Contribution ID: **134** Type: **Oral Presentation**

High-voltage silicon avalanche diodes for picosecond range pulse-sharpening applications: towards optimal design

Wednesday 6 July 2016 16:45 (15 minutes)

Silicon avalanche sharperning (SAS) diodes are capable to form kilovolt voltage ramps with 100 ps risetime for pulse power applications [1-3]. Physics of these devices still remains vague and, as a result, design of the respective semiconductor structures is up to now purely empirical. Here we present the results of comparative study of specially designed and manufactured SAS structures with the same geometrical parameters and close stationary breakdown voltages Ub˜1.1-1.3 kV. The devices differ in basic Si substrates, doping profiles, fabrication technique and carrier lifetime.

Original high-voltage picosecond-range experimental setup has been used for measurements. The setup allows determining both current and voltage across the diode with time resolution better than 50 ps. We use DLTS study to evaluate the effect of deep levels.

All types of diodes under study successfully form a voltage ramp in the load with kilovolt amplitude and ˜100 ps rise time. Switching starts when the reverse voltage is about 2 kV. Our main finding is the drastic difference between p+nn+ and p+pnn+ structures. Namely, low residual voltage Ures ˜ 150 V has been observed only for p+nn+ structures. In contrast, for all p+pnn+ structures Ures is about 1 kV hence just below Ub. Next, we reveal also different types and concentrations of deep levels: electrons traps known as Sah centers are detected in p+pnn+ structures, whereas p+nn+ are nearly clean from these levels. Remarkably, recombination centers created by electron irradiation in structures with intentionally reduced carrier lifetime have no impact on superfast avalanche switching. The question whether the observed difference in switching dynamics is caused by the difference in doping profiles or by the difference of deep levels present in the structure requires further studies. Our results show that the doping profile with abrupt pn-junction must be used for silicon avalanche sharpening diodes.

[1] I.V. Grekhov, A.F. Kardo-Sysoev, L.S. Kostina, S.V. Shenderey, Electronics Letters 17, 422, 1981.
[2] A.F. Kardo-Sysoev, in Ultra-Wideband Radar Technology, edited by J.D. Taylor, CRS Press 2001, pp.205-289.
[3] V.I. Brylevsky, I.A. Smirnova, P.B. Rodin, I.V. Grekhov, Technical Physics Letters, 40, 357, 2014.

Primary author: Dr RODIN, Pavel (Ioffe Institute)

Co-authors: Prof. GREKHOV, Igor (Ioffe Institute); Mrs SMIRNOVA, Irina (Ioffe Institute); Dr BRUNKOV, Pavel (Ioffe Institute); Dr BRYLEVSKIY, Viktor (Ioffe Institute)

Presenter: Dr RODIN, Pavel (Ioffe Institute)

Session Classification: Oral 3

Track Classification: Opening, Closing, and Solid State Switches