Ga vacancies formation in MOVPE prepared GaN layers

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Defects related to gallium vacancies (V_{Ga}) are extremely important for optoelectronic applications since they are believed by some authors to be the main cause for non-radiative recombination of carriers or by others, it is believed that V_{Ga} are responsible for yellow band luminescence and form non-radiative centers if they are in complex with donors. Another problem of these defects is shortening of the device life time, since vacancies enhance the diffusion of atoms in the structure which can lead to the decomposition of quantum wells (QWs) or deterioration of channel properties in e-HEMT structures. However, there is not much information about this kind of defects. We have prepared set of GaN layers by Metal organic vapour phase epitaxy (MOVPE) under different technological conditions and investigated them by Variable energy positron annihilation spectroscopy (VEPAS) to find a correlation between technological conditions, GaN layer properties and V_{Ga} formation. VEPAS is unique and irreplaceable method to get information about V_{Ga} concentration in thin epitaxial layers. Different correlations between technological parameters and V_{Ga} formation were observed for layers grown from TEGa and TMGa precursors as well as for different reactor atmosphere (N_2 or H_2). According to PL results surprisingly, increased V_{Ga} concentration enhances excitonic luminescence. Probable explanation is that V_{Ga} prevents formation of some other highly efficient nonradiative defect.