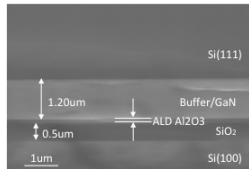


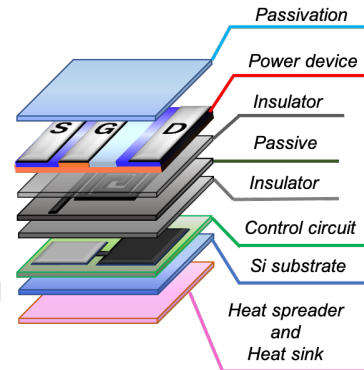
INTRODUCTION

Advantages of 3D Power SoC

- High efficiency at high frequency switching
- High power density (miniaturization)



Direct bonding of GaN - Si(100) [1]



3D power SoC [2]

Challenges

- Heterogenous integration
- Heat removal
- Electromagnetic noise shielding

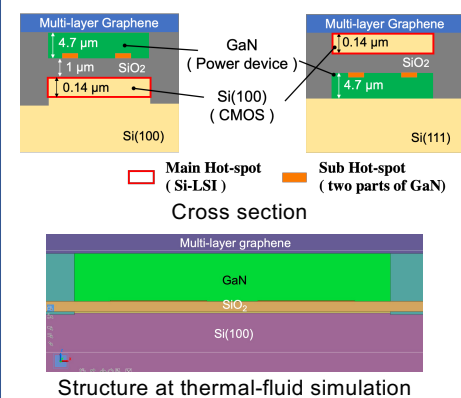
Multi-layer graphene

[1] R. Ishito, K. Ono, and S. Matsumoto, IEEE CPMT Symposium Japan 2019, ECR Session 12, 2019.

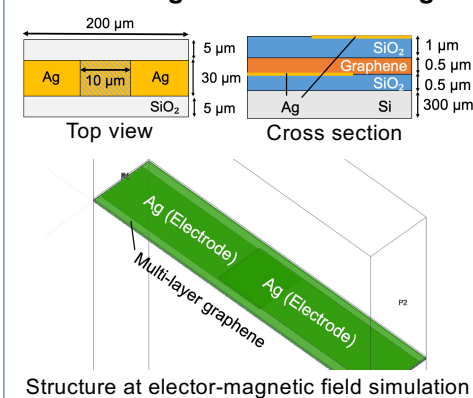
[2] K. Hiura, Y. Ikeda, Y. Hino, and S. Matsumoto, Japanese J Applied Physics, vo.56, 04CR13, 2017.

DESIGN DETAILS

Heat removal

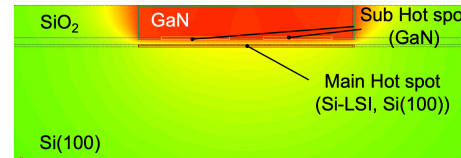


Electromagnetic noise shielding

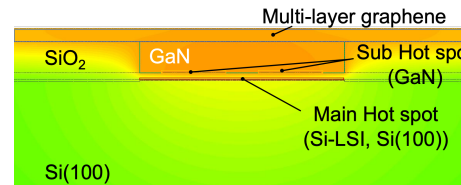


SIMULATION RESULTS

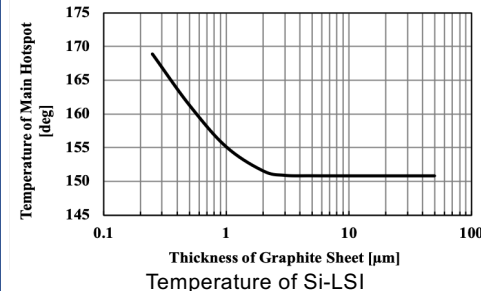
Heat removal



✓ Temperature of GaN is 192 deg without multi-layer graphene.

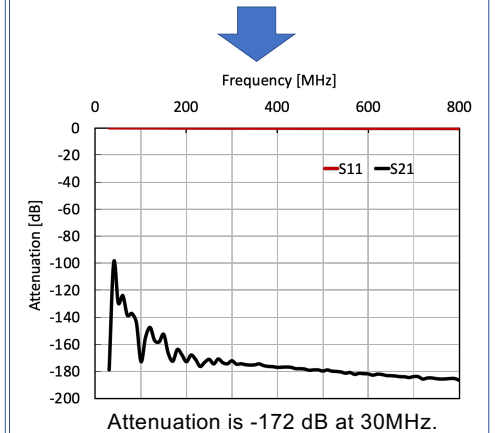
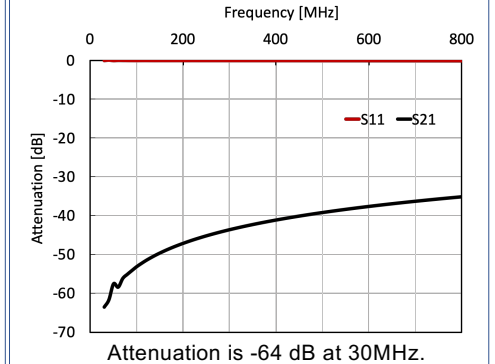


✓ Temperature of GaN is 174 deg with multi-layer graphene.



✓ Thickness of graphene needs more than 2um.

Electromagnetic noise shielding



✓ Noise attenuation with multi-layer graphene is 108 dB higher than without it.

CONCLUSIONS

- ✓ We can remove the heat of hot-spot in GaN power device by putting GaN on Si-LSI and using multi-layer graphene.
- ✓ Multi-layer graphene enables to shield electromagnetic noise.

ACKNOWLEDGEMENTS / CONTACT

The part of this work was supported by JSPS KAKENHI Grant Number 18H01430.

furue.ayano907@mail.kyutech.jp, smatsu@ele.kyutech.ac.jp