Collisions and Impacts in Semiconductor Device

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In this talk, the review of collaboration work with Prof. Zoran Petrovic and the developmental research related to collision and impacts in semiconductor devices are presented. In 1994, a first collaborative paper with Prof. Zoran Petrovic entitled “The Radical Transport in the Narrow-Gap-Reactive-Ion Etcher in SF_6 by the Relaxation Continuum Model” to Japanese Journal of Applied Physics as a result of work in Keio University are published [1]. In this paper, neutral radical transport in narrow gap reactive ion etcher using SF_6 gas was discussed. Following that a paper to Physical Review E entitled “The Radical Transport in the Narrow-Gap-Reactive-Ion Etcher in SF_6 by the Relaxation Continuum Model” are published [2]. After the simulation and modeling research of non-equilibrium plasma, my research field is shifted to semiconductor device simulation and circuit design not the semiconductor processes.

Current research fields include compound semiconductor device simulations such as GaN and SiC. Two examples of collisions and impacts in semiconductor devices are shown. With the development of power electronics in recent years, next generation power semiconductor devices are needed. Gallium nitride is a promising material for high frequency, high power, and low loss devices because it has a wider band gap, higher breakdown voltage, and higher saturation velocity. Heat generation is a serious problem because power devices operate in high current and high voltage regions. Therefore, in order to analyze non-stationary electrical and thermal phenomena in nanoscale devices, a self-consistent Monte Carlo simulation method that can simulate electron transport and phonon transport microscopically and simultaneously is used.

In second, SiC Impact Ionization Coefficients evaluation work is introduced as a recent work. To know the impact ionization coefficient in SiC semiconductor device is very important work because of SiC is key power device in near future. The device breakdown caused by impact ionization is an issue to avoid for the reliable operation. However, the measurement of impact ionization coefficient is not easy issue due to lack of direct measurement in the device itself. Therefore, we use the device simulation method to overcome this issue, and the simulated results is compared with experimental results of the measurement of break down voltage in the devices.

References

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[3] R.Sawabe, N. Ito, Y. Awano, "Advanced Quasi-Self-consistent Monte Carlo Simulations on High-Frequency Performance of Nanometer-scale GaN HEMTs Considering Local Phonon Distribution"; International Confernce on Simulation of Semiconductor Processes and Devices , 2017. in: "Proc. of SISPAD", (2017), 285 - 288.