

Motional narrowing and Rayleigh scattering of exciton polaritons in GaN/AlGaN multiple quantum wells

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Recently, it has been shown experimentally and theoretically [1,2] that the radiative coupling between excitons confined in different quantum wells (QWs) in a multiple quantum well (MQW) structure may lead to a reduction of the effective disorder acting on the exciton. The signature of this effect known as a *vertical motional narrowing* effect is an increase of the decay-time of the time-resolved reflection signal that results from the averaging of the disorder potential in a MQW structure by extended exciton-polariton modes that occupy entire the structure.

In this work, numerical simulation of time-resolved reflection of light from GaN/AlGaN single and multiple quantum wells revealed a pronounced *vertical motional narrowing* effect. Substantial reduction of the inhomogeneous broadening of the exciton peaks and increase of the decay-time of the time-resolved reflection due to the averaging of the vertical disorder in the structure by extended exciton-polariton modes has been demonstrated. The exciton polariton decay time has been found to be strongly sensitive to the period of the MQW structure and to increase with increase of the number of the QWs. The analytical formalism describing the temporary decay of the time-resolved transmission across a multiple quantum well structure has been developed.

Resonant Rayleigh scattering from semiconductor quantum structures has attracted a particular attention of the scientific community in the recent years [3]. The necessity of extension of the exciton-polariton theory in order to explain the (RRS) data is quite clear now. In our opinion, it requires a revision of the physical concept of the RRS in QWs, namely, introducing of the concept of scattering of coherent exciton-polariton states. This new theory has given an explanation of existing experimental data on the RRS from GaAs multiple QWs which were puzzling till now.

Here, we present the concept of resonant Rayleigh scattering (RRS) of *exciton-polaritons* in GaN based multiple quantum wells (QWs) in the framework of the semi-classical theory. Using realistic parameters for the radiative coupling and the inhomogeneous broadening of the QW excitons, the optical coupling between excitons in different QWs is shown to govern the RRS spectra giving rise to the characteristic pico-second scale oscillations. Bragg and anti-Bragg arranged GaN based QW structures with the same excitonic parameters are predicted to have drastically different RRS spectra.

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- [3] V. Savona, S. Haacke, and B. Deveaud, Phys. Rev. Lett. **84**, 183 (2000).