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Report on ISPSD 2019

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Abstract

This report provide a summary of some of the papers presented at the International Symposium on Power Semiconductor Devices and ICS.

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Summary

The international symposium on power semiconductor devices (ISPSD) was held in Shangahi from from May 19 to 23, 2019. As usual, the attendees come from industries and academia. However, academia makes up about more than 70% in contribution to the papers. This year, there are about 130 papers presented and major contributions come from China (including Hong Kong), Japan, USA and Europe. There were about 300 to 400 attendees and many and not surprising are from China. China has shown a remarkable increase in contribution to paper presentation given that the conference was held in Shanghai.

For this year paper contributions, GaN and SiC have one of the highest in number and stands at about 30 papers for each of them. In other words, both device technology took up about 50% of the presentation. For GaN, the main focus is still for application in power electronics and very few for RF applications. Both lateral and verticle structures of GaN were presented but for very high breakdown voltage, verticle structure is still the dominant design. The subject matter disccused on GaN ranges from impact ionization, GaN on Si substrate, multi-channel GaN devices, enhanced mode GaN, current protection, threshold voltage changes.

Reports on two records are 1) 100A vertical GaN trench MOSFETS and another on 2) >1kV breakdown voltage using vertical super-junction trench MOSFETS. However, breaking this recoed is another novel GaN claiming 2000 V normally-off MOS HEMT using AlN/GaN superlattice channel. There were about 5 papers on p-GaN gate. P-type GaN gate carries an enhancement-mode operation, which implies a possible normally off capability – a feature which is very important in power electronics for both safety and power efficiency. MERL has engaged in this type of devices some 3 to 4 year ago and filed a couple of patent applications on this kind of concept. The challenge is to maintain a good stability in its threhold votlage.

There is a GaN paper on gate degradation using low-pressure chemical vapor deposition (LPCVD) for the passivation. They discussed about the potential of holes generated by impact ionization that can leak to gate electrode through the gate dielectric to cause gate threshold instability. Holes should be prevented from either going through or accumulating under the gate dielectric.

There is an interesting claim that a diamond MOSFET has been fabricated and characterized up to a temperature at 250°C. The fabrication process has been improved in order of magnitude to significantly reduce the specific on resistance, down to 50 mΩ.cm², and as well, the gate leakage current at high temperature. The maximum electrical field in diamond, at the breakdown value of 175V, is approximated to be higher than 5.4 MV/cm when doped with boron of 2×1017 cm-3.

Finally there is an interesting paper that discusses the impact of Autonomous Driving on the role of semiconductor in general and IoT and Deep Learning in particular. Also it should be noted that Autonomous Driving will also impact the transportation industries resulting in shorter product life cycle and different kinds of business profitability. With the increasing dominance of a shared economy, the utilization rate of car sharing could be more than 10 times of that of car ownership. Currently car sharing takes up about 4%, and run up a mileage of 100,000 miles in two years. If a car costs only $ 25,000, could earn about $ 75,000 in two years from the mobility of people, goods and energy. Mobility operators would soon experience an increase in cost from EV as well as autonomous vehicle operation, and including expenses for energy, short and long-term maintenance, insurance and others.

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