Name: **Ejlal SHAHRIARI**
Email: ejlal.shahriari@univ-pau.fr
Supervisors: Laurent Pecastaing, Anton Gusev

Funding: E2S UPPA

Status: PhD Student

Fast High-Current Semiconductor Switches for Pulsed Power Applications

Abstract

The switching characteristics of semiconductor devices have been significantly improved due to the initiation of impact ionization wave in the silicon structure. This leads to the sub-nanosecond switching of semiconductor device from a blocking state to a conducting state. As a result, a switch prototype with a blocking voltage of 5 kV, switching current of more than 200 kA, current rise rate about 50 kA/µs and pulse duration of 25 µs has already been demonstrated. However, according to the up-to-date theory, critical values of the switching parameters, such as switching time, maximum current and current rise rate, can be improved by using a more powerful triggering generator and thyristors with bigger wafer diameters. Therefore, the full potential of the impact-ionization triggering approach is not revealed yet. This project will continue research on high-current thyristor switches triggered in the impact-ionization wave mode. The main goal is to prove experimentally the possibility of switching fast sub-mega-ampere currents by the semiconductor devices. Switching characteristic as a function of the triggering pulse parameters will be investigated for thyristors with a wafer diameter of up to 100 mm. A thyristor-based switch prototype with a blocking voltage of several kV, current rise rate of tens of kA/µs and current amplitude of hundreds kA will be simulated, developed and tested.

Results and Discussion

The experimental result of applying triggering pulse over a 5.2kV/⌀100 mm thyristor is illustrated in Fig.1. The triggering pulse starts from bias voltage of 5 kV applied by dc voltage source. A triggering pulse from Marx generator with rise rate of 1.15 kV/ns and maximum value of 10.4 kV (twice of blocking voltage of the thyristor) leads to the sub-nanosecond switching of the thyristor (less than 500 ps). To the best of our knowledge, this is the first time when standard thyristor with such a high rated voltage and large area is successfully triggered in impact ionization switching mode. These encouraging results open up the horizon for the fast high-energy switching by standard thyristors. The current stage of this project is focused on high-energy switching.

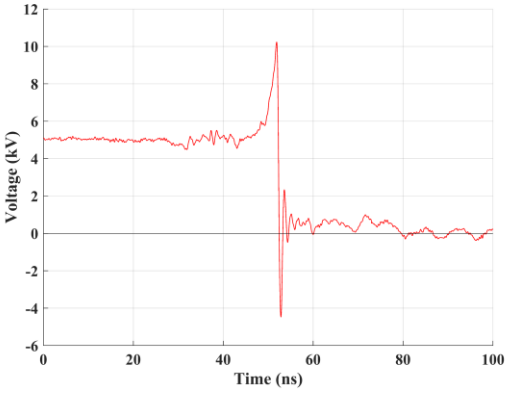

Fig. 1. The experimental result.