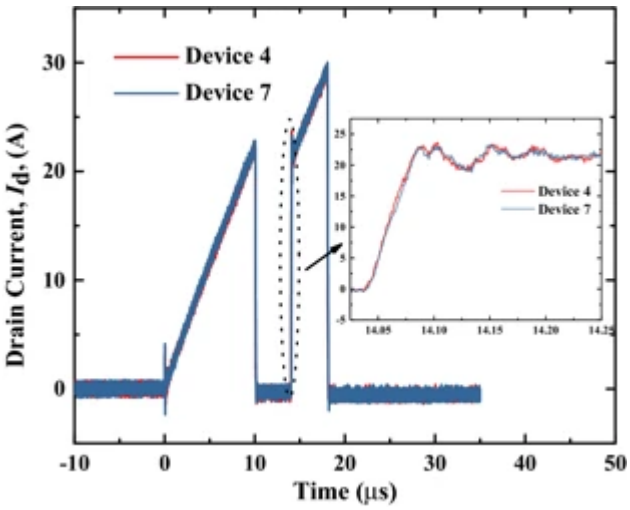
- **Fig. 17**



- **Fig. 18**



- **Fig. 19**



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