

Characterization of Layered Gallium Telluride (GaTe)

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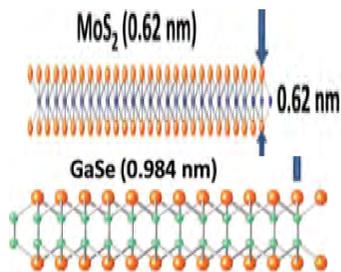


Abstract

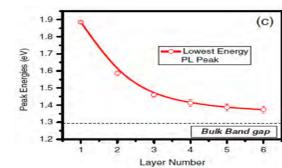
In recent years, the interest in two-dimensional (2D) semiconductors has increased, as they might play an important role in the future of electronic materials because it is relatively easy to produce complex structures from them. Gallium (II) telluride (GaTe) is a layered-monochalcogenide semiconductor. Unlike other layered-chalcogenides, GaTe has not been fully investigated, even though its 1.7 eV energy gap makes it a promising material for electronic applications. Few-layers GaTe crystals were obtained by mechanical exfoliation on a SiO₂/Si substrate. The transferred flakes were characterized by atomic force microscope (AFM) in order to determine the thickness and amount of layers, while Raman spectroscopy was performed to corroborate the presence of GaTe, and to determine the spectrum dependency on the number of layers. The flakes were further tested for variation on their energy band at different thickness by photoluminescence spectroscopy. Knowing and being able to control some key properties such as the band gap of this compound from bulk to 2D layers could open doors to many key applications for electronic and optical devices.

Introduction/Background

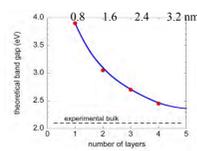
- Chalcogenides contains at least one of three grp VI element and a more electropositive element.



Recent discoveries



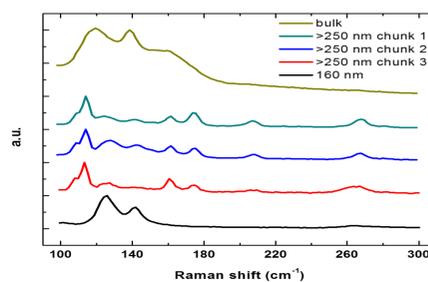
Mak, K.F., *et al.*, Phys Rev Lett. **105**, 136805 (2010).



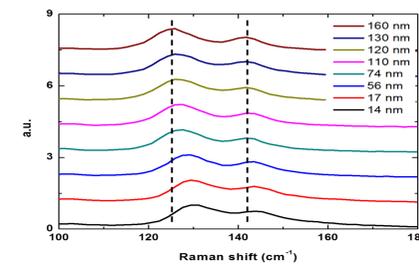
adapted from D. V. Rybkovskiy *et al.*, PRB (2011)

- GaTe has a monoclinic crystal structure that goes to hexagonal in thin film
 - p – type direct band-gap of 1.69 eV

Results/Data Analysis (Raman spectra)



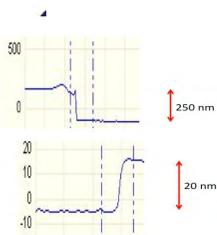
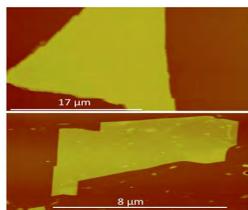
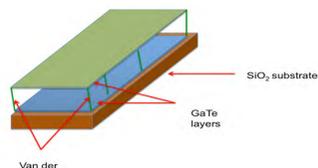
Traces of new peak in the 140 -280 region of the Raman shift.



Horizontal shift to the right of the GaTe generic peaks as we cleave down in layers.

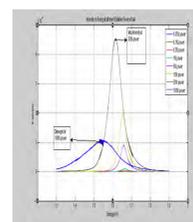
Methods

- Substrate treatment
- Mechanical exfoliation
- Optical microscopy
- Atomic force microscopy
- Raman spectroscopy
- Photoluminescence spectroscopy (PL)

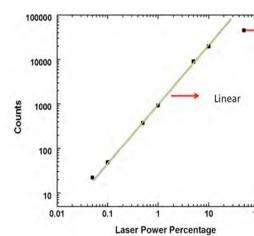


Results/Data Analysis II (PL)

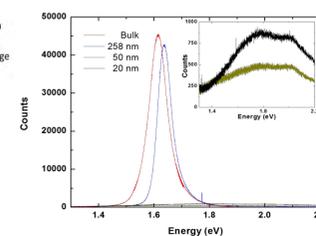
- There's a correlation between the laser intensity and peak.
- The PL of several flakes with different thickness indicated a decrease in the intensity (counts)



Laser intensity Vs counts



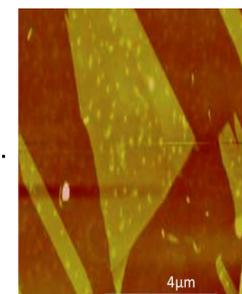
Laser intensity Vs counts (log – log scale).



Photoluminescence spectrum of GaTe samples

Discussion/Conclusion

- GaTe exhibits some anisotropic features.
- It will take further research to know what properties are actually isolated from bulk.
- Great chances of being able to cleave down to a monolayer on SiO₂ substrate.



References

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Future Directions

- Cleave down to a monolayer
- Take low temperature PL
- Take more Raman
- Devices and application

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