Process Control

GaAs-GaAlAs optoelectronic devices

Dry etching is a powerful process step widely used to manufacture structures of high complexity (stack of thin layers), like optoelectronic or microelectronic compounds. Those heterostructures can now be produced with an high uniformity, low surface damage and controllable selectivity.

An important advantage of dry etching process, is that plasma diagnostic techniques like Optical Emission Spectroscopy (OES) and Laser Interferometry can be easily used to give etch rate determination, identify heterointerfaces and make endpoint detection.

What Process ?

- ✓ Reactive Ion Etching
- ✓ Chlorine based chemistry
- ✓ GaAs layers: from 0.1 to 0.2 µm thick
- ✓ $Ga_{1-x}Al_{x}As$ layers: from 0.1 to 1.5 µm thick

  where Al composition (x) varies from 0 to 0.45
- ✓ 4 GaAs/GaAlAs Quantum Wells buried structures

What Applications ?

Stack of thin layers, like:

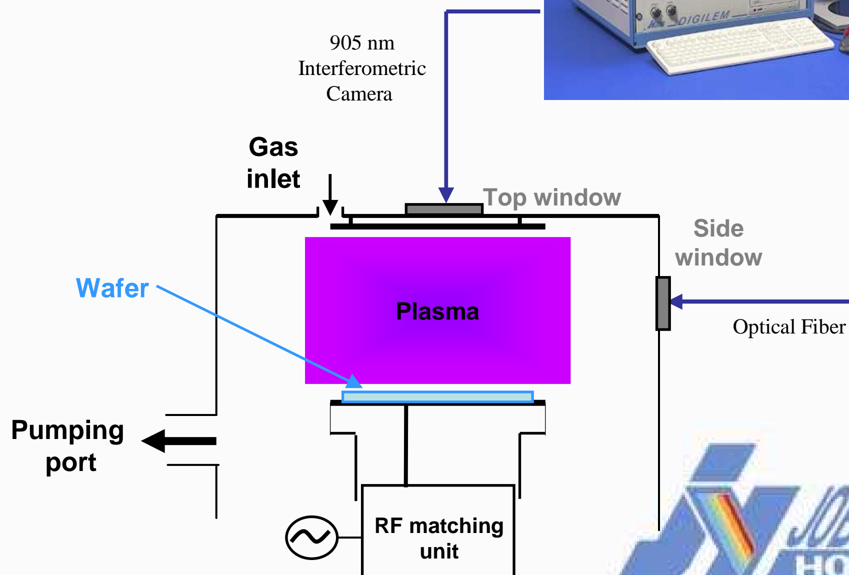
- ✓ Laser diodes
- ✓ Photodetectors
- ✓ Laser mirrors

How to control optoelectronic devices ?

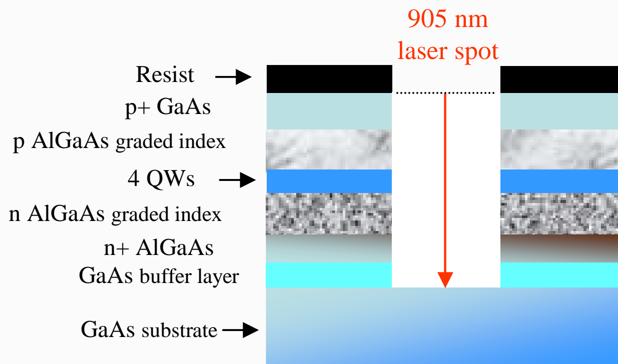
✓ Using a **Digitwin with Near Infra-Red Camera**

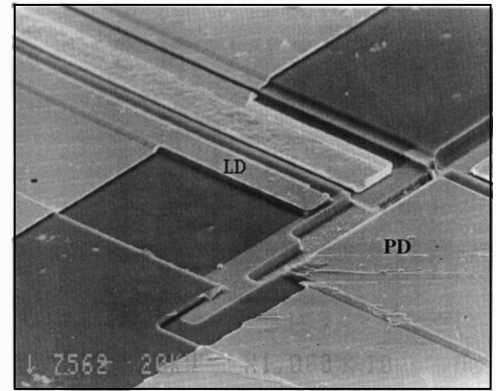
Interferometric signal is collected through the top window. 905 nm laser spot is placed on the material to etch and permits to control depth etched in real-time.

OES signal is obtained from the reactor's side window, and allows to detect heterointerfaces.



Typical wafer structures ?

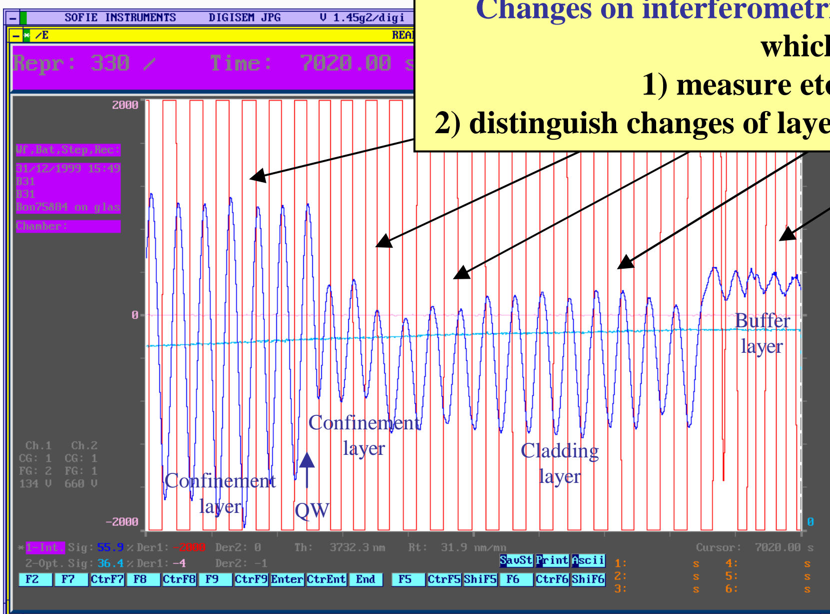




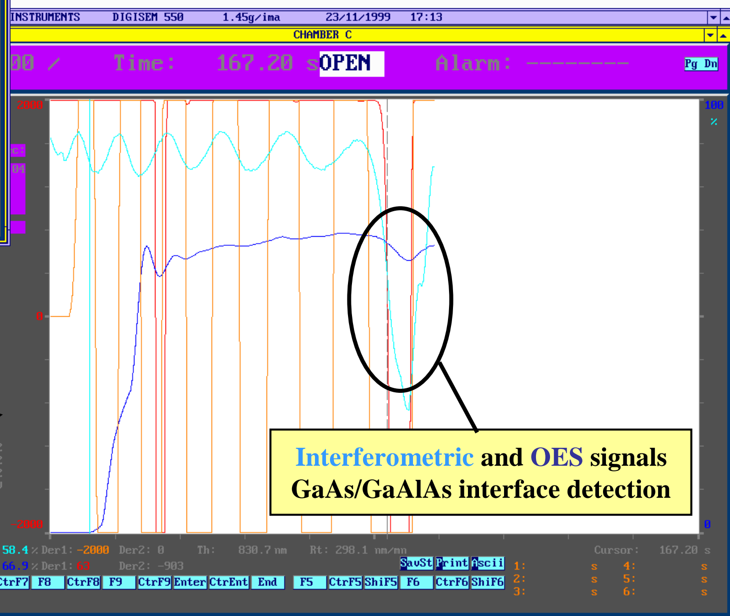
Example of wafer surface achieved
LD: Laser Diode - PD: PhotoDetector

Typical results obtained ?

Changes on interferometric signal: amplitude and period.
which allows to
1) measure etch rate in real-time
2) distinguish changes of layer composition into heterostructure



Additionnally to Laser Interferometry, changes on OES signal amplitude allows to identify interfaces between GaAs and GaAlAs



Conclusion:

Reactive Ion Etching (RIE) has been successfully combined with 905 nm Laser Interferometry (LI) and Optical Emission Spectroscopy (OES) as in-situ diagnostics for the fabrication of laser diodes & photodetectors.
Such techniques have been used to monitor the etch rate (LI), detect and identify the heterointerfaces (LI & OES), make endpoint detection on target in real-time (LI).

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