In-Situ Response During Pulsed GaP Nucleation on Silicon

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LayTec User Meeting
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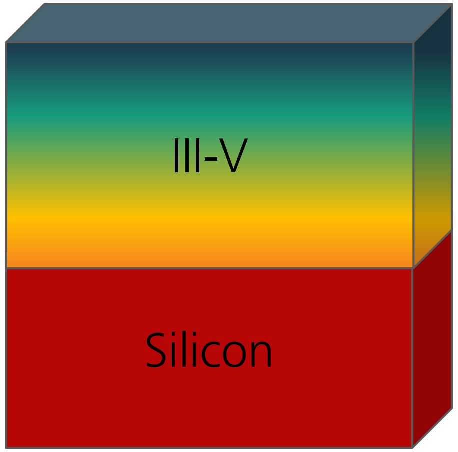
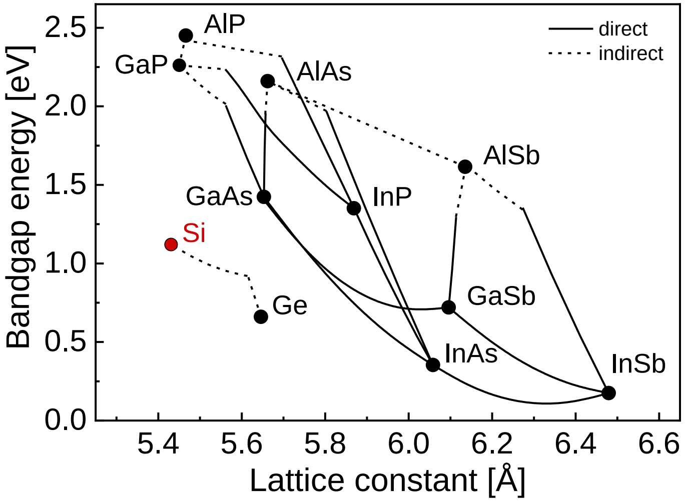
www.ise.fraunhofer.de

GaP Nucleation on Silicon

Context

- Direct deposition of III-V structures on silicon

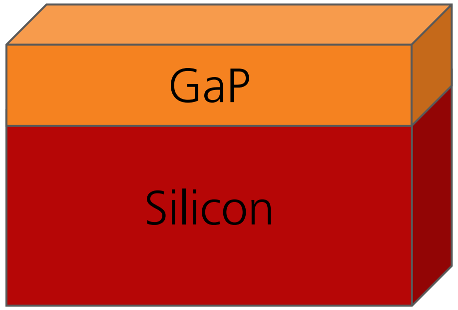


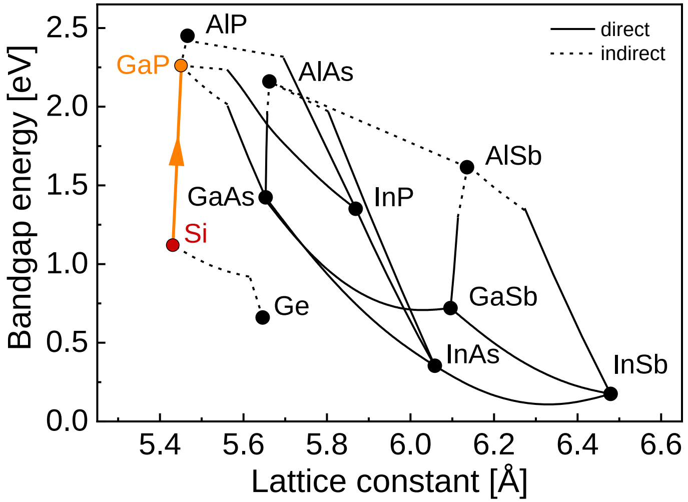


GaP Nucleation on Silicon

Context

- Direct deposition of III-V structures on silicon
- Nucleation on silicon with minimal lattice mismatch of 0.3%

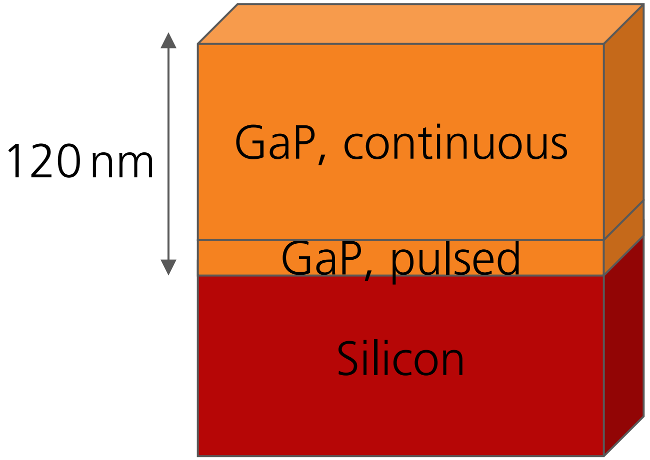


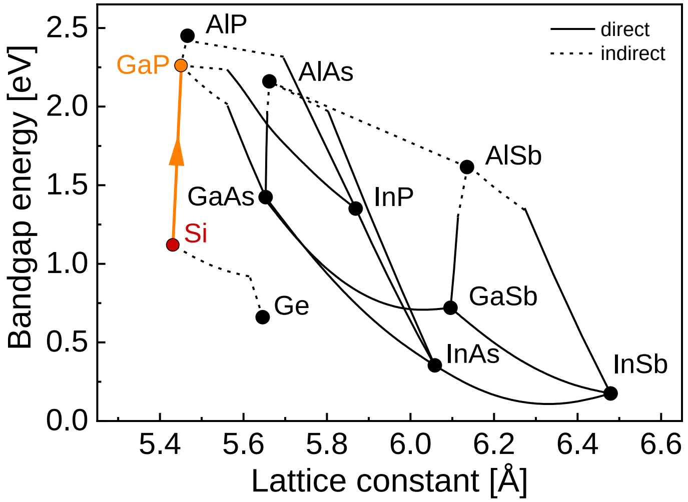


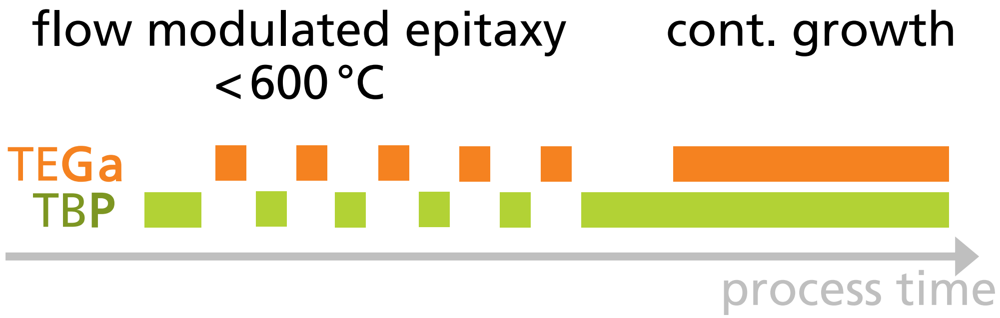
GaP Nucleation on Silicon

Context

- Direct deposition of III-V structures on silicon
- Nucleation on silicon with minimal lattice mismatch of 0.3%
- Deposition using flow modulated epitaxy







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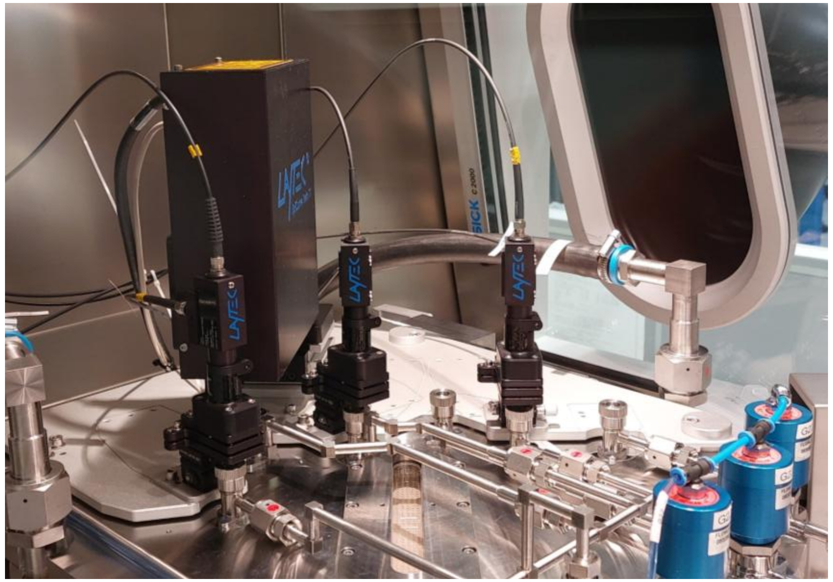
GaP Nucleation on Silicon

Setup

7x4“ Aixtron CRIUS CCS MOVPE

LayTec EpiCurve Twin TT

- EpiTT reflectance @ 405, 633, 950 nm
- AbsoluT
- EpiCurve



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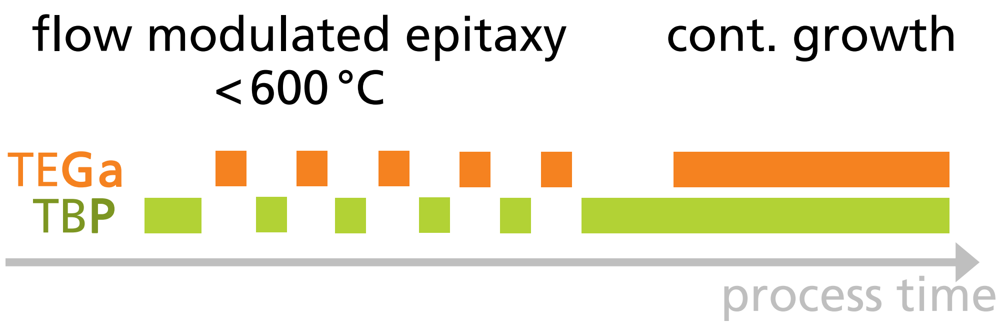
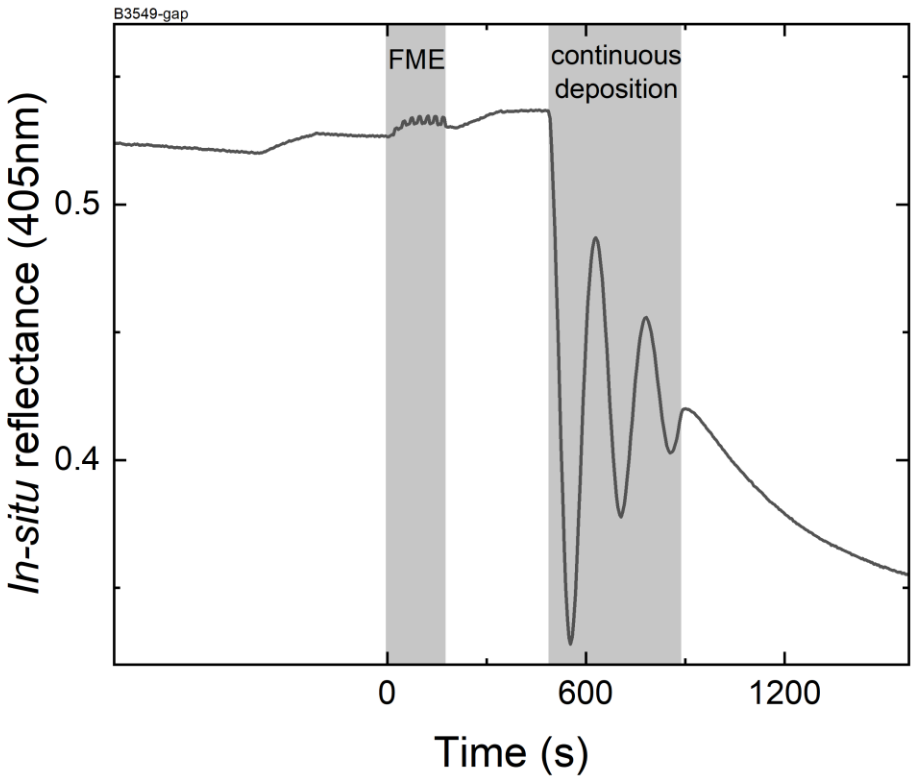
In-situ Observation of Surface Processes

Pulsed GaP Nucleation

In-situ reflectance at 405 nm during GaP nucleation

- Sensitive to surface, e.g. roughness
- Small oscillation during flow modulated epitaxy (FME)





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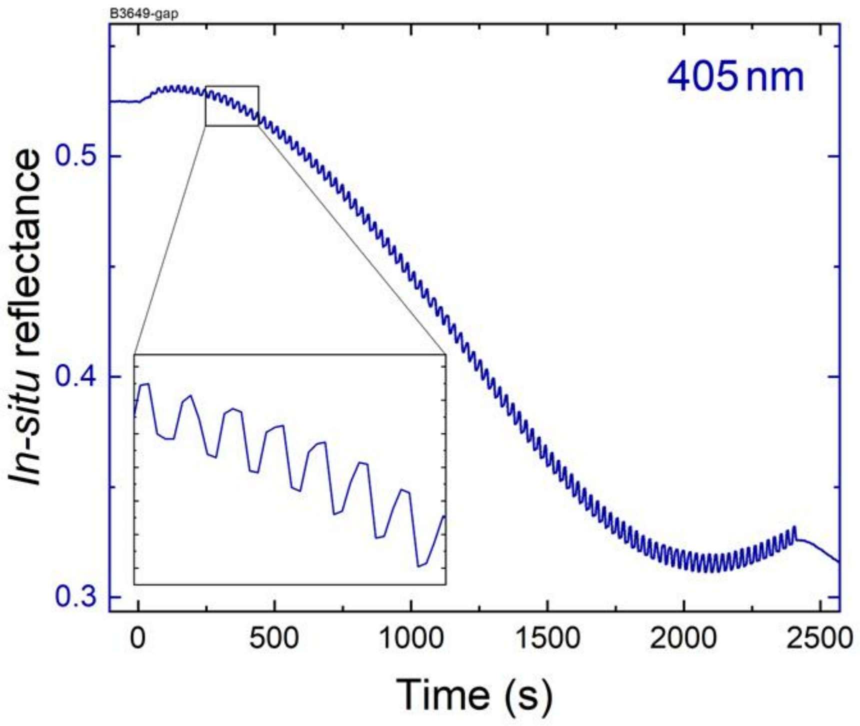
In-situ Observation of Surface Processes

Pulsed GaP Nucleation

In-situ reflectance at 405 nm during GaP nucleation

- Fabry-Pérot oscillation with additional modulation during flow modulated epitaxy (FME)

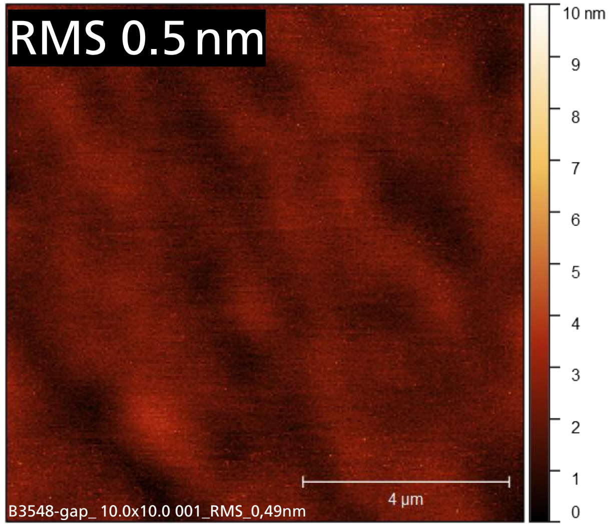


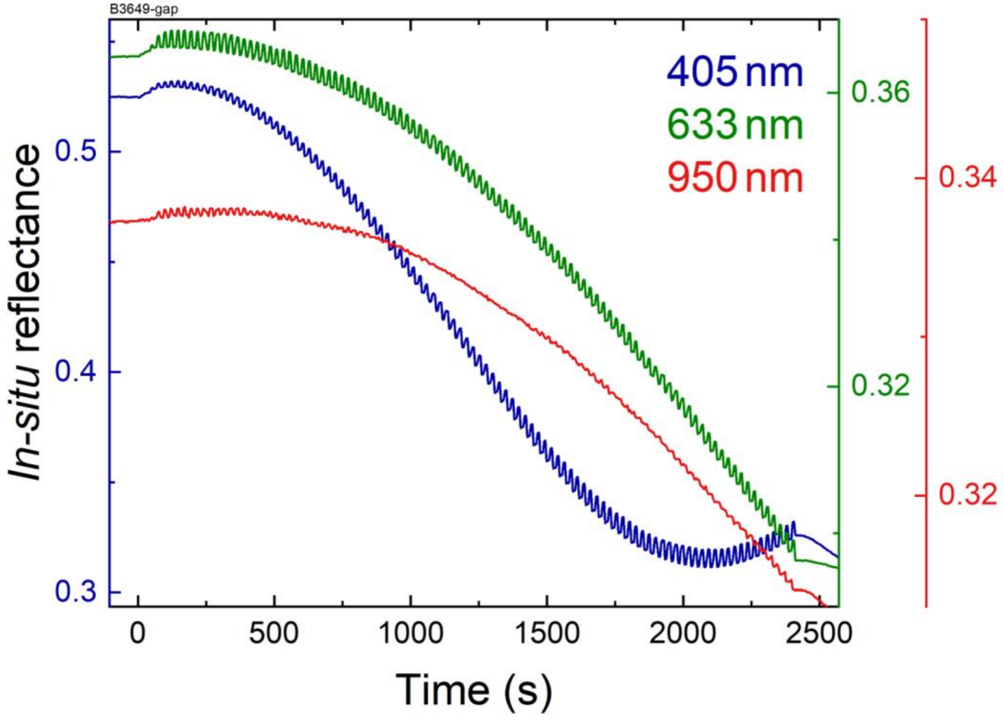
In-situ Observation of Surface Processes

Pulsed GaP Nucleation

In-situ reflectance during GaP nucleation

- Fabry-Pérot oscillation with additional modulation during flow modulated epitaxy (FME)
- No surface roughening



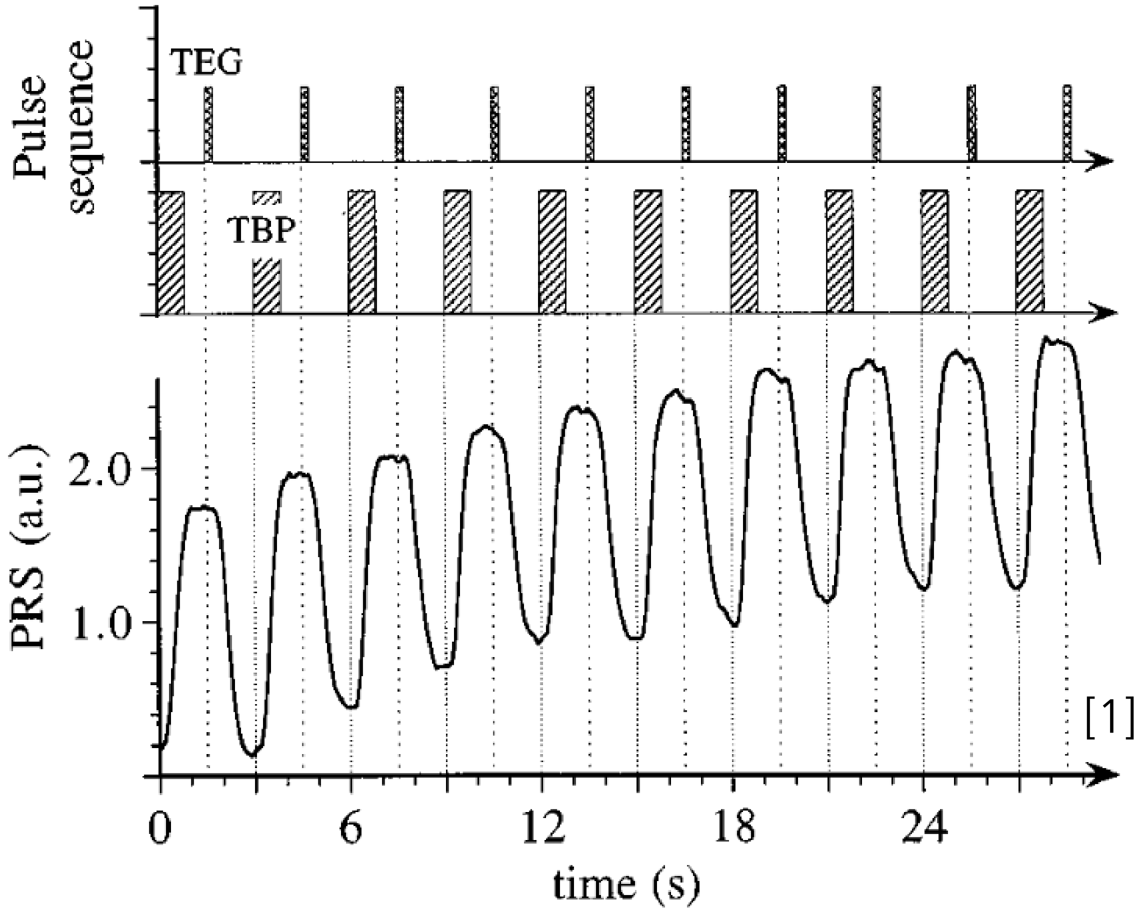


In-situ Observation of Surface Processes during Chemical Beam Epitaxy

Literature

P-polarized reflectance

- Pulsed CBE deposition of GaP on Si
- Oscillation of reflected signal due to thin film interference
- Additional modulation of reflection signal



[1] K. Bachmann *et al.*, J. Vac. Sci. Technol. B 14 (4), 1996
[2] N. Dietz *et al.*, Vacuum 47 (2), 1996

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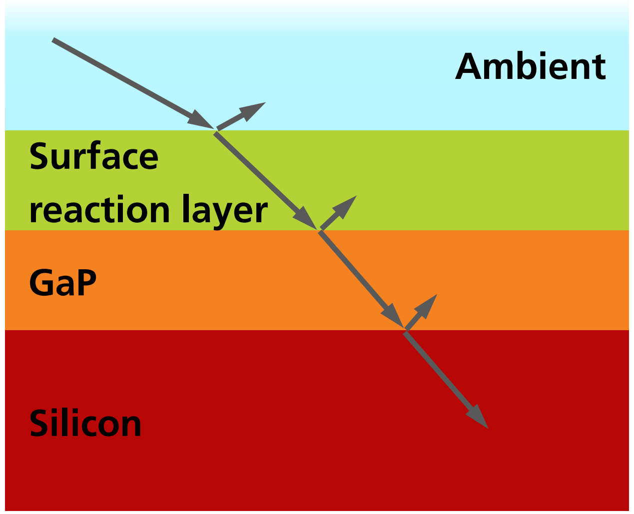
In-situ Observation of Surface Processes during Chemical Beam Epitaxy

Literature

P-polarized reflectance

- Pulsed CBE deposition of GaP on Si
- Oscillation of reflected signal due to thin film interference
- Additional modulation of reflection signal
- Model considering response of surface reaction layer

→ Potential access to surface chemistry processes



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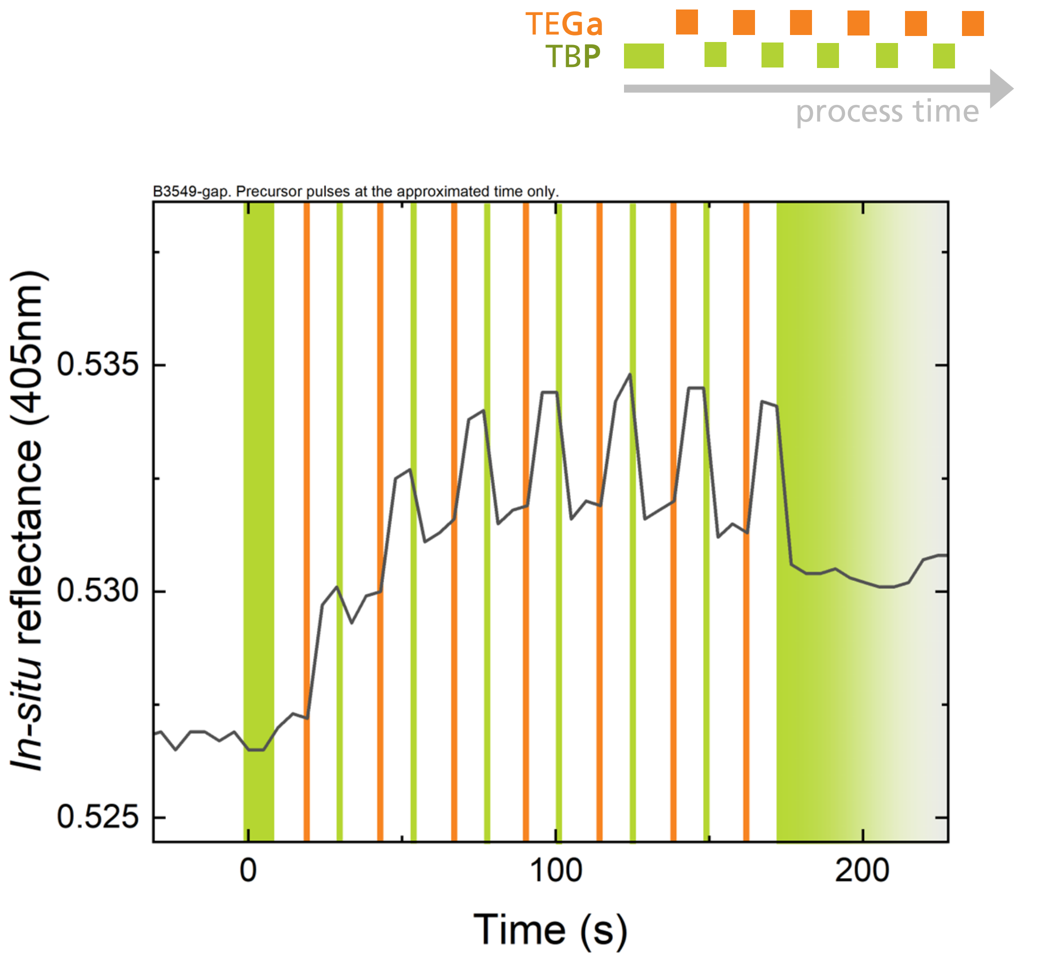
In-situ Observation of Surface Processes

Pulsed GaP Nucleation

In-situ reflectance at 405 nm during GaP nucleation

- **Increased reflectance after TEGa pulse, back to "baseline" after TBP pulse**

- Time resolution limited due to susceptor rotation



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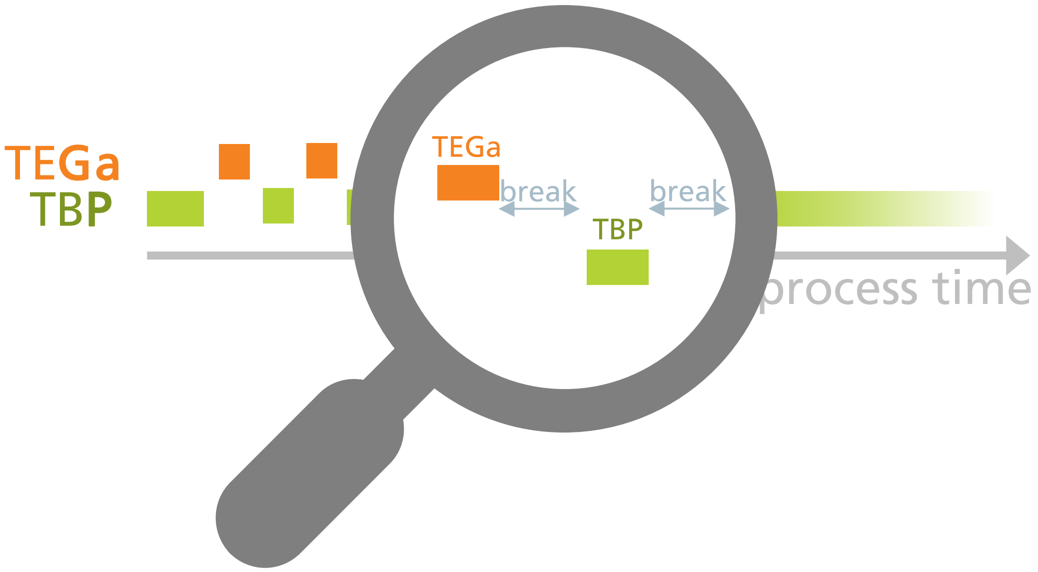
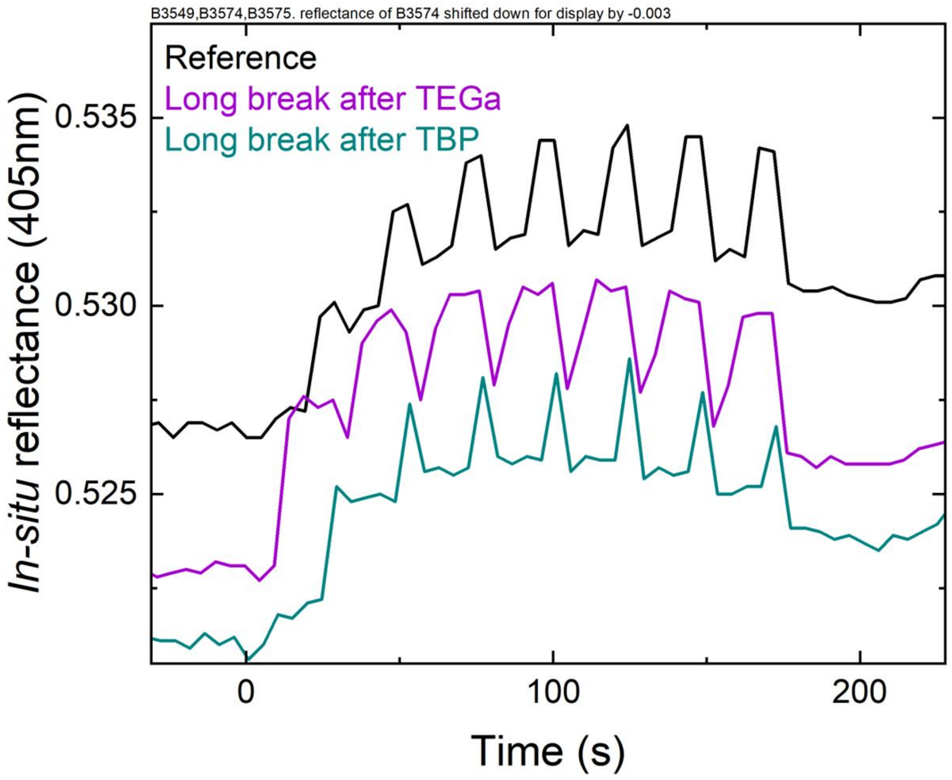
In-situ Observation of Surface Processes

Reflectance during FME

- Investigation of pulse sequence





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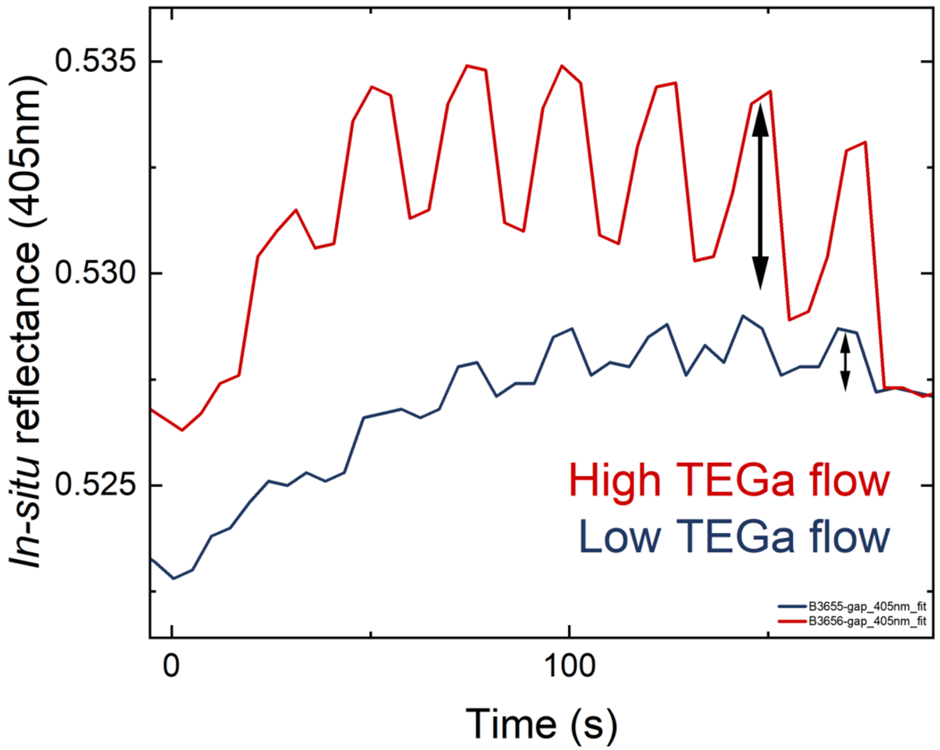
In-situ Observation of Surface Processes

Reflectance during FME

Variation of TEGa flow rate

- Signal strength determined by TEGa flow



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In-situ Observation of Surface Processes

Reflectance during FME

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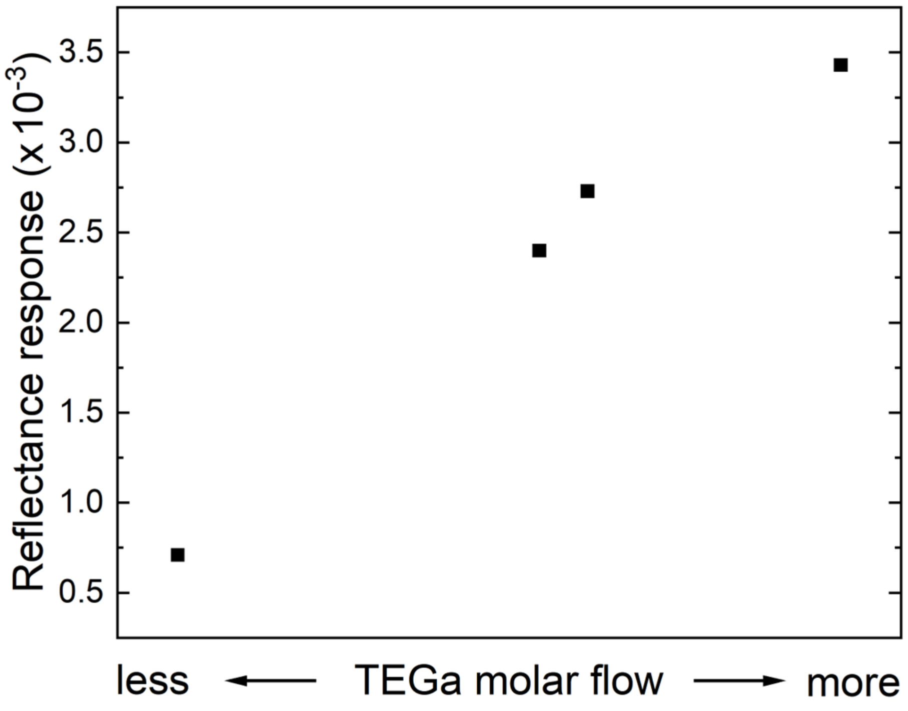


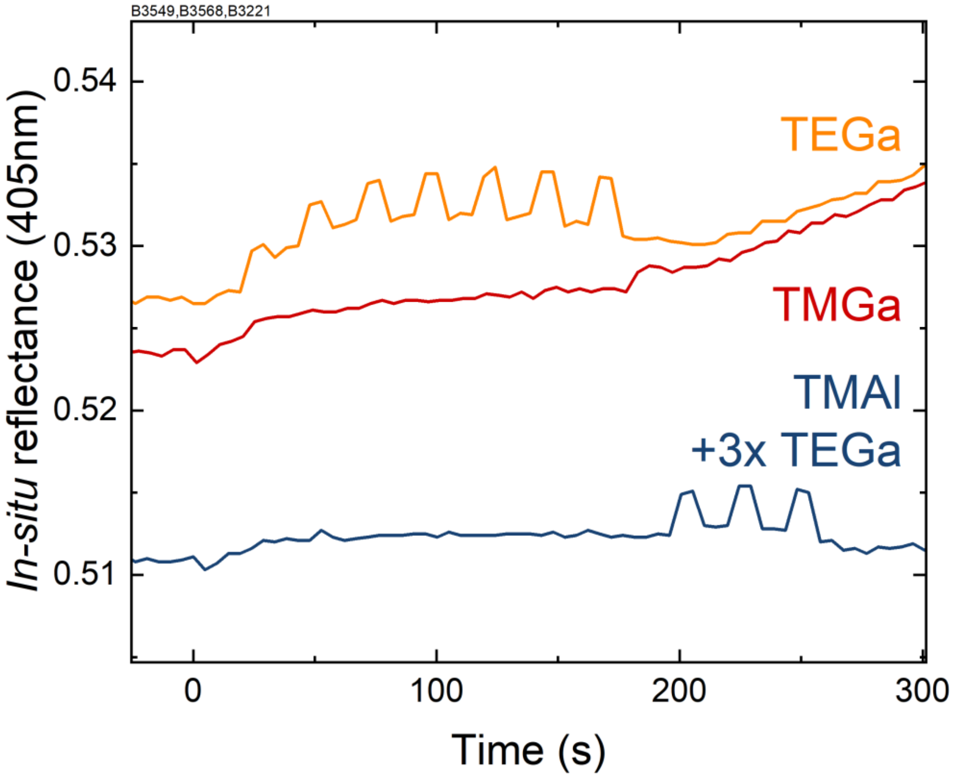
In-situ Observation of Surface Processes

Reflectance during FME

Flow modulated epitaxy with alternative precursors

- Signal strength determined by TEGa flow
- Oscillation only observed using TEGa
- Different decomposition and incorporation using TMGa/TMAl
- Change of optical response due to ethyl-groups of TEGa?

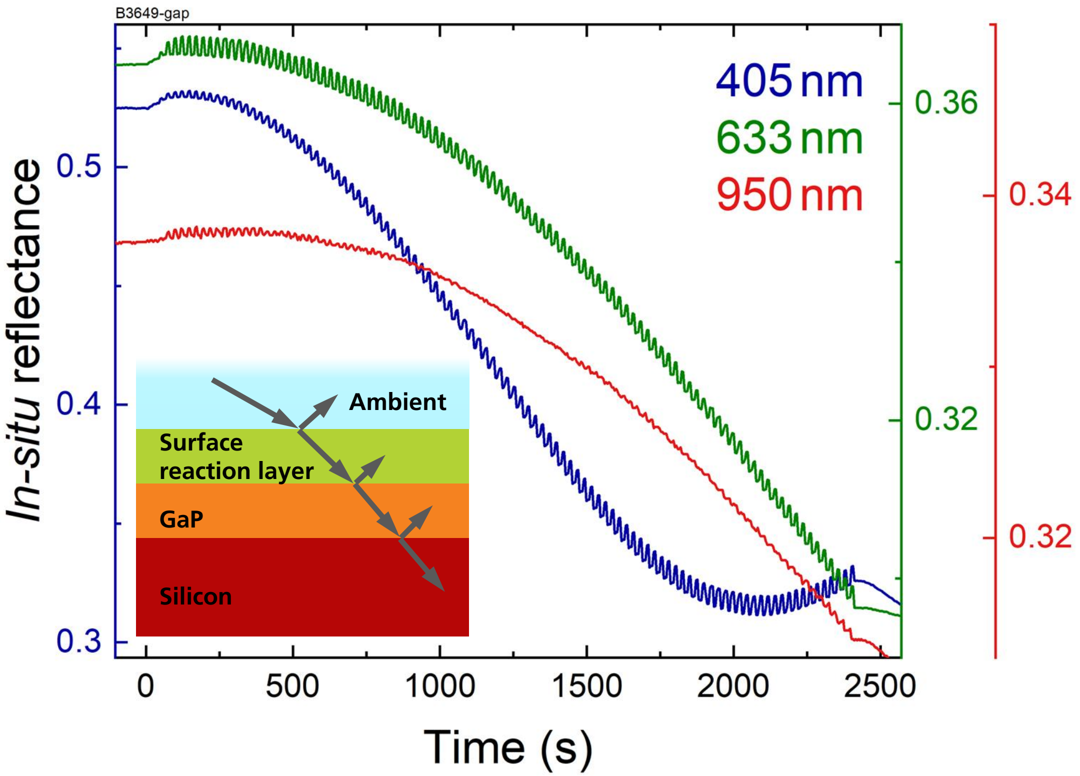
→ *In-situ* observation of decomposition processes



In-situ Observation of Surface Processes

Conclusion

- Oscillation in EpiTT reflection signal during pulsed nucleation of GaP on silicon
- Optical response due to surface reaction layer
- Effect only observed using TEGa, not TMGa/TMAl
- Signal strength determined by TEGa flow
- Observation of decomposition processes possible
- Determination of reaction kinetics (given adequate resolution)



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Thank you for your attention!

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