Crystal Quality of 2D Gallium Chalcogenides using Raman Fingerprint

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2D metal chalcogenides are expected to provide new types of applications in next-generation nanoelectronics and nanophotonics [1-2]. GaTe and GaSe belong to the III-VI group of 2D layered metal chalcogenides with both direct band gap and crystal asymmetry in their few layers. Schematics of GaTe and GaSe crystal structures are presented in **Figure 1**. Since the thickness of single-layer GaTe and GaSe are known to be about 1 nm, the flake thickness in nm corresponds roughly to the number of layers. Two adjacent tretra-layers (TLs) are weakly coupled via van der Waals forces. However, the surface of GaTe and GaSe oxidises over time in ambient condition. Investigation of the crystal quality of GaTe and GaSe using Raman fingerprint has not yet been studied intensively.

In this study [3], we present a systematic Raman analysis to monitor the quality of GaTe and GaSe due to oxidisation in ambient condition. The time dependent atmospheric degradation of these materials is examined separately. We also carried out XPS analysis to understand the oxidisation effect of GaTe and GaSe surfaces. Systematic stability study as a function of time was carried out focusing on Raman fingerprint of few-layer GaTe and GaSe to identify their crystal quality, which is vital to understand the oxidation process of the materials in ambient condition, are presented in **Figure 2**. It is also highly beneficial to have a straightforward method to evaluate material quality. The Raman fingerprint established in this study is therefore highly beneficial in this regard. We confirm that the 50 nm Al_2O_3 deposited by atomic layer deposition (ALD) protects flakes from ambient oxidation, beneficial for device applications and material integration point of view.

References

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Figures

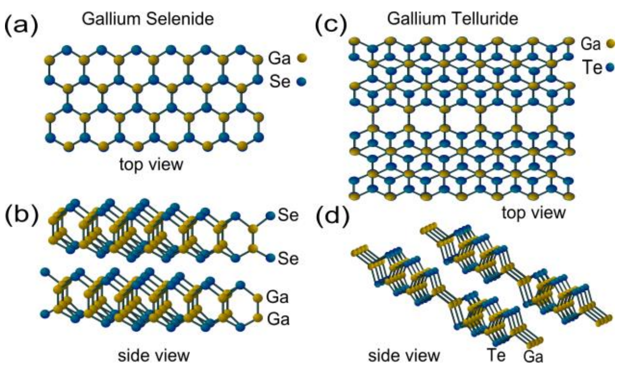

Figure 1: The top and side views of the hexagonal GaSe (a), (b) and monoclinic GaTe (c), (d) structural models [3].

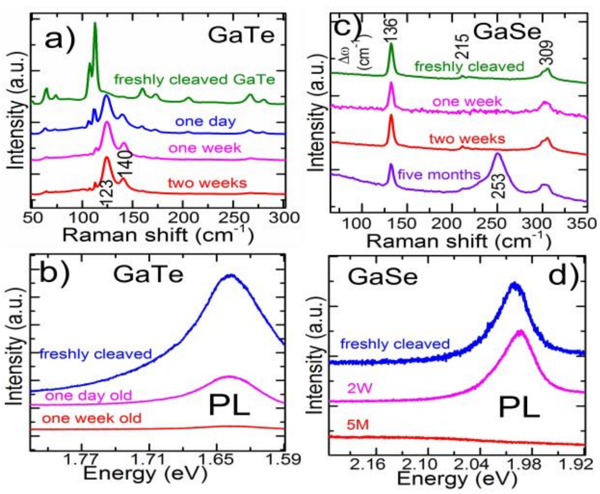

Figure 2: Raman spectrum and photoluminescence (PL) of freshly cleaved GaTe (a-b) and GaSe (c-d) are plotted as a function of oxidation time [3].