Photoluminiscence spectroscopy of thin sheets of Gallium Selenide

S. Schwarz[1], O. Del Pozo-Zamudio[1], D. Sercombe[1], E. A. Chekhovich[1], D. N. Borisenko[2], N. N. Kolesnikov[2], A. I. Tartakovskii[1]

[1]Department of Physics and Astronomy, University of Sheffield, Sheffield, S3 7RH, UK
[2]Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka 142432, Russia

Interest in atomically thin two-dimensional (2D) layered compounds, including metal chalcogenides, has increased in recent years due to unique physical properties of a few monolayer (ML) structures [1], and also growing effort in fabrication of novel heterostructures composed of layered materials. So far, main focus in studies of light-emitting layered materials was on MoS_2, which however shows dramatic decrease in photoluminescence (PL) for sheets with thicknesses above single ML [2]. Here we present low-temperature micro-PL (μ-PL) studies of thin sheets of mechanically exfoliated thin layers of GaSe capped with a thin SiN layer. We show that GaSe exhibit significantly brighter PL than MoS_2 around 2.05 eV for layers up to 160 nm thick. μ-PL enables observation of unusual sharp lines (with linewidths 3-10 meV) possibly originating from quantum-confined states in very thin dislocated layers embedded within quasi-bulk GaSe sheets. Our results indicate significant enhancement of exciton binding energies in such dislocated layers potentially enabling wider range of applications of GaSe in light emitting opto-electronic devices.

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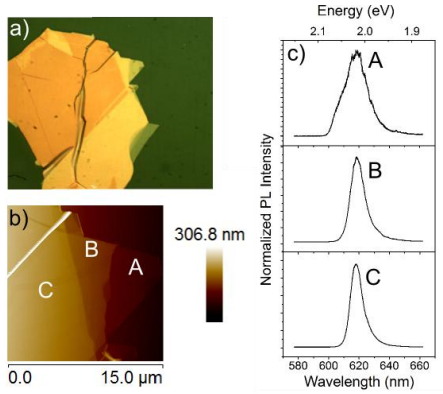

Fig.1. a) Optical image of a mechanically exfoliated GaSe thin flake. b) AFM image of a region of the flake shown in (a). Three different thicknesses are observed. c) Photoluminescence (PL) spectra measured for tree different places of the flake (A, B and C).

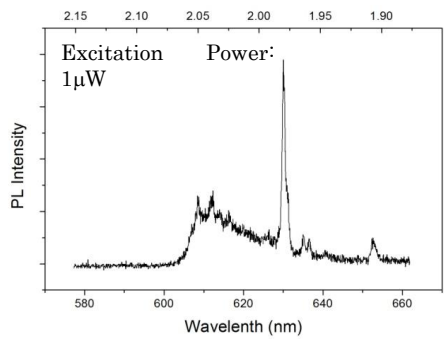

Fig.2. PL spectra of a GaSe thin flake measured with excitation power of 1 μW. Narrow lines appear with low excitation power at lower energies than the main PL line.