

# High Temperature Devices and Fabrication

Sara Stone  
11/29/2021

How and why Silicon Carbide devices are taking over in high temperature applications.

# What is Silicon Carbide?

- Discovered 1891
- Better than Si alone because of covalent bonds between the carbon and silicon atoms
- Great thermal stability and conductivity
- Fast electron saturation drift velocity

# Today's presentation agenda

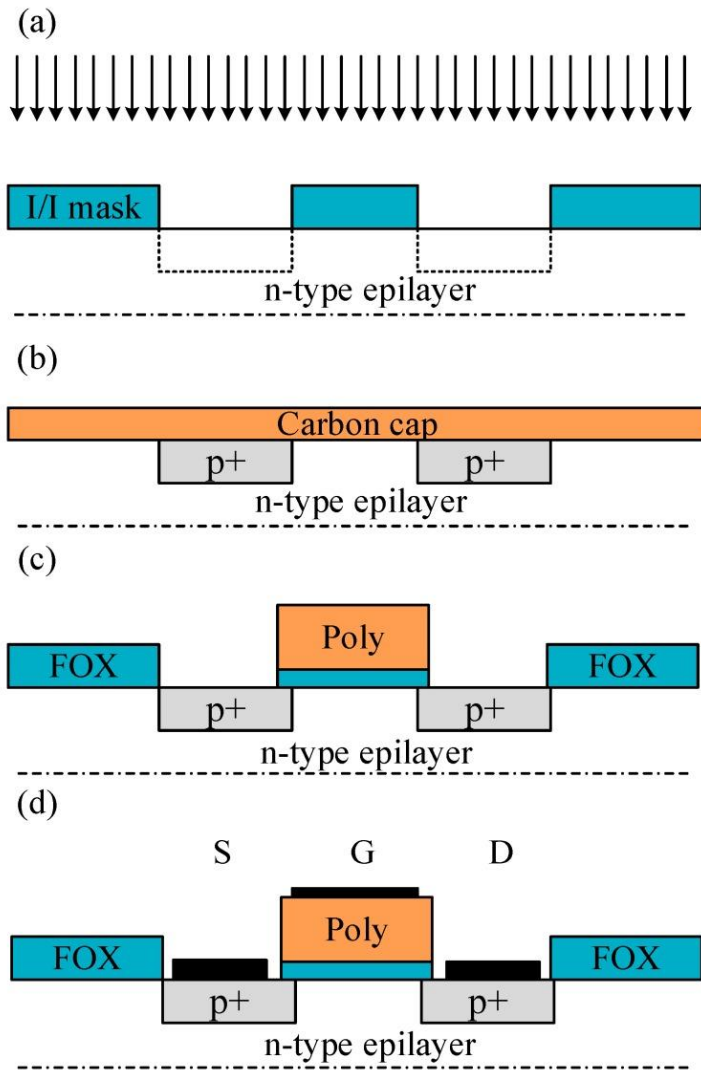
- What is Silicon Carbide?
- Why do we need high temperature devices?
- Overview of SiC MOSFET
- Current limitations to SiC devices
- Other high temperature materials
- Summary and looking forward

# Why do we need these?

High temp devices are currently being used in the aerospace and oil and gas industries- Operating temps of 225° up to 480°C

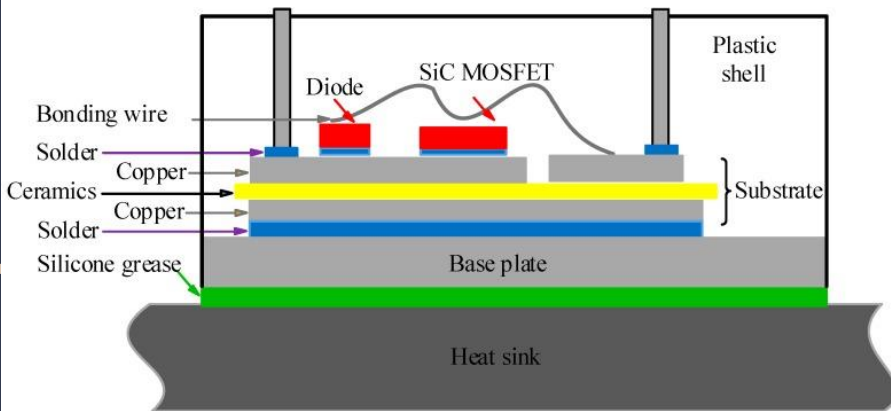
Why not just cool them?

# SiC metal oxide MOSFET



# Current limitations

- Packing not suitable for high temperatures
- Diffusion in contact layer and reaction between contacts
- Schottky barriers between metal and semiconductor increase
- Gate Drives
- Expensive
- Passive components



# Other high temperature materials

-GaAs

-Diamond

-Graphene

# Looking forward

This is the future!

Electric cars, electric planes, electric combat vehicles, etc.



# Sources

Willander, Magnus & Friesel, Milan & Wahab, Qamar & Straumal, Boris. (2006). Silicon carbide and diamond for high temperature device applications. *Journal of Materials Science Materials in Electronics*. 17. 1-25.  
10.1007/s10854-005-5137-4.

R. K. Kirschman, "Extreme-Temperature Electronics Newsletter Issue #1," 26-Apr-2001.

Guo, Xiaorui et al. "Silicon Carbide Converters and MEMS Devices for High-temperature Power Electronics: A Critical Review." *Micromachines* vol. 10,6 406. 19 Jun. 2019, doi:10.3390/mi10060406

# Final Exam topics

- SiC devices are found in many industries including aerospace and oil and gas.
- SiC devices are better than Si devices because of their high junction temperature, thermal stability and conductivity, and fast electron saturation drift velocity.
- The biggest limitation facing SiC devices is the technology surrounding them
- As passive device technology improves, the operating temperature for SiC devices increases
- Other high temperature materials are GaAs, Diamond, and Graphene