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Invited Contribution: Bipolar Super Junction Power Devices: A Case Study for Complex Numerical Modelling

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Super Junction (SJ) power MOSFETs have become a well established power semiconductor component over the last years in a range of applications such as switched mode power supplies (SMPS). This unipolar semiconductor switch relies on the charge compensation principle across a PN junction made of alternatingly stacked, strongly doped N and P columns. SJ power MOSFETs have been able to break the Silicon limit for unipolar power semiconductor switches.

Conceptually, the evolution of the IGBT from the VDMOSFET more than 20 years ago was realized by an apparently straightforward replacement of the n-doped drain by the p-type anode emitter. The invention of the IGBT had far-reaching consequences with the extinction of the Silicon BJT. This paper presents results of a numerical simulation study investigating a similar scenario for bipolar Super Junction power devices. It is shown that modern multi-dimensional simulation tools are well suited to obtain a fair understanding of the basic characteristics of complex device behaviour.

As an outcome, there is no one-to-one correspondence of the Silicon IGBT when using the SJ charge compensation principle for the central base region. The characteristics of the SJBT (Super Junction bipolar transistor) differ substantially from the IGBT and mainly result in a strong decrease of the switching losses. The idea of a MOS controlled Super Junction thyristor (SJMCT) is shortly discussed and compared to IGBT, SJBT and SJ MOSFET.