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# Selective CdTe Nanoheteroepitaxial Growth on Si(100) Substrates Using the Close-Spaced Sublimation Technique Without the Use of a Mask

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The development of HgCdTe detectors requires high sensitivity, small pixel size, low defect density, long-term thermal-cycling reliability, and large-area substrates. CdTe bulk substrates were initially used for epitaxial growth of HgCdTe films. However, CdTe has a lattice mismatch with long-wavelength infrared (LWIR) and middle-wavelength infrared (MWIR) HgCdTe that results in detrimental dislocation densities above mid-$10^6$ $cm^{-2}$. This work explores the use of CdTe/Si as a possible substrate for HgCdTe detectors. Although there is a 19% lattice mismatch between CdTe and Si, the nanoheteroepitaxy (NHE) technique makes it possible to grow CdTe on Si substrates with fewer defects at the CdTe/Si interface. In this work, Si(100) was patterned using photolithography and dry etching to create 500-nm to 1-$\mu$m pillars. CdTe was selectively deposited on the pillar surfaces using the close-spaced sublimation (CSS) technique. Scanning electron microscopy (SEM) was used to characterize the CdTe selective growth and grain morphology, and transmission electron microscopy (TEM) was used to analyze the structure and quality of the grains. CdTe selectivity was achieved for most of the substrate and source temperatures used in this study. The ability to selectively deposit CdTe on patterned Si(100) substrates without the use of a mask or seed layer has not been observed before using the CSS technique. The results from this study confirm that CSS has the potential to be an effective and low-cost technique for selective nanoheteroepitaxial growth of CdTe films on Si(100) substrates for infrared detector applications.

**Key words:** Selective growth, CdTe, infrared detectors, CSS, SEM, FIB, TEM

## INTRODUCTION

Epitaxial growth of CdTe thin films on various substrates has been explored for the purpose of using it as a suitable substrate for the fabrication of mercury cadmium telluride (HgCdTe) thin films. HgCdTe is a semiconductor material used in the fabrication of infrared (IR) detectors and focal-plane arrays (FPAs). HgCdTe films have been grown on high-quality CdTe films that have been deposited on silicon (Si) substrates using liquid-phase epitaxy (LPE),[1–3] molecular-beam epitaxy (MBE),[1,2,4–9] metalorganic vapor-phase epitaxy (MOVPE),[10–12] and hot-well epitaxy (HWE)[13] methods. However, these techniques are expensive, complex to use, and associated with slow growth rates. For this reason, special interest has been given to the close-spaced sublimation (CSS) technique, since it has been proven to produce high-quality CdTe films,[14,15] is associated with high growth rates ($>1$ $\mu$m/h), and is inexpensive compared with the techniques mentioned above. The CSS technique is a common method used in the fabrication of polycrystalline

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