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HgCdTe/Te Intergrowths and Precipitates in HgCdTe alloys grown by Molecular Beam Epitaxy

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$Hg_{1-X}Cd_XTe$ is an important material for infrared (IR) detectors especially because of its variable bandgap, depending on Hg composition, which provides an unprecedented degree of freedom in IR detector design. However, high densities of defects are the largest drawbacks in utilization of HgCdTe for IR focal plane arrays (FPAs). [1] The common surface void defects observed in HgCdTe alloys grown by molecular beam epitaxy, have been investigated using scanning and transmission electron microscopy. These surface craters, which are attributed to Hg-deficient growth conditions, originate mostly within the HgCdTe epilayer, not at the CdZnTe substrate, and they are associated with the local development of polycrystalline morphology. High resolution observations established the occurrence of finely-spaced HgCdTe/Te intergrowths with semi-coherent and incoherent grain boundaries, as well as small HgCdTe inclusions embedded within Te grains (Figs.1 (a) and (b)). [2]

Precipitates, which are known to have detrimental effects on IR detector performance, [3] are also major defects in HgCdTe alloys. They are believed to be Te-rich because a eutectic reaction is present in both HgTe and CdTe binary phase diagrams in the Te-rich region, and precipitates in bulk materials were identified as Te. [3] The size of the precipitates in MBE-grown HgCdTe is typically less than 40nm while the precipitates in the bulk are of the order of 0.1μm or more. [4] Transmission electron microscopy as well as small probe microanalysis has been used to investigate the microstructure and chemistry of precipitates in MBE-grown HgCdTe. Fig.2 (a) is a conventional electron micrograph, and (b) is a high-resolution electron micrograph showing the microstructure of a {111} precipitate. The typical size of the precipitates was 10 to 20nm in length and 2 to 3 monolayers in thickness. It is clearly seen that the precipitate does not nucleate at defects such as dislocations. Also they are accompanied by a surrounding compressive stress field, presumably introduced by the lattice mismatch between the precipitate and the matrix. Occurrence of precipitation within HgTe layers of HgTe/HgCdTe superlattices has been observed on the atomic scale after 30 minutes' annealing at 225^{o}C, as shown in Fig. 3 (b). Here, compressive stress field is again present around the precipitate. Small-probe microanalysis is being used to identify the nature of the precipitates.[5]

References

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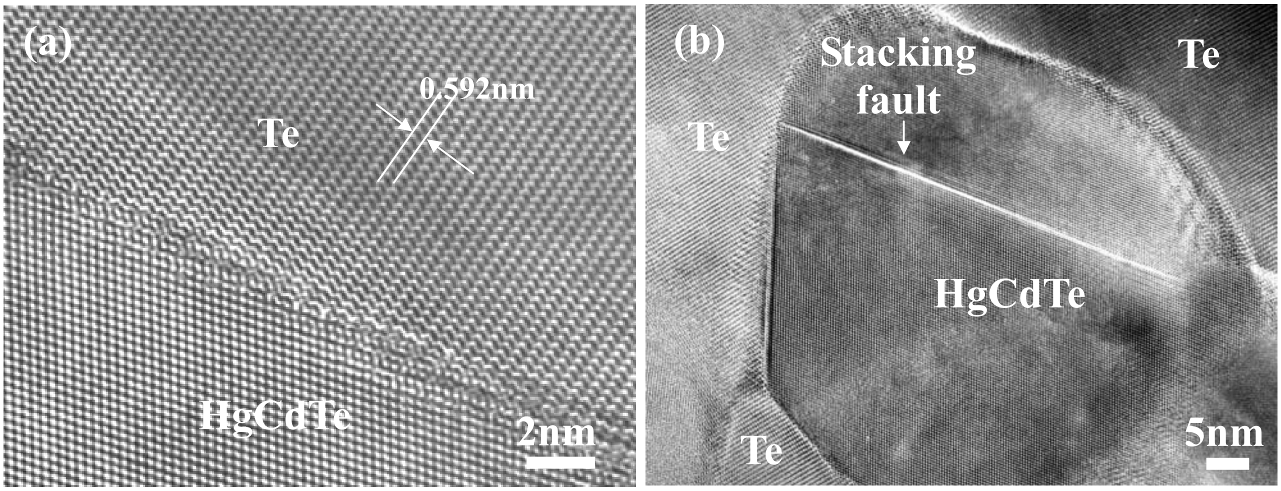

Fig. 1. (a) High-resolution lattice image showing inclined boundary between underlying, single crystal HgCdTe and edge of Te crystal; (b) polycrystalline region showing incoherent HgCdTe grain surrounded by elemental Te.

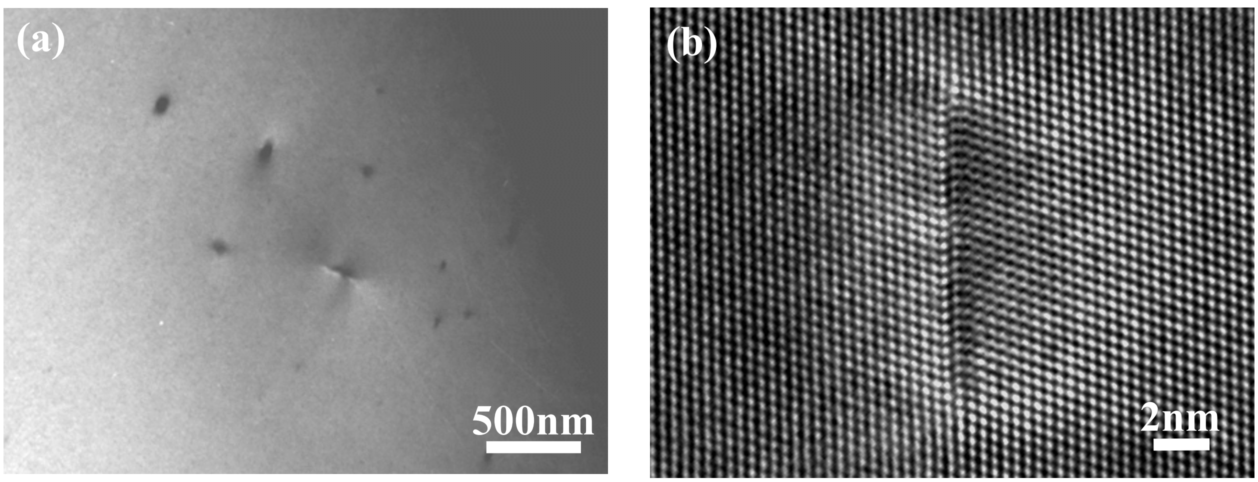

Fig. 2. (a) conventional electron micrograph showing the presence of precipitates in MBE grown HgCdTe; and (b) high resolution electron micrograph showing the microstructure of precipitates and surrounding stress field.

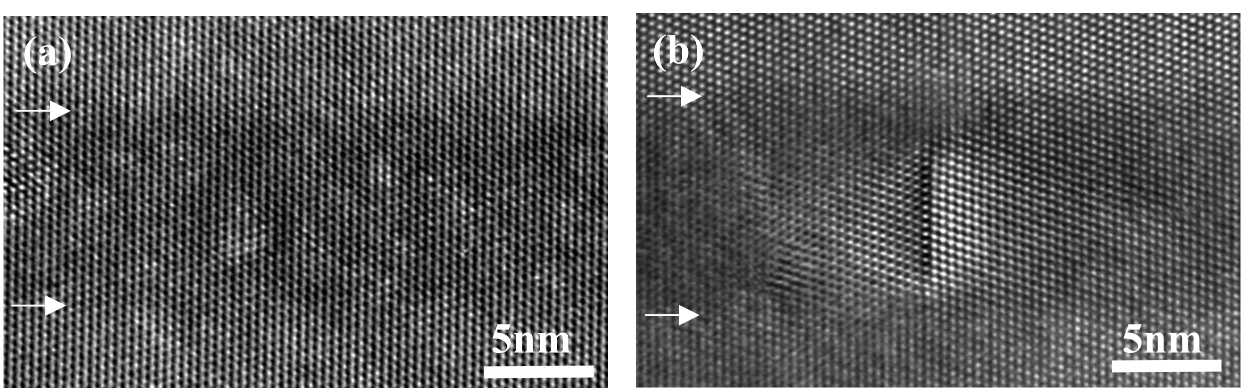

Fig. 3. High resolution electron micrographs showing; (a) as-grown HgTe/HgCdTe superlattices (SLs); and (b) annealed at 225^{o}C/30 minutes. Arrows indicate interface position.

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