Design optimization of the gallium nitride high electron mobility transistor with graphene and boron nitride heat-spreading elements

© *V. Volcheck, I. Lovshenko, V. Stempitsky*

Belarusian State University of Informatics and Radioelectronics,
Research and Development Laboratory 4.4 „Computer-Aided Design of Micro- and Nanoelectronic Systems“,
220013 Minsk, Belarus

E-mail: vlad.volchek@bsuir.by

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The self-heating effect has long been a persistent issue for high electron mobility transistors based on gallium nitride due to their inherently poor heat dissipation capability. Although a wide variety of thermal management solutions has to date been proposed, the problem of the extremely non-uniform heat dissipation at the micrometer scale is still challenging. It has recently been demonstrated, however, that the performance of gallium nitride high electron mobility transistors can be substantially improved by the introduction of various heat-spreading elements based on graphene, boron nitride or diamond. In this paper, using numerical simulation, we carried out a design optimization procedure for a normally-off gallium nitride high electron mobility transistor containing both graphene and cubic boron nitride layers. First, a screening experiment based on a very economical Plackett–Burman design was performed in order to find the most critical geometric parameters that influence the dc characteristics. After that, a full two-level factorial experiment consisting of three factors was implemented and an optimized parameter set was yielded. By applying this set, the output power was increased by 11.35%. The combination of the most significant parameters does not include any factors related to the heat-spreading layers.

Keywords: gallium nitride, high electron mobility transistor, optimization, Plackett–Burman design, screening experiment, self-heating.

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