# Lattice stability and elastic evolution of CdTe membranes fabrication using a III-V heterostructures as a substrate

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## Supplemental material

In the supplemental material, we would like to provide some additional information towards samples and sample characterization.

**Additional X-ray and Raman diffraction measurements (CdTe on the (rigid) GaAs (001) substrate)**

Figure S1 shows the X-ray diffraction and Raman measurements considering the growth of CdTe (001) on the (rigid) GaAs (001) substrate. Figure S1(a) shows the data of rocking curve around the (004) reflection of CdTe identified in Figure 1(a) of the manuscript with 50, 200, and 500 nm thicknesses. The defect density reduces as a function of layer thickness as can be seen by the reduction of the rocking curve FWHM shown in Figure S1(b) as expected [https://doi.org/10.1016/0022-0248(90)91042-O]. The Figure S1(c) and (d) correspond to the spectra using the backscattering geometry given by $\mathrm{Z(X,X)\bar{Z}}$ (parallel polarization) and $\mathrm{Z(X,Y)\bar{Z}}$ (crossed polarization) for CdTe (001) thin films with 200 and 500 nm thicknesses growth on the (rigid) GaAs (001) substrate, respectively. The Raman measurement process was fully explained in the experimental part of the manuscript. The behavior observed in the Figure S1(c) and (d) is analogous to that observed for the 50 nm of CdTe thin film sample described in the manuscript (Figure 1(d)). The TO and LO phonon signal of GaAs around 269 $cm^{-1}$ and 290 $cm^{-1}$ is no longer observed in these thicker samples due to the low optical penetration depth using 514.5 nm. The optical penetration depth, e.g., using 532 nm excitation wavelength is approximately 60 nm in CdTe[1]. In this case, the alignment to measure the polarized Raman spectra was performed according to the maximum and minimum signal of the CdTe phonon considering the parallel and crossed polarization configuration, respectively.

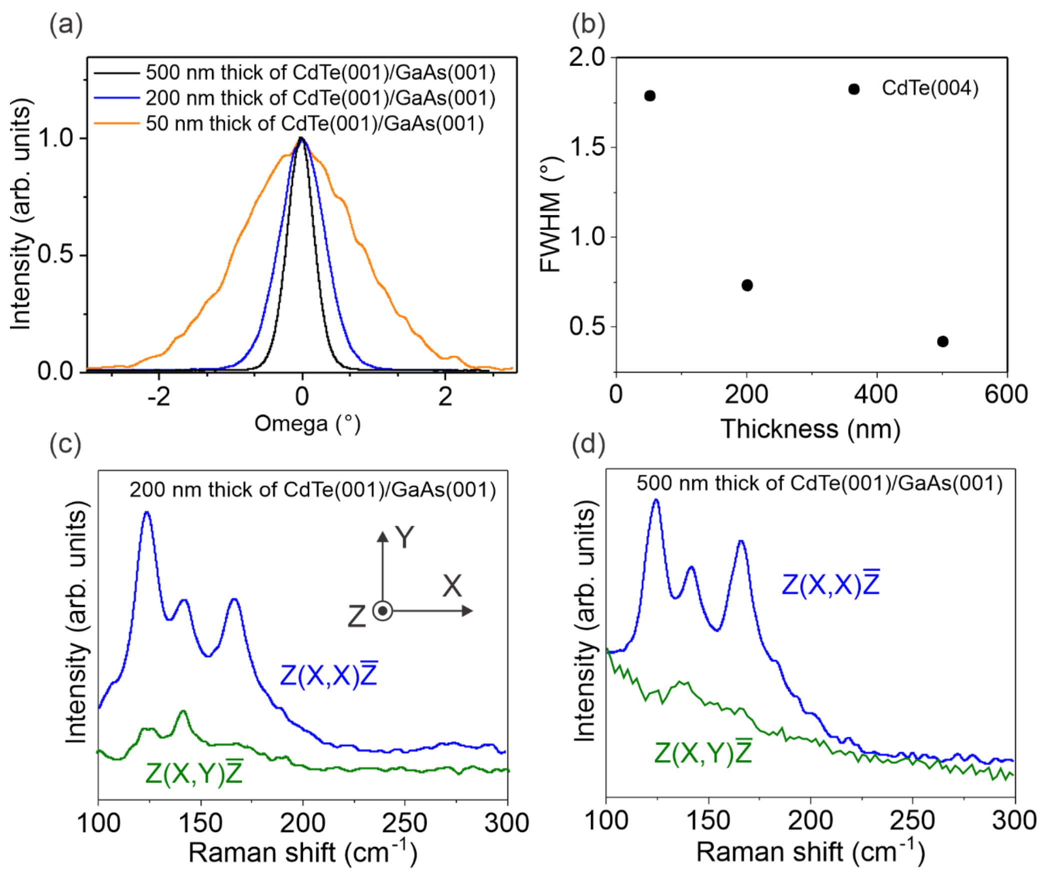


**Figure S1.** (a) and (b) show the rocking curve from (004) reflection of CdTe films grown with thicknesses of 50 nm, 200 nm and 500 nm on the (rigid) GaAs (001) substrate using high resolution X-ray diffraction results. Parallel polarization ($Z(X,X)\bar{Z}$) and crossed polarization ($Z(X,Y)\bar{Z}$) for CdTe (001) thin films with (c) 200 and (d) 500 nm thicknesses.

**Additional X-ray and Raman diffraction measurements (CdTe(111) on the (rigid) GaAs (001) substrate)**

The Figure S2(a) shows the HRXRD results of the CdTe (111) reflection around 23°, while the Figure S2(b) shows the circular symmetry expected for a typical (111) surface.

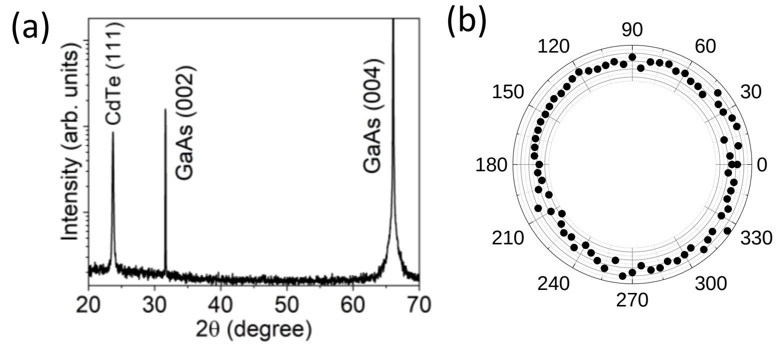


**Figure S2.** (a) High resolution x-ray diffraction and (b) polar plots of CdTe experimental Raman data measured in parallel polarizations for the CdTe(111) films grown with thicknesses of 150 nm.

**Additional atomic force microscopy images for CdTe on the (rigid) GaAs (001) substrate**

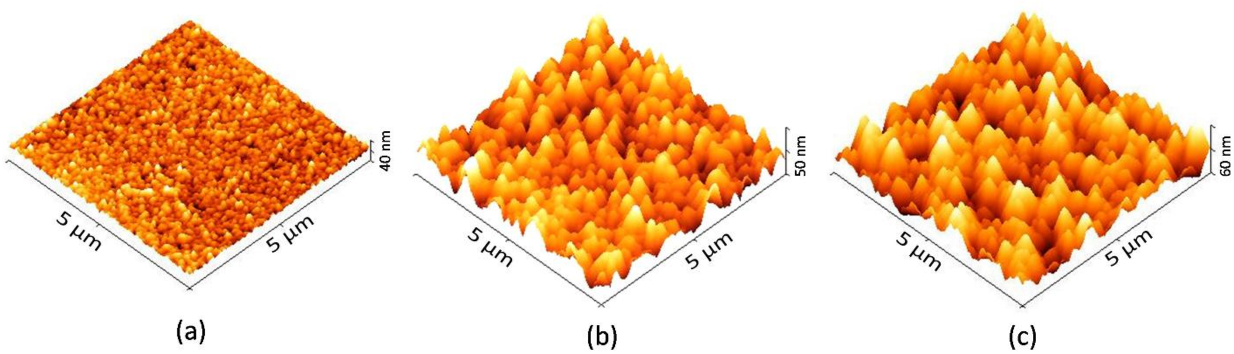


**Figure S3.** Additional AFM measurements in CdTe (001) thin films grown on (rigid) GaAs (001). Film thickness ranges from (a) 50 nm, (b) 200 nm and (c) 500 nm.

**Additional atomic force microscopy images of transferred CdTe membrane**

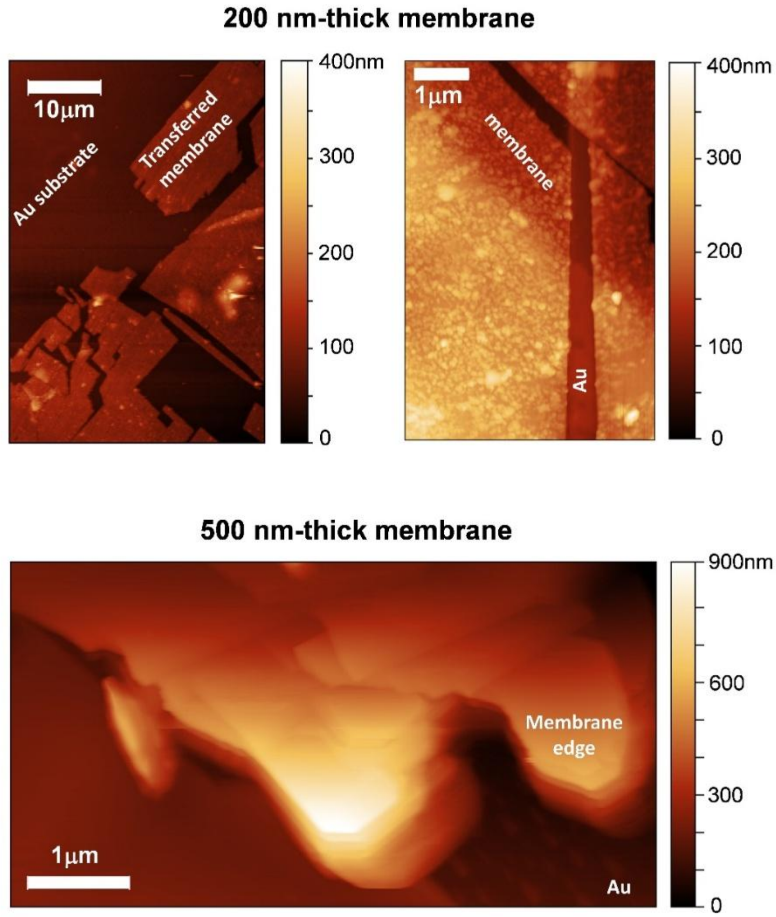


**Figure S4.** Additional AFM images of transferred CdTe membrane on Au substrate. Upper panel corresponds to 200 nm thick-membrane and lower panel corresponds to 500 nm-thick membrane.

## Geometric Phase Analysis (GPA) results using a high-resolution TEM image

Geometric Phase Analysis (GPA) of a High-Resolution TEM image is provided in Figure S5. Using two distinct orientations (marked with white circles) of the Fourier Transform (FFT) of the leftmost panel in this figure, the process provides a phase map and allows the visualization of extended defects. Defects are shown as linear features along the diagonal direction at the rightmost panels (dotted lines are drawn as a guide to the eyes). The color fluctuation at the rightmost panels also points out that locally strained areas are retrieved within the CdTe thin film. Although GPA shows that both extended defects and strained areas contribute to the overall CdTe layer strain, leading to the observed wrinkling/buckling, the inherent poor statistics from TEM analysis cannot be used to provide a quantitative match to the global scenario analyzed using the combination of techniques developed inside the manuscript main text. This result is shown here as an indication of the coexistence of defects and elastic strain in the CdTe layer.

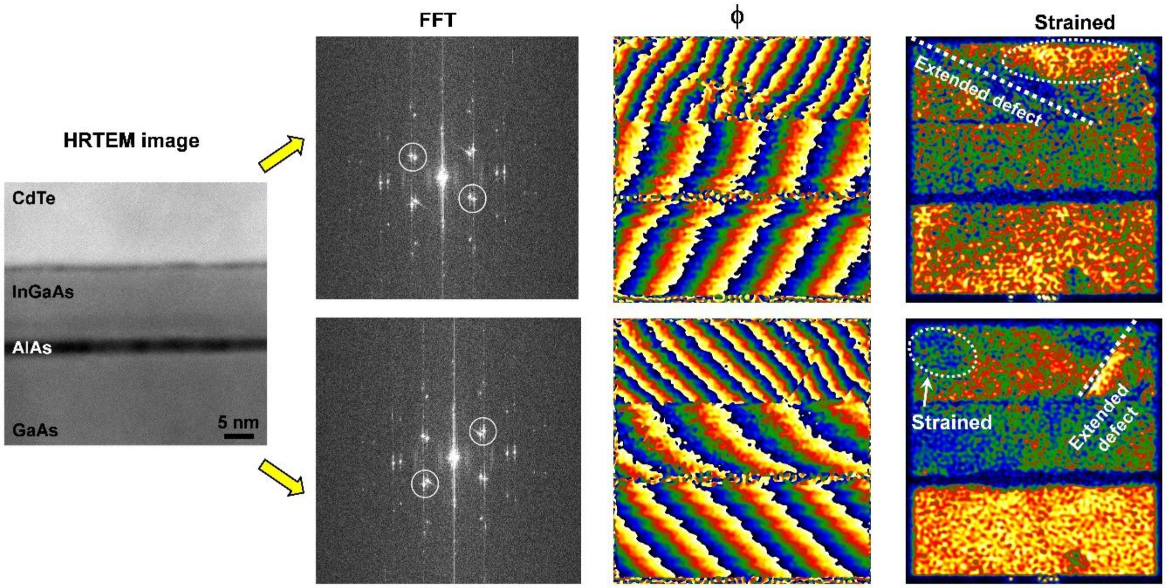


**Figure S5.** Geometric Phase Analysis (GPA) results using a high-resolution TEM image at the vicinity of the CdTe/InGaAs interface for an unreleased CdTe nanomembrane. From the leftmost image we have selected distinct spots at the FFT, allowing the observation of changes in phase and consequent inference of the occurrence of extended defects and strained regions within the CdTe film.

## References

1 Sohal, S. Edirisooriya, M. Myers, T. and Holtz, M. *Journal of Vacuum Science & Technology B*,2018, **36**, 052905-1.