GaP/Si Antiphase domains annihilation at the early stages of growth

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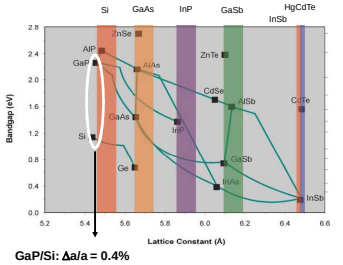
Introduction



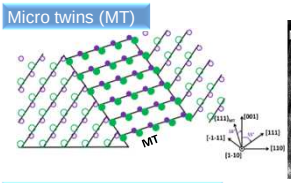
GaP/Si: Δa/a = 0.4%

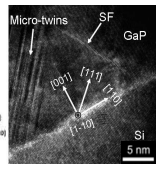
- **Pseudomorphic growth**

without misfit dislocation

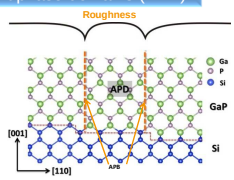
BUT defects at the interface

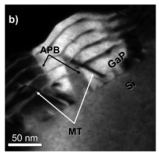
Micro twins (MT)





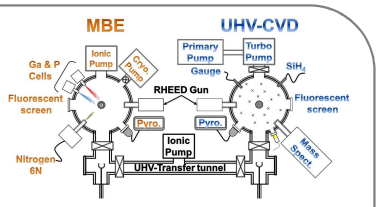
Antiphase domains (APD)



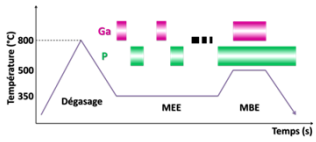


Solutions

- Clean and flat interface (free if contaminants)
- Control of the first monolayer of GaP
- Bistepped silicon surface (Si (001) 6° off)
- III / V growth conditions



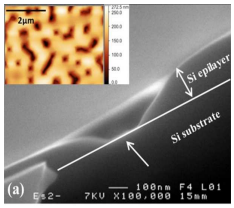
UHVCVD-MBE growth cluster for III-V-Si integration

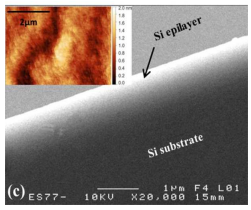


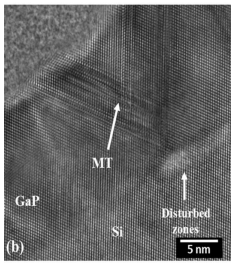
10ML of GaP (MEE) + GaP (MBE)

GaP/Si interface : MT generation, and abruptness

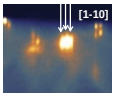
Modified RCA treatment | **UV/O_3 treatment**



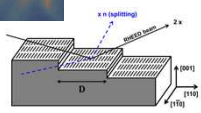




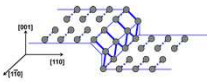
Influence of Si chemical preparation on MT generation



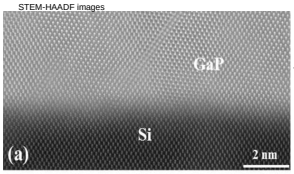
RHEED (×n) splitting



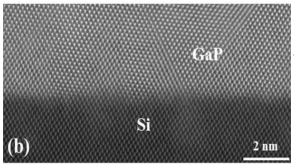
Homoepitaxy of bistepped silicon buffer on Si (001) 6° off



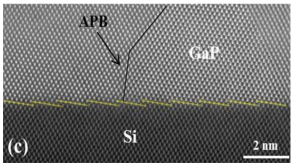
STEM-HAADF images



Modified RCA treatment
III / V on Si



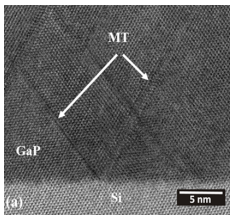
UV/O_3 treatment
III / V on Si



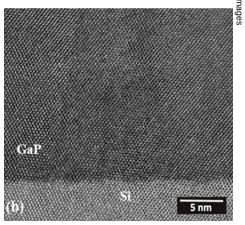
UV/O_3 treatment
III / V on Si-épi // Si

Influence of the Si chemical preparation and of the use of a bistepped Si buffer on the abruptness of the GaP/Si interface

III / V on Si without Si buffer



1 ML Ga coverage



STEM-BF images

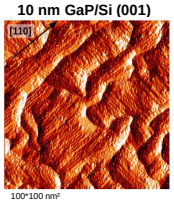
0,7 ML Ga coverage

Influence of growth conditions on MTs

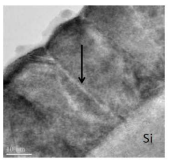
Y. Ping Wang et al., Appl. Phys. Lett., submitted (2015).

Influence of APB propagation and V/III flux ratio

10 nm GaP/Si (001)



APD propagation across the layer

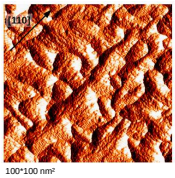


35 nm GaP/Si (001)-6°-off

Roughness induced by APDs

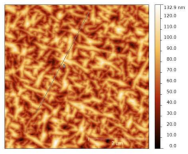
Vicinity of the Si substrate influences GaP growth

10 nm GaP/Si (001)-6°-off

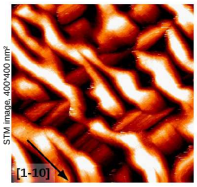


STM-BEEM images

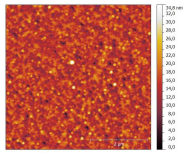
GaP (200 nm)/Si (6° off)



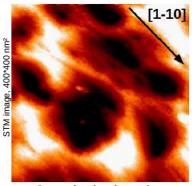
V/III = 5.5



Two types of antiphase domains : one domain is covered by the other

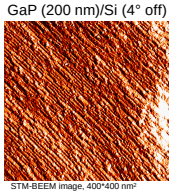


V/III = 11



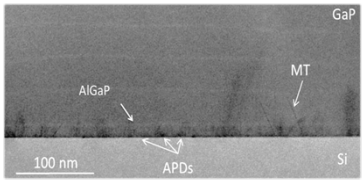
One single domain

GaP (200 nm)/Si (4° off)



STM-BEEM image, 400*400 nm²

Early annihilation of antiphase domains



High V/III flux ratio seems to favor the annihilation of APD. Obtention of monodomains of GaP.

Conclusions & Perspectives

- MTs and abruptness of GaP/Si interface : sensitive to chemical preparation and improved by the use of a bistepped Si buffer . BUT antiphase boundaries are still observable.
- High V/III flux ratio tends to favor APD annihilation at the early stages of growth.

Perspectives : Detailed study of the influence of the growth parameters is required to understand these observations (ANR Antipode).

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