Hydrostatic pressure studies of gallium nitride doped with beryllium.

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Before realization of the p-type doping in gallium nitride by using magnesium, beryllium had been taken into account as a natural candidate for such doping. On the one hand, it is a well-established fact that beryllium is the shallowest acceptor in gallium nitride. On the other hand, so far no one was able to realize p-type conductivity in such way. The reason for this is unclear and still controversial. One theory suggests that with increasing p-type doping most of the beryllium is incorporated into the crystal in the interstitial position. In such position beryllium acts as a donor not as an acceptor [1]. A second recently published theory proposes that the nitrogen vacancies are responsible for self-compensation mechanism in doped gallium nitride [2]. It was found experimentally that with increasing beryllium doping, donor-acceptor pair luminescence vanished, and new yellow luminescence line appeared at around 2.2 eV.

This strong yellow luminescence is very characteristic of gallium nitride doped with beryllium, however its origin is not clear. In order to shed more light on this issue we performed high hydrostatic pressure studies of bulk gallium nitride crystal doped with beryllium by using diamond anvil cell technique. We observed splitting of the yellow luminescence under hydrostatic pressure. These results could be explained taking into account double nature of the initial state of 2.2 eV line. This initial state includes shallow donor and deep donor, whereas final state is a deep acceptor. At a higher pressure, we also observed the new intensive luminescence which is probably related to pressure induced crossover of the resonance state with the bottom of the conduction band. The nature of this resonance state is unclear.

[1] J. Neugebauer and C. G. van de Walle, J. Appl. Phys. **85** , 3003 (1999).
[2] J. Buckeridge et al. Phys. Rev. Lett. **114**, 016405 (2015).