Design of Beta-Phase Gallium Oxide Junction Barrier Schottky Diodes for Efficient Power Electronics

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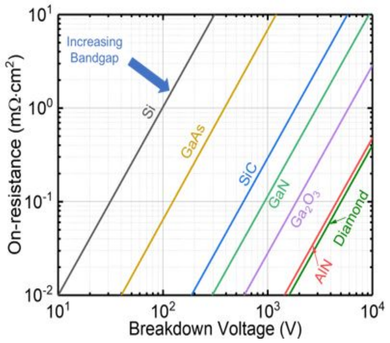
1. Introduction

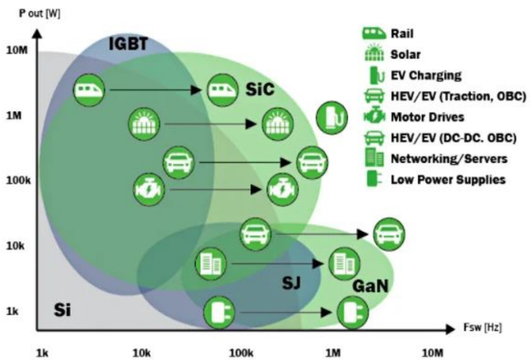
Problem Statement:

- By 2030, 80% of electricity consumption will be due to Power Electronics industry ($41.3 billion market 2024)
- Reduce energy losses by transitioning from Wide Band-Gap Silicon devices to Ultrawide Band-Gap (UWBG) Gallium Oxide devices.



UWBG devices have greater performance than WBG devices with their larger band-gap leading to higher breakdown voltage, higher critical electric field and larger Baliga's figure of merits

2. Applications for Power electronics



Project Aim:

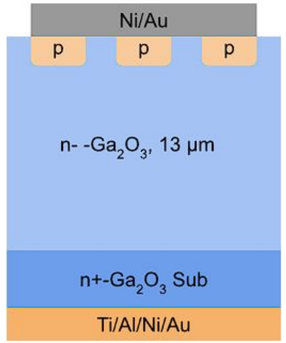
Solutions on UWBG devices (Ga_2O_3) efficiency through:

- ➢ varying junction barrier sizes
- ➢ various P and N type semiconductor materials

3. Results and Data Analysis

ATLAS Silvaco Simulation Results

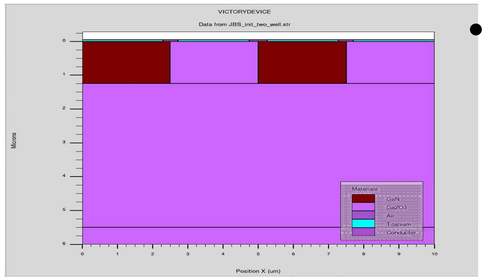
Ga_2O_3 Junction Barrier Structure



Findings

- Variables: Width (x mesh), height (y mesh), well spacing, number of wells
- Too large or small changes cause for less efficiency for the device

Simulation



- When simulated, the variables are altered to the most optimal well size for the greatest power efficiency

4. Notes

- Doping Methods: Ion implantation and diffusion are key processes for modifying semiconductor properties.
- PN Junction Formation: Created by doping a P-type semiconductor with donors to form an N-type region, leading to unique electrical properties.
- Schottky Diodes: exhibit low forward voltage and are ideal for high-speed applications.

5. Future Work

1. Testing various N and P type semiconductor materials with these parameters
2. Fabricating advanced structures in the Nanofab lab

6. References

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7. Acknowledgements

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