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Diamond Based Current Aperture Vertical Transistor and Methods of Making and Using the Same

The exceptional electronic, thermal, and mechanical properties of diamonds make them ideal for applications in high power devices that need to operate in extreme temperature or radiation environments. Diamonds can improve performance and reduce the form factor in electronic devices. This would allow for smaller electronic control nodes, which are critical for electric power and renewable energy applications. For example, an ideal power switch has zero conduction loss and low switching loss, but current technologies must sacrifice one characteristic for the sake of the other. However, the high breakdown field, carrier mobility, and superior thermal properties in diamonds offer a solution to overcome the limitations of current technologies. Therefore, there is a need to develop diamond-based technology that can improve the performance and reduce the size of electronic applications.

Researchers at Arizona State University have developed innovative methods for the fabrication and use of current aperture vertical transistors on diamond substrates. The aperture in the current blocking layer is formed using conductive material to ensure that the current flow from the source to drain is vertical. This innovative design gives the device the ability to handle several kilowatts of power in power devices. Additionally, the excellent thermal properties of diamonds allow this technology to operate at very high temperatures and improves the overall system efficiency due to the absence of an external cooling system. Furthermore, the high carrier mobility and wide bandgap of diamond materials could enhance performance and reduce the form factor of electronic devices.

Potential Applications

- Diamond electronics
- Semiconductor components
- Electric power
- Renewable energy

Benefits and Advantages

- Innovative Design - A vertical structure for a power device is a better suited for handling several kWs of power.
- High Carrier Mobility - The high carrier mobility of diamonds would enable large output current and low ON-Resistance (Ron).
- Improved Thermal Properties - Electronic devices made using diamonds will have large thermal conductivity and a low coefficient of thermal expansion which would enable operation at very high temperatures and improve the overall system efficiency due to the absence of an external cooling system.

- Reduction of Form Factor - The wide bandgap of diamonds could replace other materials to reduce the form factor of electronic parts and devices.

For more information about the inventor(s) and their research, please see

Dr. Robert Nemanich's directory webpage

Dr. Srabanti Chowdhury's directory webpage