Band gap tuning of gallium selenide by strain engineering

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Controlling the optical and electronic properties is one of the more challenging and exciting ways to understand the physical properties of 2D crystals. We study the absorption edge of GaSe by inducing strain in flakes fabricated by mechanical exfoliation [1]. The viscoelastic substrate is prestretched before depositing the nanosheet and when the substrate is released, we obtain rippled flakes with a tensile and compressive strain at the summits and valleys, respectively. By using a buckling-induced delamination model, we calculate the maximum strain in the ripples with a period of 2-3 μm as shown in Figure 1 [2]. We illuminate the sample using a white light source and the light is collected from a region of 500 nm in diameter using a fiber as a pinhole using a diffraction limited optical microscope [3]. Micro-transmittance spectra are recorded using a cooled CCD camera coupled to a Czerny-Turner spectrograph and in order to measure spatially resolved micro-transmittance maps, the sample is actuated by two nanoprecise linear positioners. Absorption coefficient is calculated from the micro-transmittance measurements and can be represented *vs.* photon energy as shown in Figure 2.
We found a redshift and a blueshift of the absorption edge under tensile and compressive strain, respectively, which is in agreement with DFT calculations. The total absorption edge shift for the GaSe at room temperature is up to 1.1 eV, which is a higher value than the reported shift in BP [4].

References

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[4] Quereda, J., San-Jose, P., Parente, V., Vaquero-Garzon, L., Molina-Mendoza, A. J., Agraït, N., ... & Castellanos-Gomez, A. (2016). *Nano letters*, 16(5), 2931-2937.

Figures

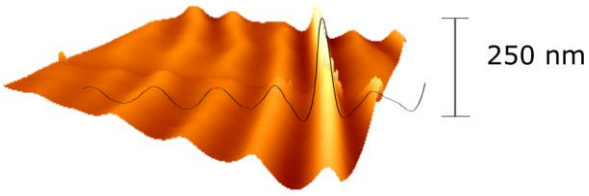

Figure 1: An atomic force microscopy image of a rippled nanosheet with a maximum amplitude of 250 nm.

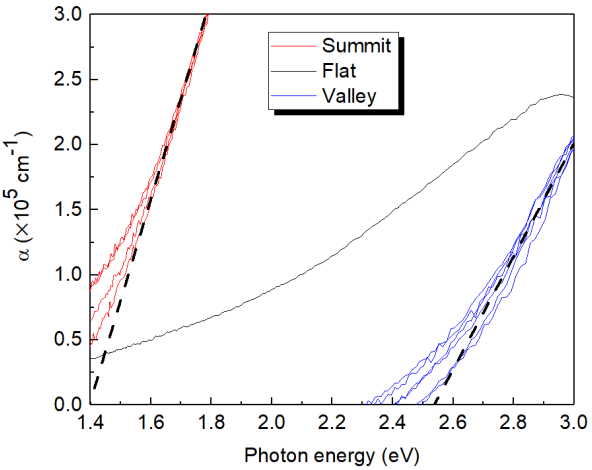

Figure 2: Optical absorption spectra acquired at three different regions of the rippled nanosheet: the black solid line is the absorption spectrum in the flat region, the red solid lines are the spectra at the summits of the ripples under a tensile strain and the blue solid lines represent the absorption at the valleys under a compressive strain.