Development of High Power and Millimeter-long Wave Diamond Transistors Using Two Dimensional Hole Gas

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【Outline of survey】

The base station for third generation or newer mobile communication and the new radar system require high-power and low-distortion power amplifiers based on the extremely highpower RF field effect transistors (FETs). Recently, diamond attracts an attention as a material for high-power and high frequency devices due to its superior physical properties such as a wide band gap (5.45eV), a high breakdown field (10MV/cm), and a high thermal conductivity (22W/cmK). In a high frequency operation, the current through the FET should be controlled at high speed. To realize this function, the FET must possess very shallow channel less than 10 nm in thickness. The hydrogen terminated diamond surface exhibit an ideal properties for fabricating FETs. Within the 10nm thick layer, 90% of carriers are present and can be controlled effectively by gate voltage. Using this advantage, we have developed the first diamond FET comparable to the modern FETs by normal semiconductors.

In this program, 1) we focus on the improvement of the surface channel mobility and the surface density of two dimensional hole gas.2) Through the miniaturization of FET down to 0.1μm and the optimization of device structure, we fabricate a prototype device satisfying practical demands for commercial devices as well as possible.

【Expected results】

Diamond is superior to other semiconductors in p-type conduction (hole mobility >2000cm^2/Vsec). On the other hand, GaN FETs exhibit extremely good performance in n channel operation, but not in p channel. The combination of GaN n channel FET and diamond p channel FET provides an ideal complementary device for low power consumption, high speed, and high power switching devices, which have not been realized in semiconductor device.

【References by the principal investigator】

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【Term of project】 FY2007－2011	**【Budget allocation】 32,000,000 yen** (2007 direct cost)

【Homepage address】 http://www.kawarada-lab.com/