Strong interaction of GaN nanowires with bulk MoS_2: Raman and photoluminescence studies

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Disulfide molybdenum (MoS_2) crystal has very interesting physical properties. It is commonly known that luminescence of disulfide molybdenum strongly depends on its thickness. Decreasing the number of MoS_2 layers leads to strong increase of photoluminescence intensity which is explained as transformation of indirect to direct bandgap semiconductor.

In this work, we show that substantial enhancement of both Raman and photoluminescence spectra of MoS2 crystals can be achieved by deposition of gallium nitride (GaN) nanowires on top of them.

The MoS_2 samples were exfoliated from synthetic bulk crystal and placed on silicon substrate covered with silicon dioxide. The GaN nanowires of length of 1-2μm and diameter of 30-50nm were grown by MBE on Si(111). Subsequently they were separated from the Si substrate using methanol ultrasonic bath and deposited on MoS_2 surface.

Presence of GaN nanowires on the MoS_2 surface was verified by optical microscopy (see black spots on Fig.1, top part) which matches very well with the Raman signal of E_2 GaN mode.

Interestingly enough, positions of GaN nanowires perfectly correspond to the enhancement of both Raman and photoluminescence of MoS_2 crystal. As presented in Fig.1, E^1_{2g} Raman mode of MoS_2 was amplified by factor of $\sim$1.5 and PL even by a factor of $\sim$3.

The obtained results may indicate strong interaction leading to the apperance of photonic effects in Raman and selection rule breaking for emission spectra from MoS_2 bulk crystals.

The observed effect would be important from the point of view of nanooptical devices based on MoS_2 structures.

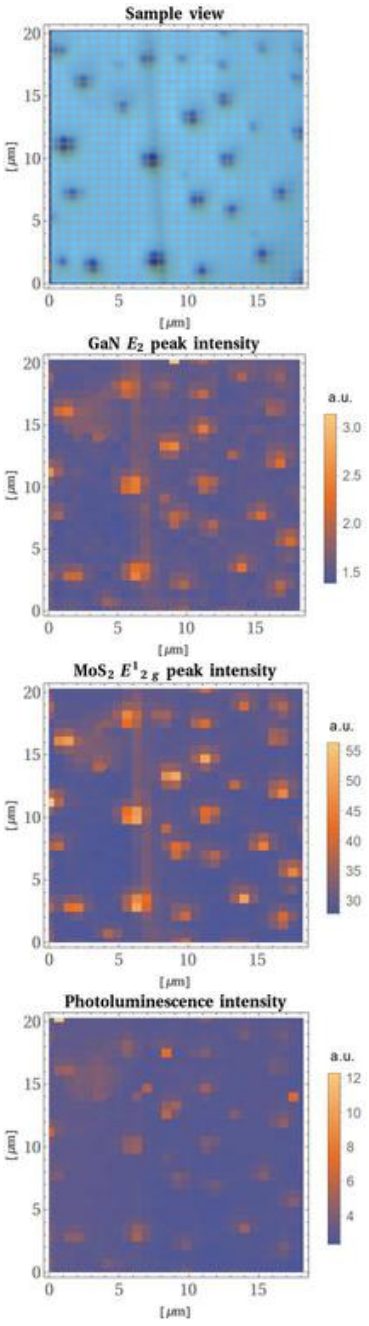

Figure 1: Results of spacially resolved Raman and photoluminescence spectroscopy of GaN nanowires deposited on bulk MoS_2.