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Defects characterization of GaN heteroepitaxial growth wafer using nSPEC images vs ECCI

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The new challenges of the green economy are related at high efficiency power converters for energy efficiency, electrical mobility and connectivity high speed (5G). These applications required new technological approach and new and more efficient materials on which to develop these devices. Wide band gap materials are becoming increasingly important for their characteristics and the excellent performance that can be achieved in power devices. In particular, SiC and GaN are attractive materials for power devices owing to superior physical properties, such as its high breakdown electric field strength, high electron mobility, and low anisotropy [1].
The GaN technology is quite mature, but the new challenges are large-diameter bulk growing, in that case, both SiC and GaN power devices will be widely employed for the high performance and low cost. However, cost-effective heteroepitaxial growth of GaN goes along with high defect densities as compared to a pure GaN based approach. Clarifying the role of defects in terms of their impact on device performance and reliability needs to fulfill several requirements when aiming for an overall technology improvement. The development of an understanding of how they form, what consequences they have on local material properties as well as the relation of this knowledge to the behavior of devices and the ability to detect defects it appears fundamental. Especially the last point is very difficult to accomplish from an experimental point of view when high densities of defects are involved and many of them are superficial without any consequence for the device [2].
Many inspection tools have been developed to be able to try to identify and classify this type of defects (eg. KLA Candela [3], nSpec, [4] Altair [5] etc.) but all based on optical or surface scattering inspections. It is not easy to characterize the defects detected by these tools by electron microscopy due to the difference in the nature of the image
Electron Channeling Contrast Imaging (ECCI) is a Scanning Electron Microscopy (SEM) technique that allowing to observe a variation in the periodicity of the sample lattice using electron backscattering (EBS) detector. Normally in typical BSE image, three kinds of contribution at the contrast can by observed. The main contribution is given by Z-contrast, the second is given by surface topography the smallest contribution is given by Channeling contrast. When well-collimated electron beam is aligned with crystal zone axis increase the likelihood of electron channeling and the third contribution became prevalent [6].
In this paper we start form some unknown withe spots not yet classified coming from optical inspection in dark field mode on a GaN Epy-Layer to reach a defect characterization by Transmission Electron Microscopy (TEM) using ECCI technique to identify the points. In particular, the methodology to identify the area of analysis, the ECCI results and the TEM photo are detailed described.

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