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FKE-Seminar

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Challenges in III-Nitride Device Technologies - Contacts and Surface

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Abstract: GaN based devices, mainly HEMTs, LEDs have matured over a period of more than 2 decades and mainstream technologies have developed. Device technologies have become rather standard following the gradient of improvement. With native GaN and AlN substrates rather low defect densities has become available, but industrial work on Si indicates that the role of defects and related instabilities is not clear. They are in generally associated with traps, suggesting that the elimination of those traps will cure the problem. But, passivation and buffer layer problems are still extensively discussed; obviously no sweet solution has been found yet after more than 20 years. Recently also power switching devices and DUV lasers have been added to the device matrix, relying on the same technological background and its problems.

The focus of this talk will be on the discussion of rather conventional technological building blocks like ohmic and blocking contacts and dielectric surface passivation in light of a number of specific experiments, questioning “common wisdom”. Clearly, chemical/physical boundary conditions are equally important to band structure engineering but are often not well identified, especially considering that active layer systems start to span all the way from GaN up to AlN. It seems that Ni gates in HEMTs are usually not Schottky barriers, that SiN is generally heavily trap loaded which is widely neglected in device cross sectional energy band diagrams, and that ohmic contacts to n-GaN do not need alloying into the semiconductor even when doped below tunneling levels. Values of p-type contact resistances span over more than 2 decades, indicating the empirical development of their technology, but their basic behavior can be traced back to the classical Alloyed Contact Model developed in the 1980’s, despite Mg being a deep acceptor.

Experiments can still result in controversial results and can still not be backed up yet by DFT calculations. Thus, it seems that despite the fact that contacts and passivation have often determined the fate of device concepts, a fundamental understanding of many of the “standard” device building blocks is still lacking, at least in part. So, there seem to be more than enough challenges ….

Host: D. Pogany