Study of pit formation in MBE grown GaP on misoriented Si wafers

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Heteroepitaxial growth of III-V materials such as GaAs, InGaP, GaAsP on Si have been a subject of keen interest for years due to its potential for high performance optoelectronic devices on low cost substrates. However, the inherent difference in lattice constants between these compounds and silicon lead to the formation of large number of crystalline defects [1]. Additionally, the growth of polar films on non-polar substrates gives rise to the formation of antiphase domains at the interface that propagate throughout the film [2]. Some of these defects can be suppressed by the growth of a GaP buffer layer before growing the target structure, making GaP a key part of III-V integration with silicon [3]. The surface quality of GaP films will determine the quality of subsequent III-V layers grown and impact the electrical properties of these material systems.

In this work, the focus is on the investigation of surface pit formation in epitaxially grown GaP on different misoriented Si wafers using MBE. The epitaxial GaP layers were grown on Si substrates of precise (001), 4° offcut in (110) and 6° offcut in (110) orientations by a combination of Migration Enhanced Epitaxy (MEE) and MBE methodologies. The reflection high energy electron diffraction (RHEED) patterns observed (Fig. 1a) were a mixture of spots and streaks, indicating the presence of some islands in conjunction flat layers. Atomic force microscopy (AFM) imaging suggests the presence of pits on the GaP surface (Fig. 1b and 1c). These pits could be a result of melt back etching on the Si substrate caused by the Ga adatoms impinging on the substrate during growth process. Pit formation due to melt back etching will be verified by removal of grown GaP layer and characterizing the Si substrate surface by further AFM imaging. The effect of substrate orientations and the growth techniques on the pit formation along with methods to suppress them will be presented.

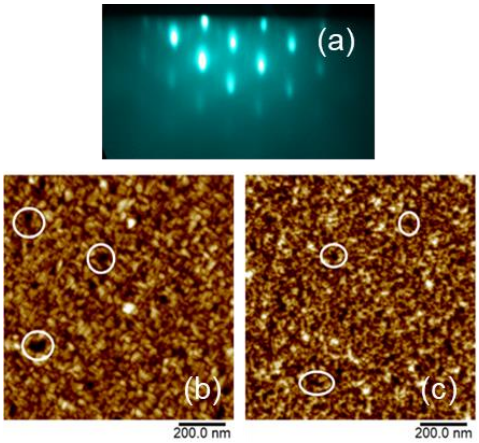

Fig 1. (a) RHEED pattern observed during the growth of GaP on Si. (b) AFM image of GaP grown by 2MLs MEE+MBE method on 4° offcut silicon wafer (c) AFM image of GaP grown by MEE method on 4° offcut silicon wafer (encircled are the pits observed)

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Supplementary Pages

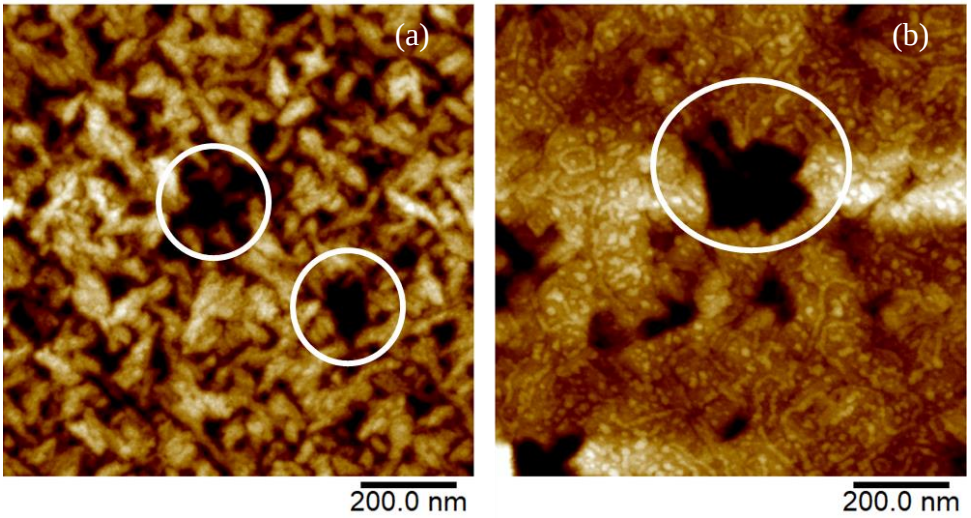

Fig 2. (a)-(b) AFM images of GaP grown on Precise (001) oriented Si wafers by MBE method (encircled are the pits observed)