Application of High-Thermoelectric-Power Materials to Self-Cooling Device

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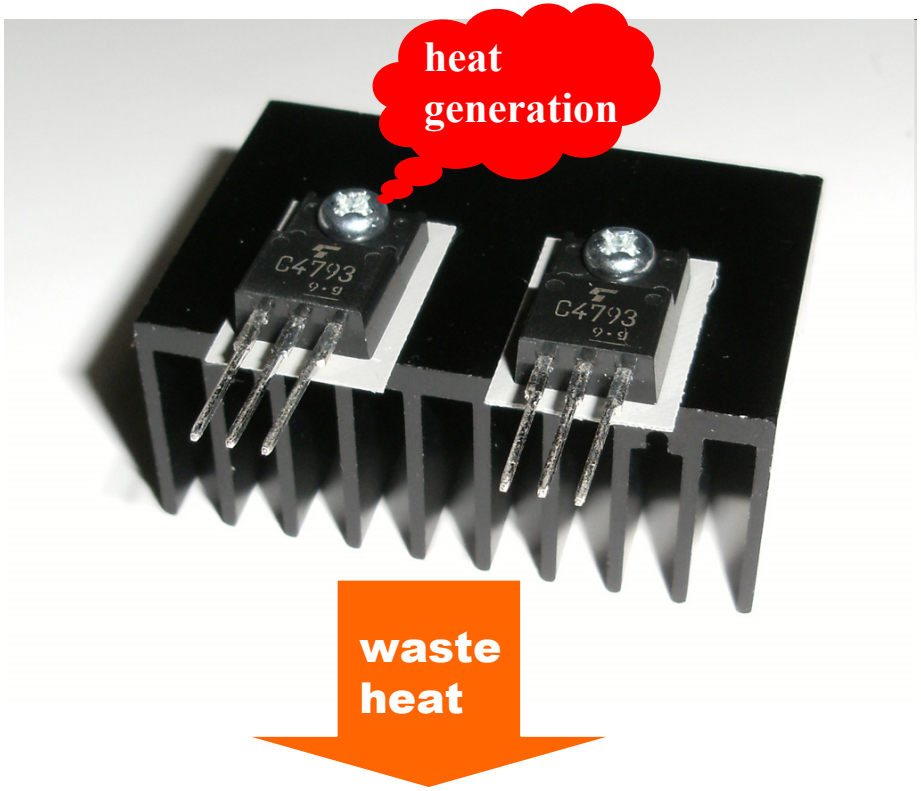
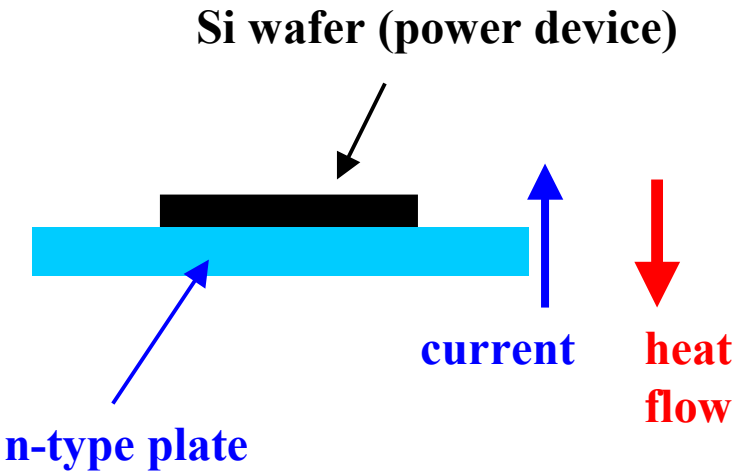
Introduction



heat spread by heatsink

heat release to air by fin or fan



Uses heat flow by both thermal conduction and by Peltier heat for its electric current.

self-cooling device

S.Yamaguchi, ULVAC, 52, 14 (2007)

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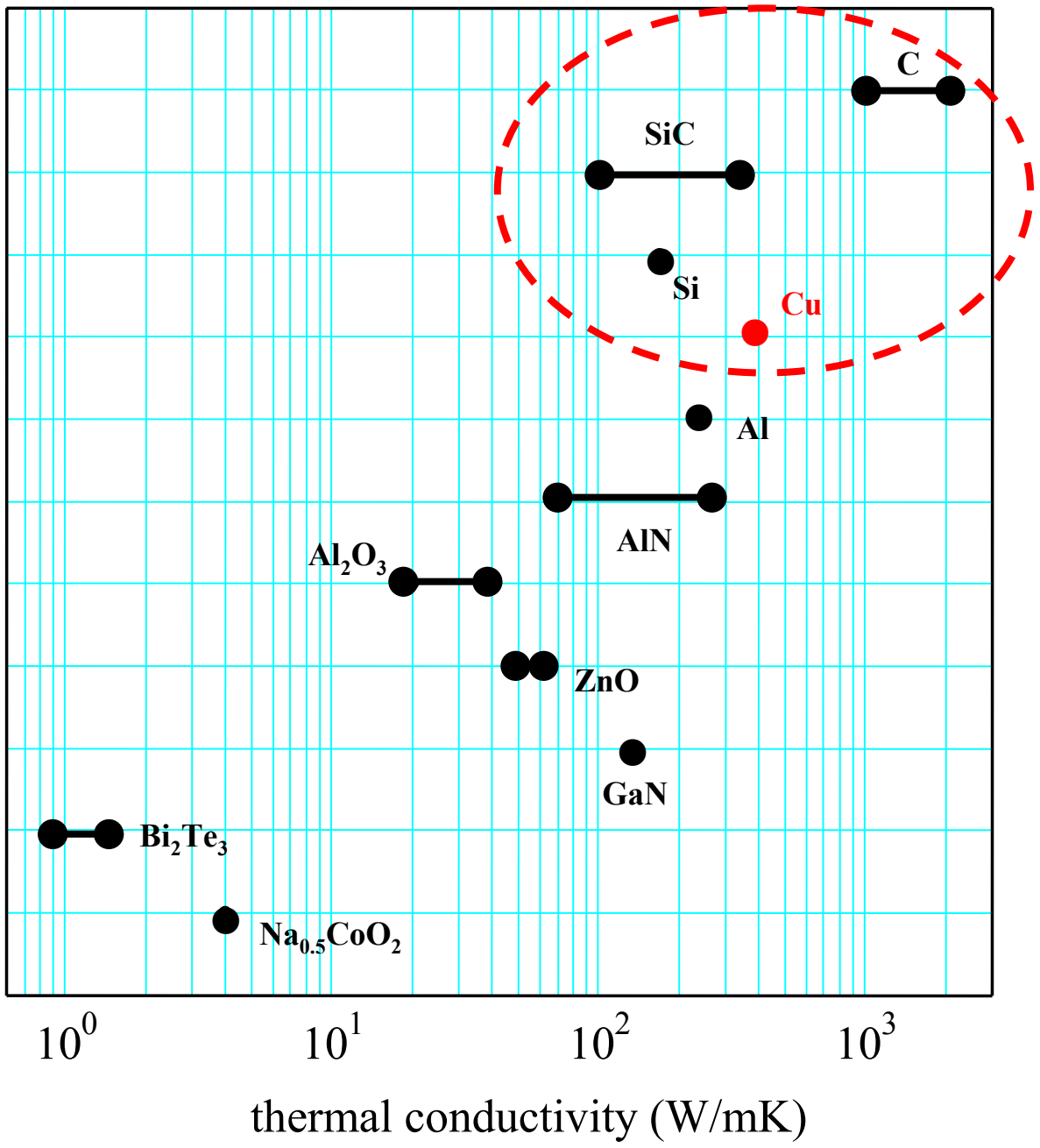

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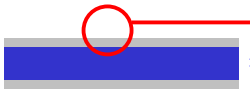
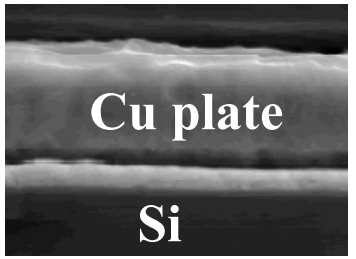
Experimental

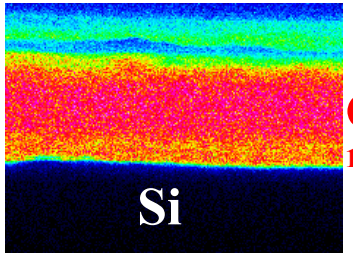
Electron Probe Micro Analyzer (EPMA)



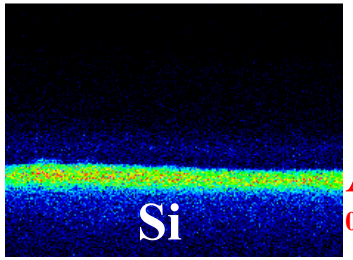
0.5mm

copper plating n-type Si (111) wafer

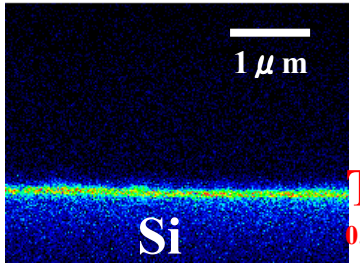




Cu
1-2 μ m

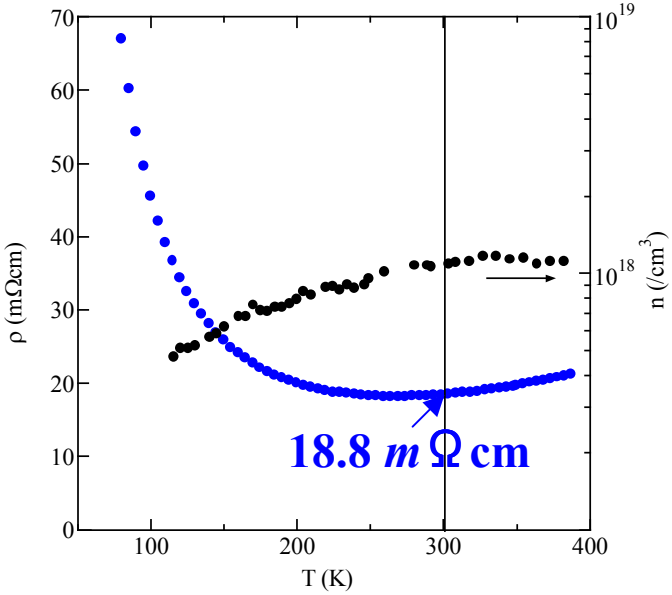


Au
0.4 μ m

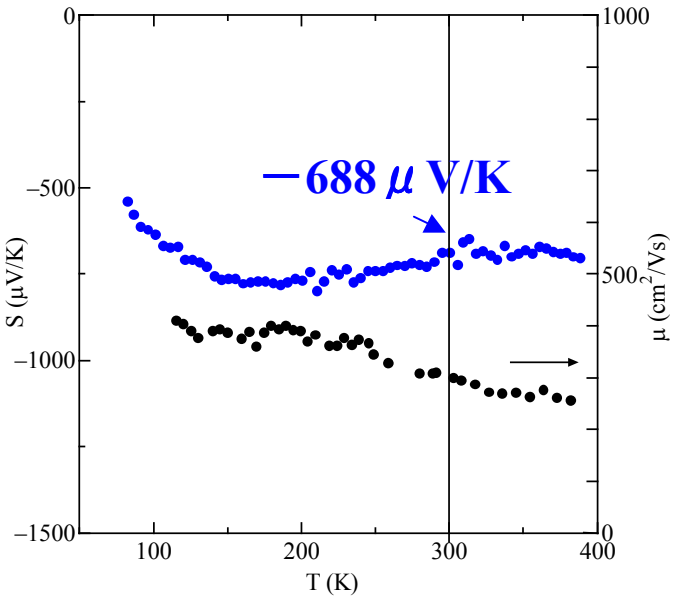


Ti
0.1 μ m

electrical resistivity



Seebeck coefficient



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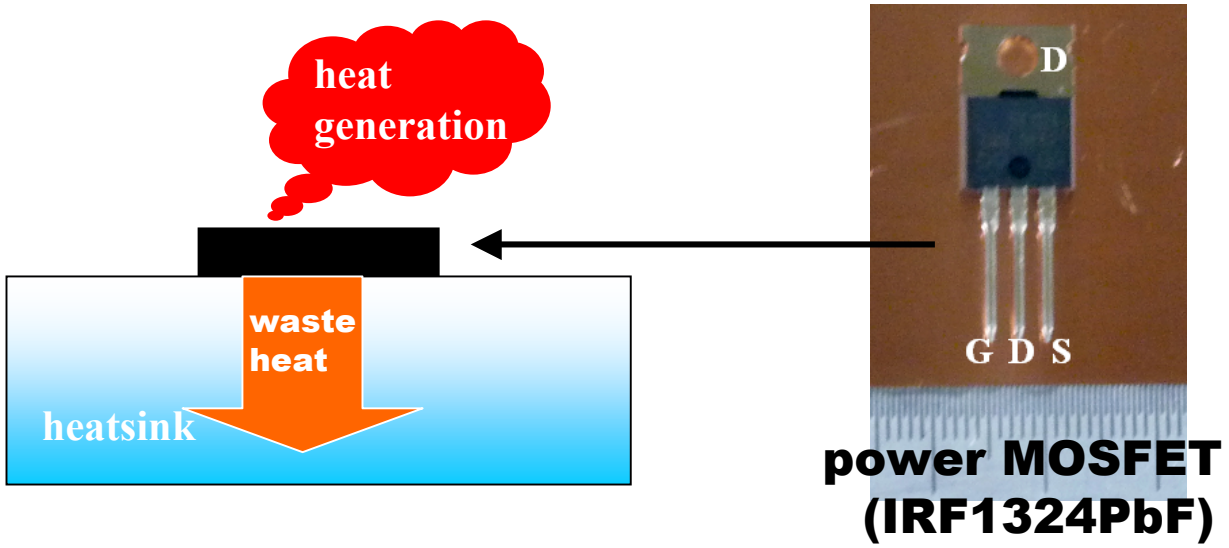

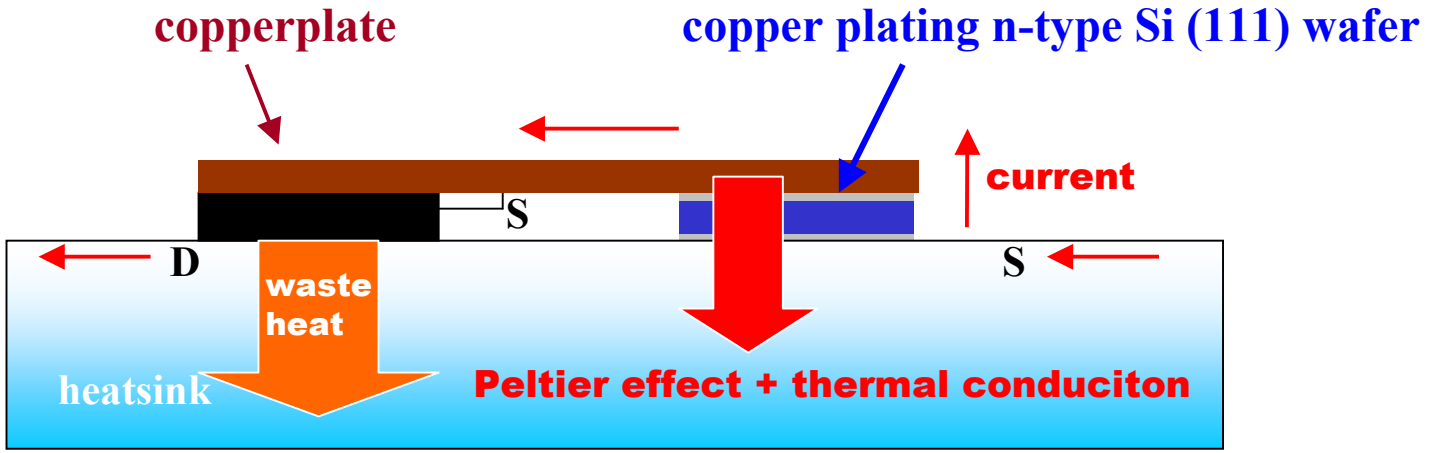

Schematic structure of self-cooling device

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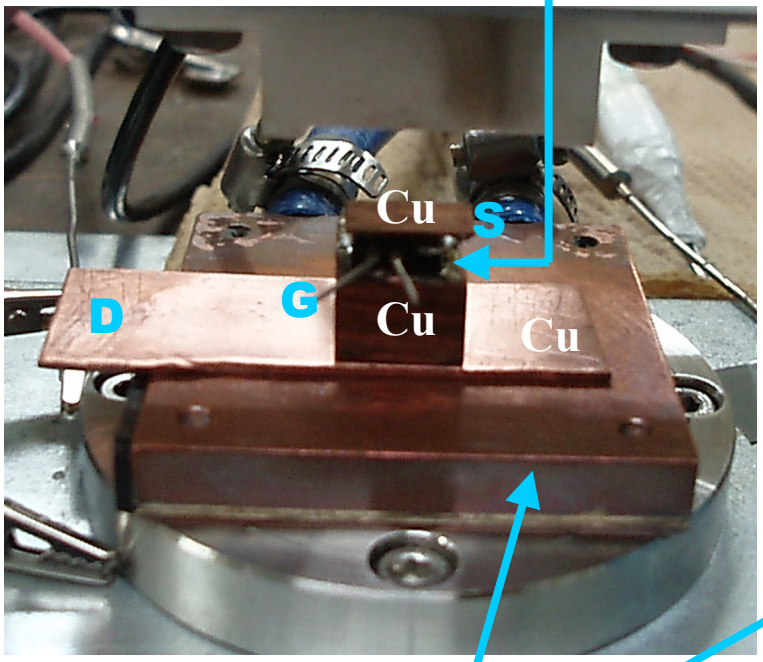
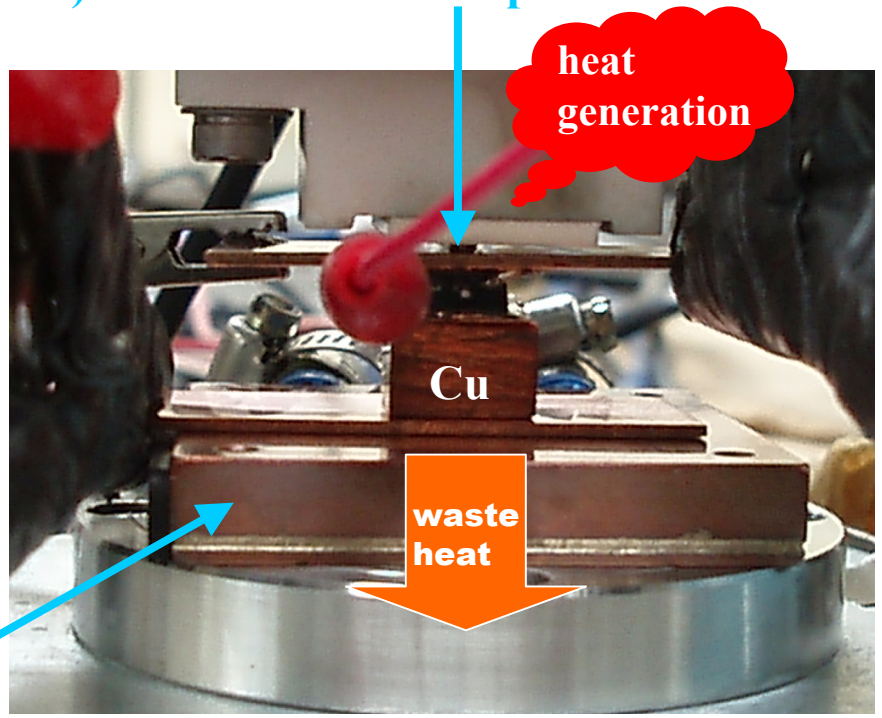
Results & Discussion

power MOSFET (IRF1324PbF)

thermocouple





water cooled heatsink (10±2℃)

V_{GS} = 10V

I_{DS} = 40A, 50A, 60A

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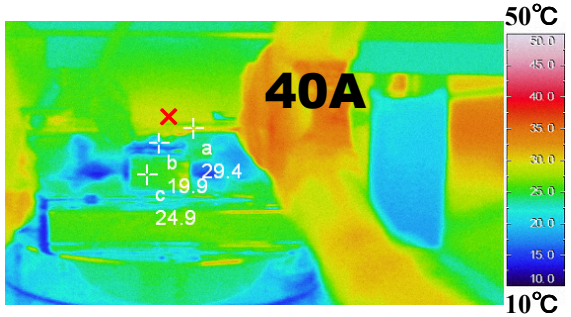
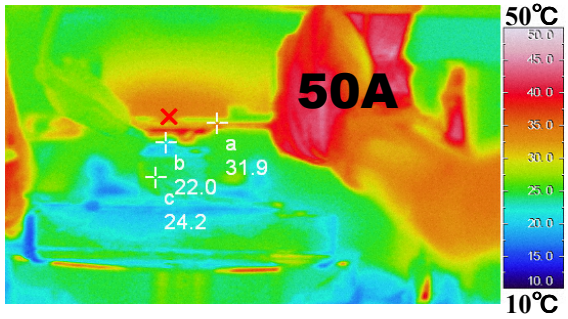
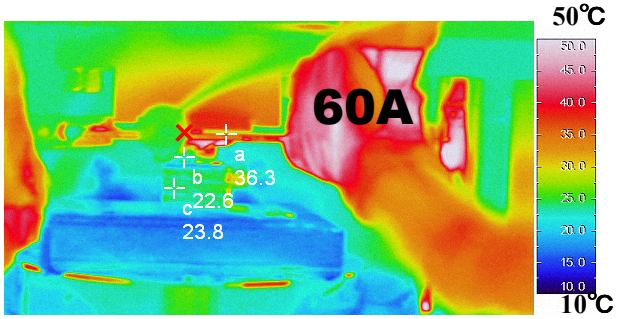
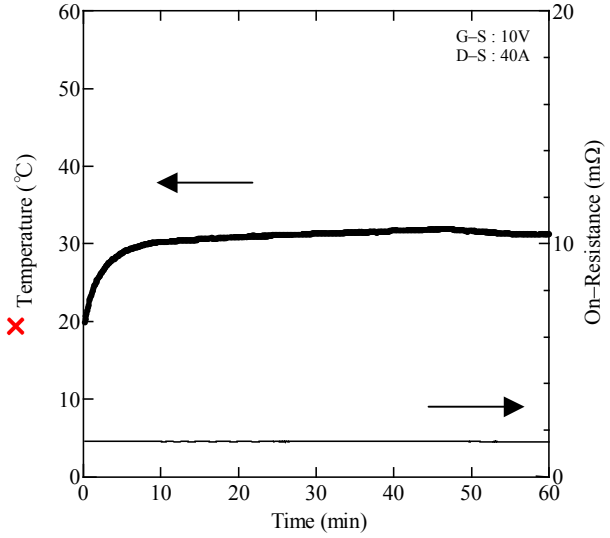
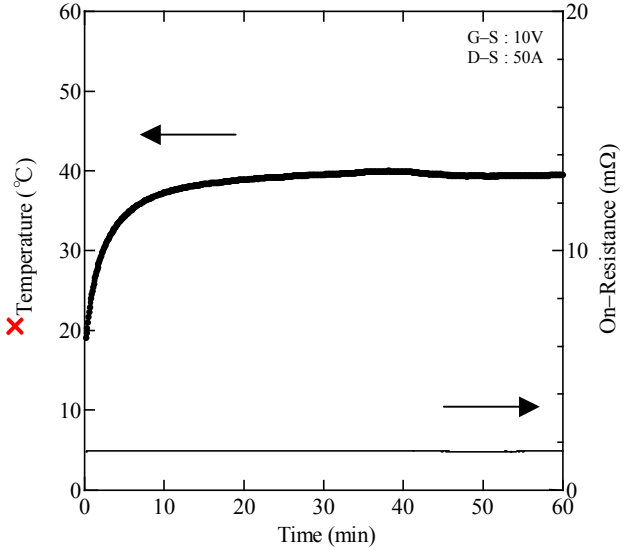
temperature survey 1

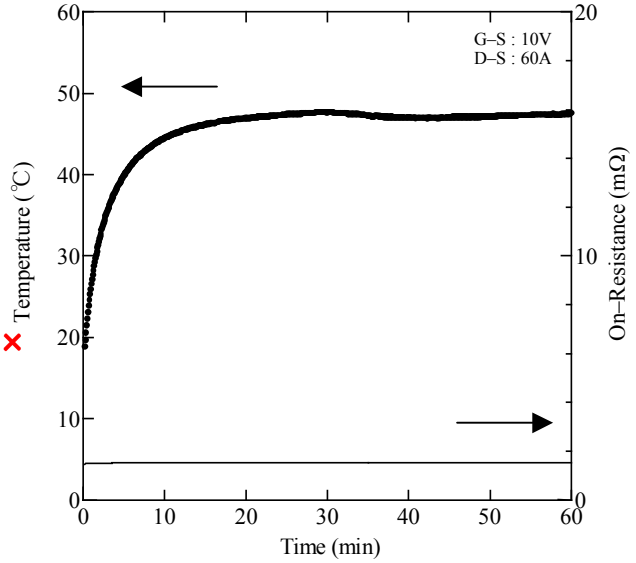












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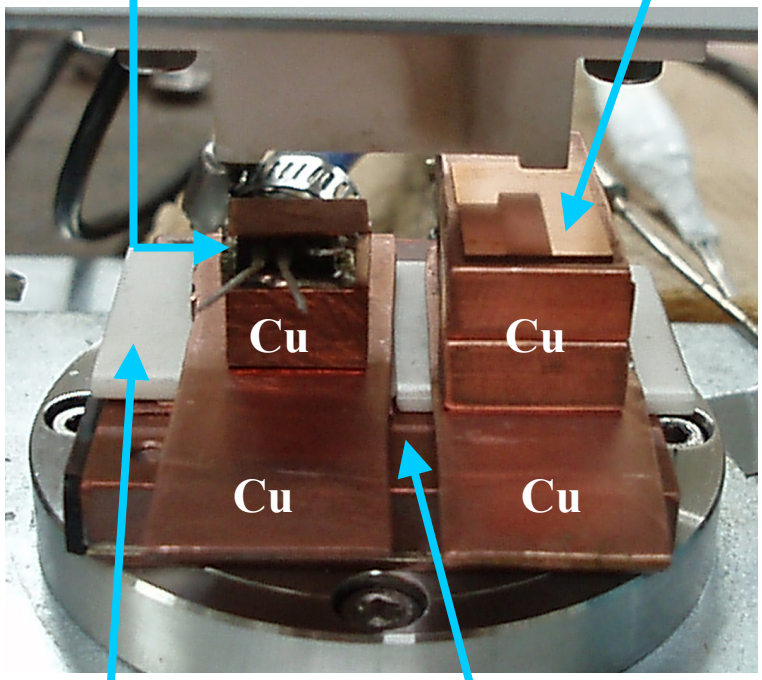
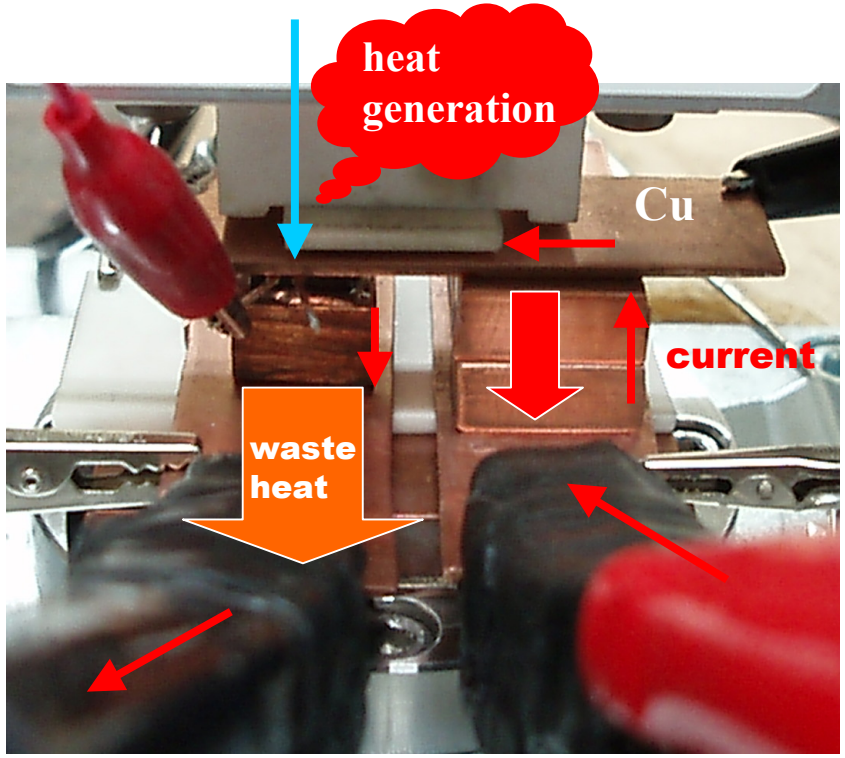
self-cooling device 1





$V_{GS} = 10V$

$I_{DS} = 40A, 50A, 60A$

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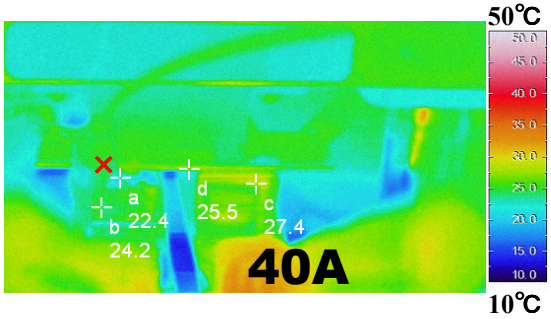
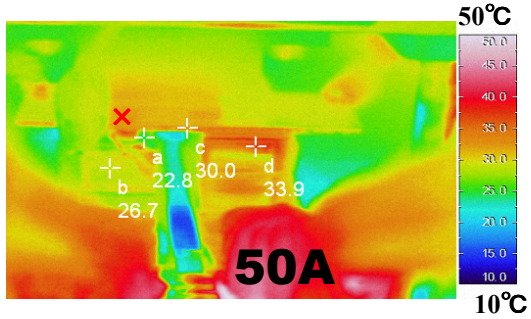
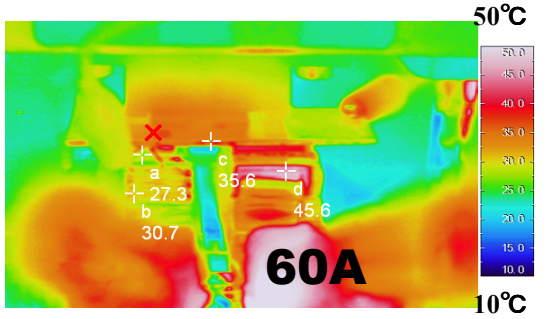
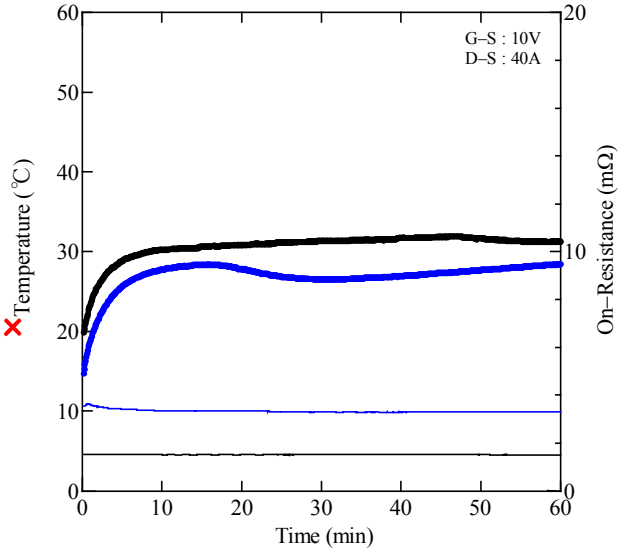
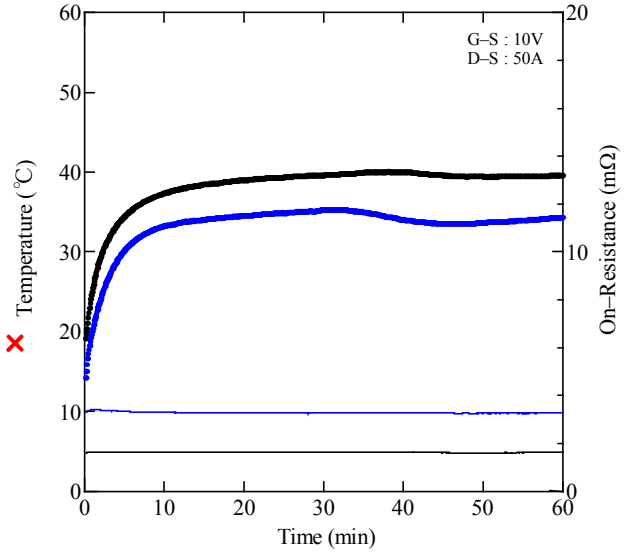
temperature survey 2

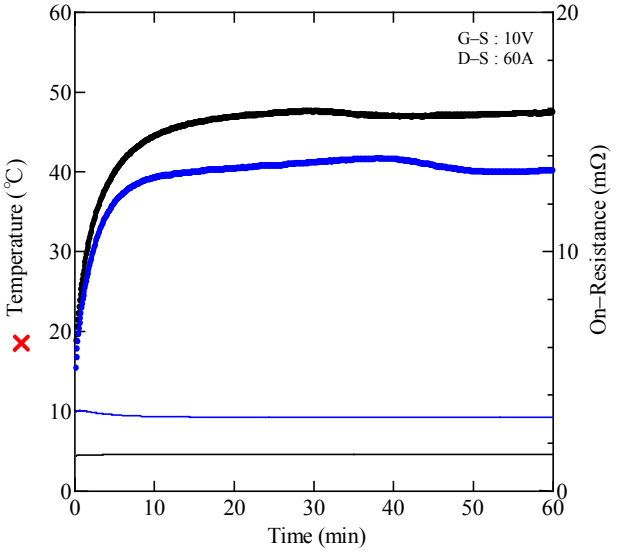












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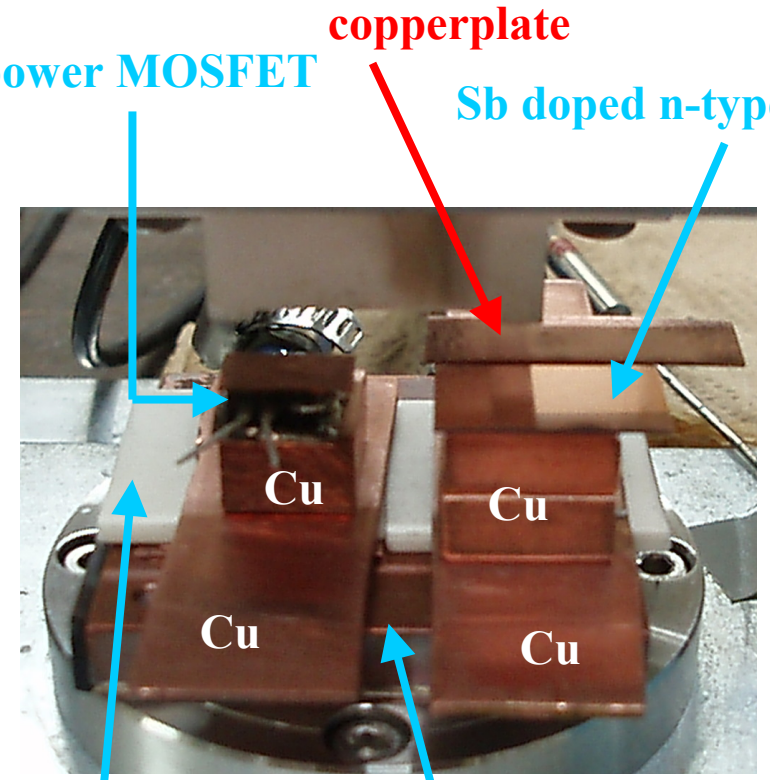
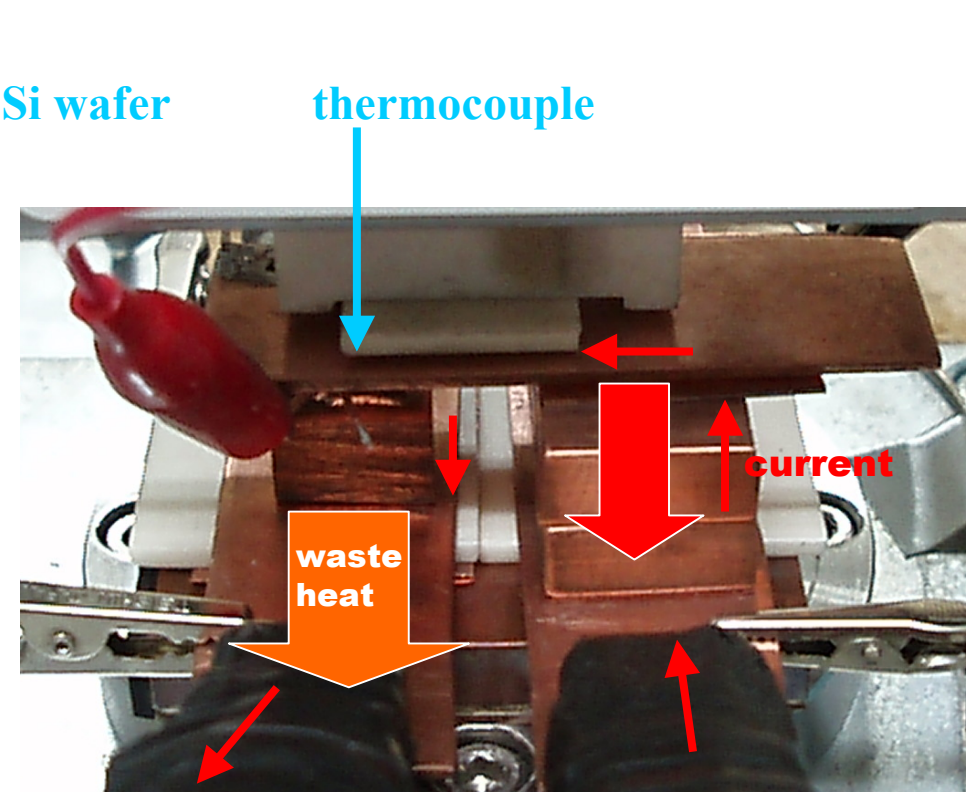
self-cooling device 2





$V_{GS} = 10V$

$I_{DS} = 40A, 50A, 60A$

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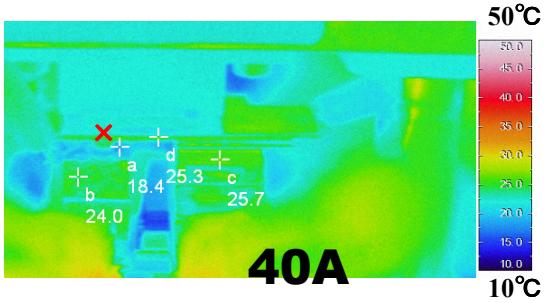
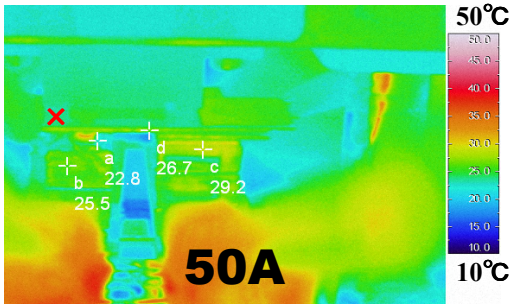
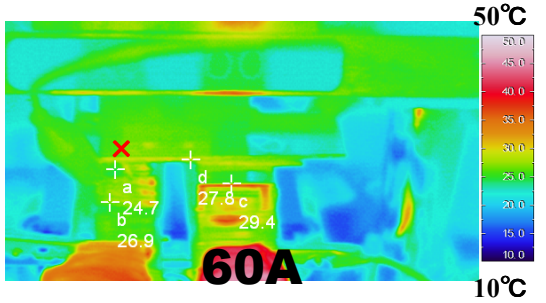
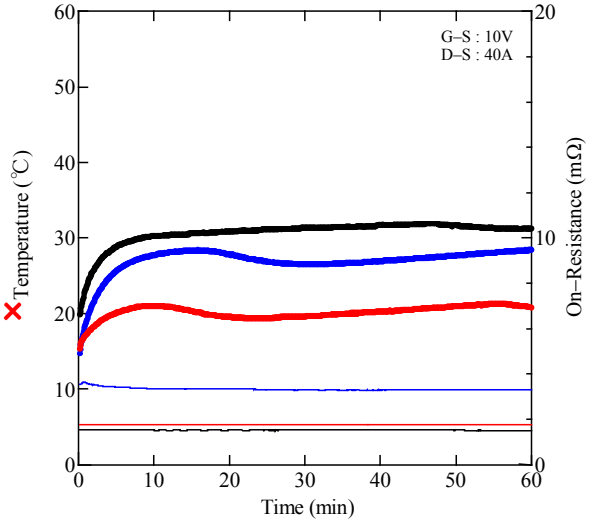
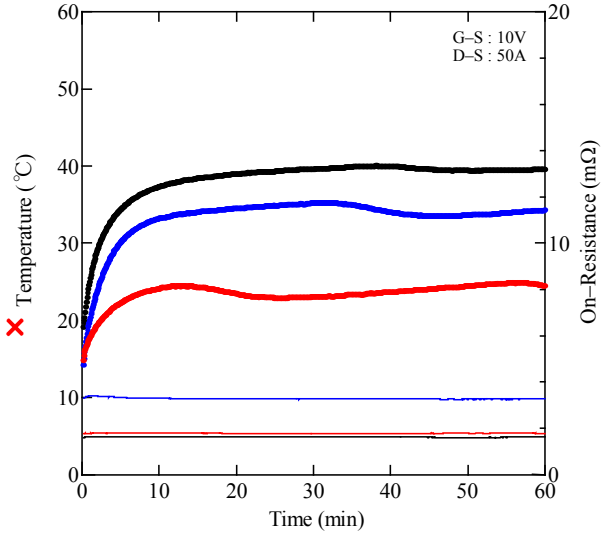
temperature survey 3

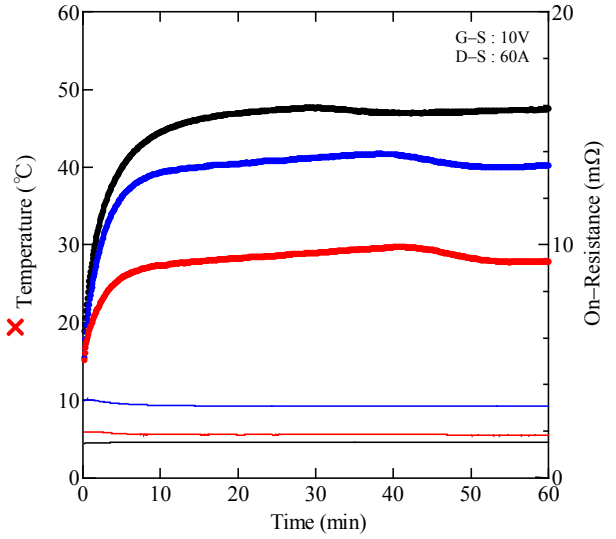












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Summary

- **The Sb doped n-type silicon (111) wafer has been applied to the self-cooling device.**
- **The self-cooling device using the heat flux both by Peltier effect and by thermal conduction has removed the heat generation on the upper side of the power MOSFET.**
- **In particular, the heat removal has been enhanced drastically by the increase of the heat flux.**

Acknowledgement

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Thank you for your attention.