nakatsugawa [1]

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Abstract Title:

Observation of self-cooling on power MOSFET with silicon wafers using infrared thermography

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Abstract Text:

Silicon semiconductor power devices that include metal oxide semiconductor field effect transistors (MOSFETs), insulated gate bipolar transistors (IGBTs) and central processing units (CPUs) are used in a daily life to give us modern life in the present time. When we use the electrical equipment incorporating these devices, the improvement of heat removal or cooling is one of the most important issues because they will not function correctly if they are operated at temperatures above 423K. The simple self-cooling device consists of the n-type thermoelectric material connected to the Drain for a power MOSFET. In this scheme, it is required that thermoelectric materials for the self-cooling device have a high Seebeck coefficient, a high electrical conductivity, and a high thermal conductivity which is different from the requirement for typical thermoelectric materials. Fortunately, it is easy to find the combinations of high electrical conductivity, high Seebeck coefficient and high thermal conductivity because the higher thermal conductivity material usually has higher electrical conductivity. The typical high thermal conductivity semiconductors are silicon carbide and silicon. In the present work, the self-cooling device has been developed by combining the commercial n-channel power MOSFET and the copper plating single-crystalline antimony doped n-type and boron doped p-type silicon wafers in order to improve heat removal or cooling for power devices. The time dependence of the temperature distribution in the

self-cooling device is measured to estimate both the conventional thermal conduction and the Peltier heat. We find for the first time that the average temperature of the upper side on the power MOSFET is cooled down by using the self-cooling device. This warrants future work on the improvement of the measurement condition. Nonetheless, this fact strongly indicates that the copper plating silicon wafer is one of the candidate materials for use in self-cooling devices.

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