Diamond high voltage Schottky barrier diode (SBD) for next generation power electronics

High speed switching of diamond SBD achieved at 200 °C

We have developed a fast switching, high temperature, high voltage diamond Schottky barrier diode (SBD) for next generation power electronics. Based on the excellent material properties of diamond, a high performance SBD was fabricated on epitaxially grown drift layer with a ruthenium Schottky electrode.

The fabricated diamond SBD shows excellent thermal stability at 400 °C and high blocking voltages (1.8 kV). Switching characteristics of the diamond SBD have been measured at elevated temperature (up to 200 °C) by the double-pulse measurement. Thanks to the unipolar operation and low dielectric constant, the turn-off time is shorter than 20 ns and is constant to the temperature and forward current density. Turn-off time of the diamond SBD is much shorter than the conventional silicon PiN diodes and comparable to silicon carbide SBDs.

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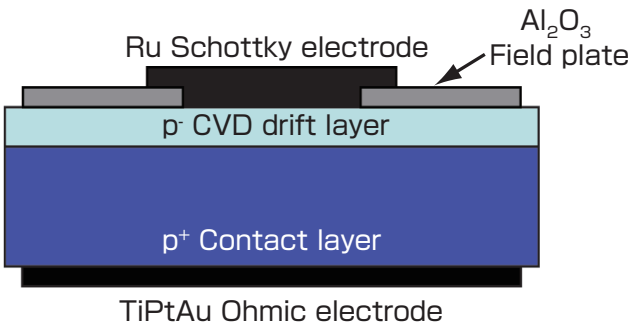

Cross sectional view of diamond SBD

Development of a silicon nitride ceramic material which maintains strength even under large thermal changes

Dispersion of boron nitride fine particles results in dramatic improvement in resistance to thermal shocks

We have developed a silicon nitride ceramic material which displays significantly higher resistance to thermal shocks and strength at high temperatures than conventional silicon nitride ceramics. Using silicon nitride (Si_3N_4) as a base, the material was developed by forming a grain boundary phase with high thermal conductivity and dispersing almost amorphous nanometer-order particles of boron nitride (BN) in the grain boundary phase. While the strength of conventional silicon nitride ceramics declines at a temperature difference of 1,000 °C, there was almost no deterioration in the strength of the developed material even when heated to 1,400 °C in an electric furnace and dropped into water ten times. In addition, the material displayed the same level of strength in high-temperature bending tests conducted in air at 1,200 °C as at room temperature.

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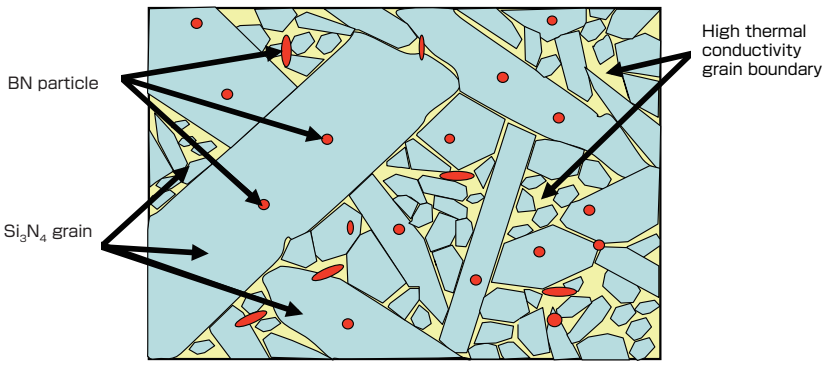

Microstructure image of the developed material