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Material quality characterization of CdZnTe substrates for HgCdTe epitaxy

G.A. Carini[1,2], A.E. Bolotnikov[1], G.S. Camarda[1], R.B. James[1], R. De Wames[3], J. K. Markunas[4], J.H. Dinan[4], J. Zhao[5], S. Sivananthan[5], C. Arnone[2]

[1]Brookhaven National Laboratory, Upton, NY 11973 USA
[2]Department of Electrical Engineering, University of Palermo, 90128 Palermo, Italy
[3]Electro-Optics Center, Penn State University, Freeport, PA 16629 USA
[4]US Army RDECOM CERDEC NVESD, Ft. Belvoir, VA 22060, USA
[5]Microphysics Laboratory, University of Illinois at Chicago, Chicago, IL 60607, USA

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Brookhaven National Laboratory
P.O. Box 5000
Upton, NY 11973-5000
www.bnl.gov

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[3] Electro-Optics Center, Penn State University, Freeport, PA 16629, USA
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CdZnTe (CZT) has been traditionally used as substrate for HgCdTe (MCT) epitaxy. The constraint of good lattice matching plays a fundamental role in the use of this substrate. In fact, despite the difficulties in growing large area of affordable high-quality substrates, CZT wafers remain the best choice for high yield infrared devices. Nevertheless, material quality of the substrate and epilayer play a limiting role in IR focal plane array (FPA) detector technology. Furthermore, data suggest that the quality of the epilayer is affected by imperfections in the CZT substrate. In addition the pixel size for the current generation of FPAs (less than 20μm) suggests a need for detailed microscale characterization and an understanding of the substrates and epilayers on at least the spatial scale of the pixel dimensions.

In an effort to understand the correlation between material quality and device performances, we have begun to study CZT substrates to investigate bulk and surface properties. The National Synchrotron Light Source (NSLS, BNL) permits a wide variety of material investigations that take advantage of the highly collimated photon radiation emitted from the X-ray and VUV-IR rings. Synchrotron radiation offers the capability to

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Gabriella Carini, BNL, Bldg. 197D, Upton, NY, 11973; phone: 6313443004, fax: 6313443374; email: carini@bnl.gov.

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combine good resolution and shorter exposure times than conventional X-ray sources, which allow the ability for high-resolution mapping of relatively large areas in an acceptable amount of time.

Transmission X-ray diffraction techniques, such as white beam topography and rocking curves, have already been used for bulk investigation [1] as well as IR transmission microspectroscopy. Surface studies on CZT substrates were performed using X-ray diffraction. By correlating results from the different material and device investigations, we offer a more complete characterization of bulk and surface crystalline quality and their effects on device performance. Information on the location of grain boundaries and precipitates, evaluation of impurity content, and stoichiometry variations will be reported. The ultimate goal is to understand the defects in CZT substrates and their effects on the performance and uniformity of MCT epilayers [2], and then to apply this understanding to produce better infrared detectors.

References.

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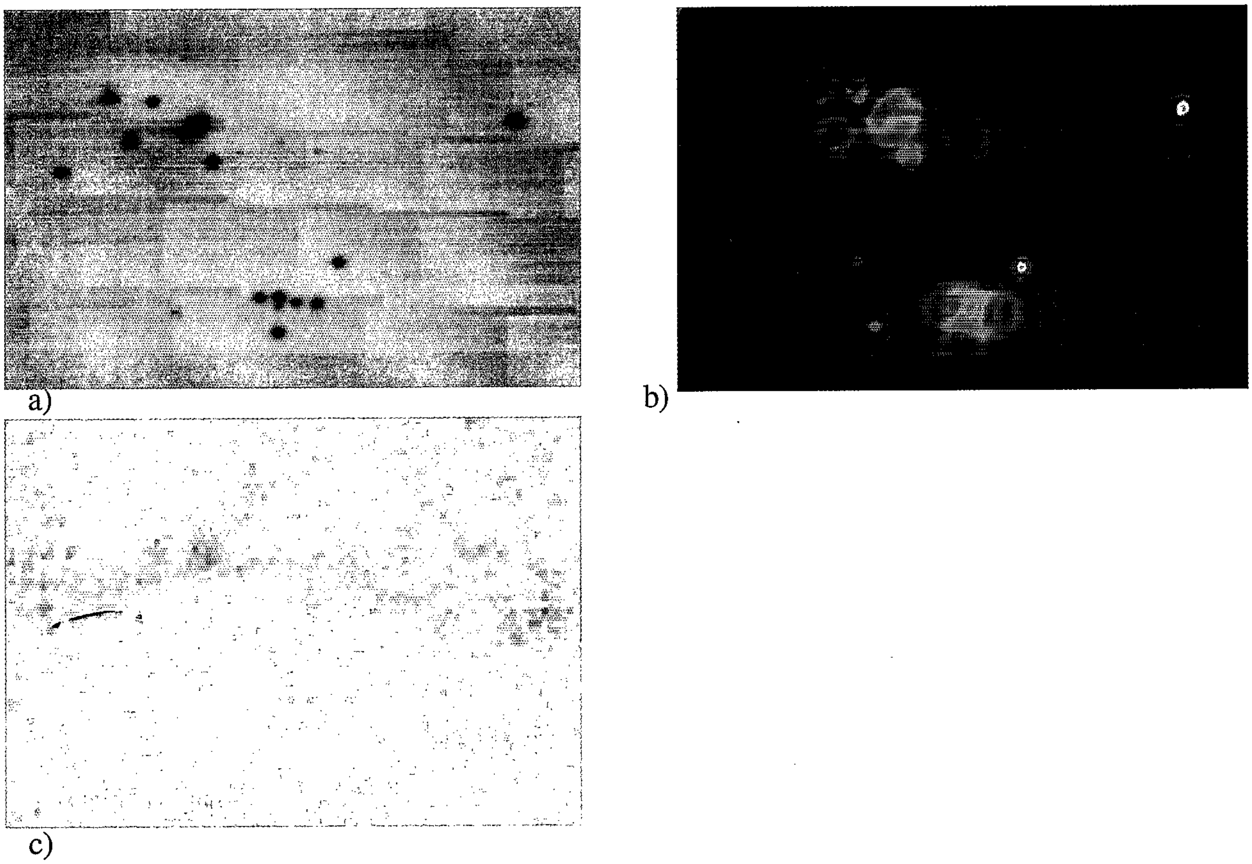
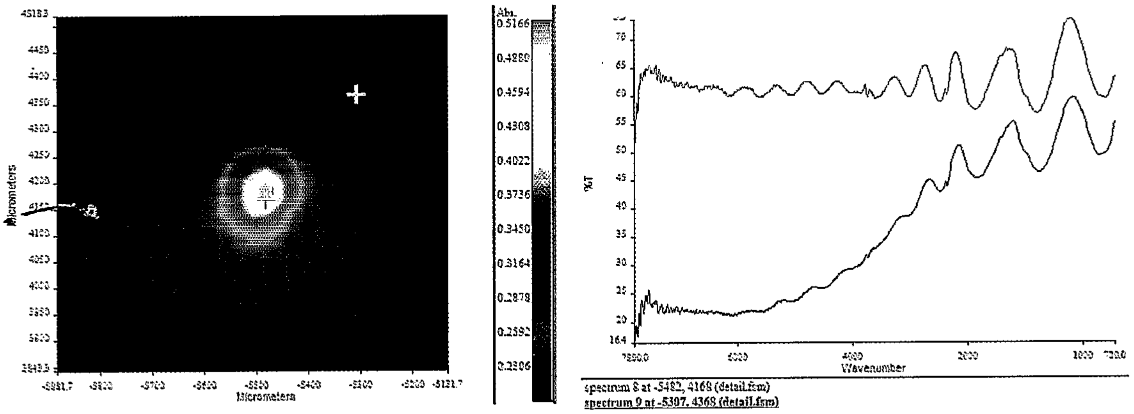


a)

b)

c)

Fig.1. a) NIR-Transmission map; b) FT-IR microspectroscopy absorption map (scan performed with 25 µm resolution and with energy ranges between 7800 cm-1 and 720 cm-1); c) White beam diffraction topography detail.



a)

b)

Fig.2. a) FT-IR absorption map detail of Te-inclusion; b) Transmission spectra at the cross locations.