

# GaN:Cs Photocathode for SRF Guns

## Method

- p-type GaN (magnesium doped) on sapphire or other substrate is studied
- Wet chemical pre-cleaning to remove dust and organic parts from the surface (analysis with AFM measurements)
- The GaN is transferred into UHV chamber via portable suitcase

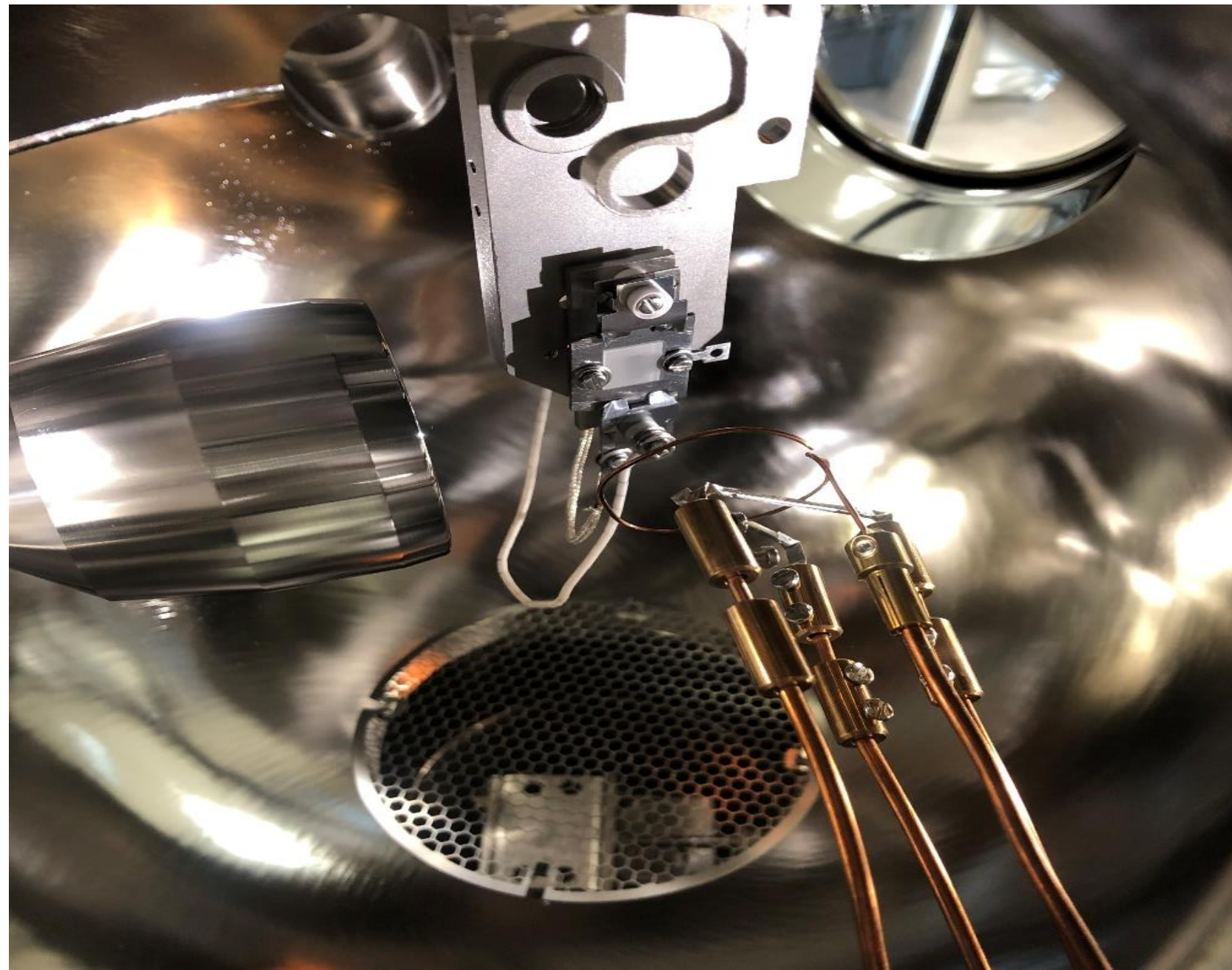


Fig. 1: experimental set-up inside of GaN UHV-chamber

- In UHV chamber the GaN undergoes a cycle process, which consists of the following steps:

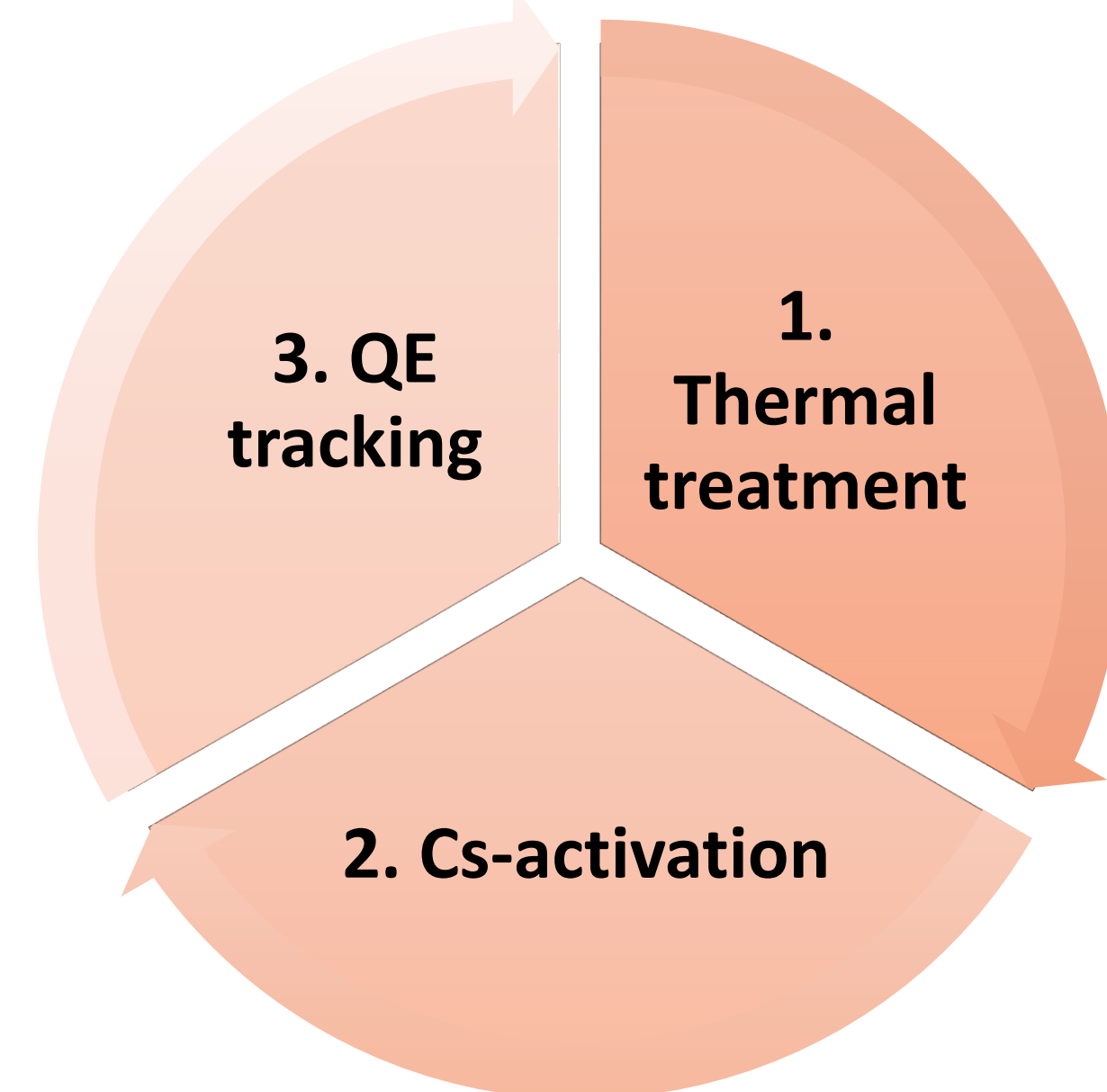


Fig. 2: scheme of cycle process

- 1) Thermal treatment at certain temperature to desorb residual gases
- 2) deposition of caesium on clean surface while illuminating with UV-light

- 3) QE tracking of the prepared GaN:Cs photocathode over time till it drops to zero

→ Starting again with thermal treating and activation process (re-activation)

## Quantum efficiency (QE)

- The released photoelectrons enter into the vacuum and are collected by a copper ring anode
- The number of released photoelectrons in ratio of the input photons of UV-light derives in the quantum efficiency (QE)

$$QE = \frac{N_{\text{photoelectrons}}}{N_{\text{photons of UV-light}}} \quad (1)$$

$$QE = \frac{h \cdot c}{q_e \cdot \lambda} \cdot \frac{I}{P_{\text{UV-light}}} \quad (2)$$

## Results

### GaN on silicon

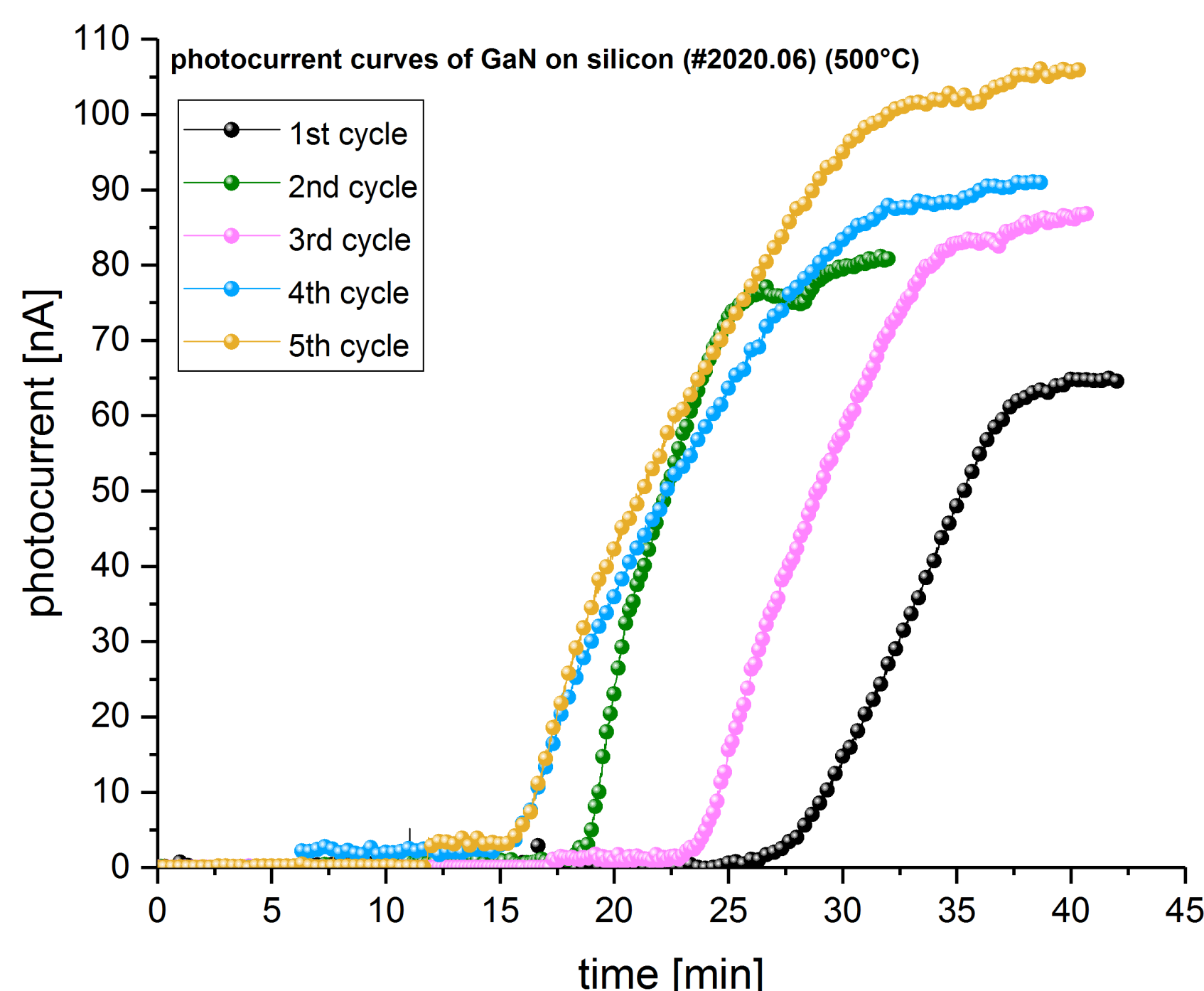


Fig. 3: photocurrent activation curves for GaN on silicon

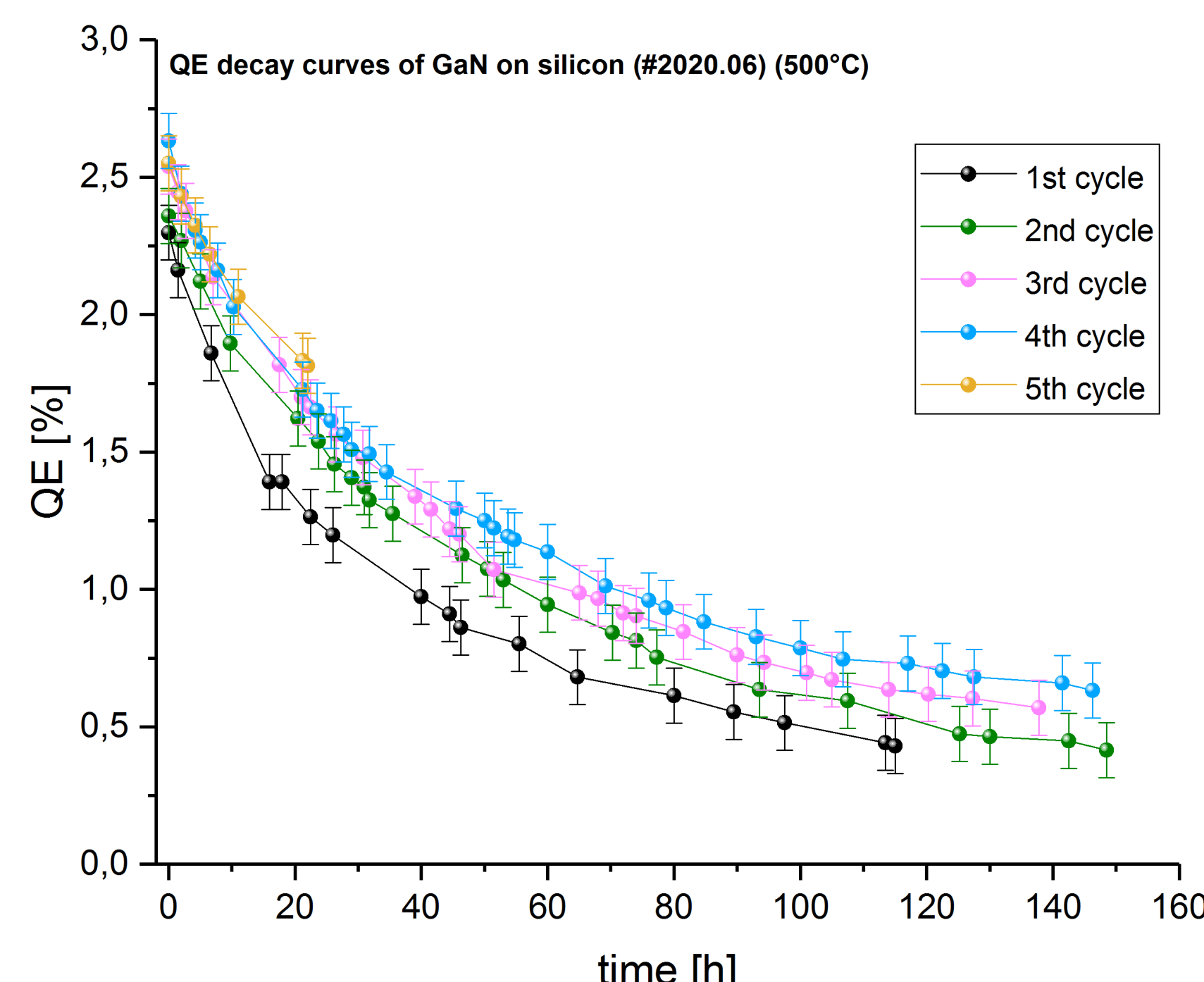


Fig. 4: QE tracking from GaN on silicon

### SEM Image

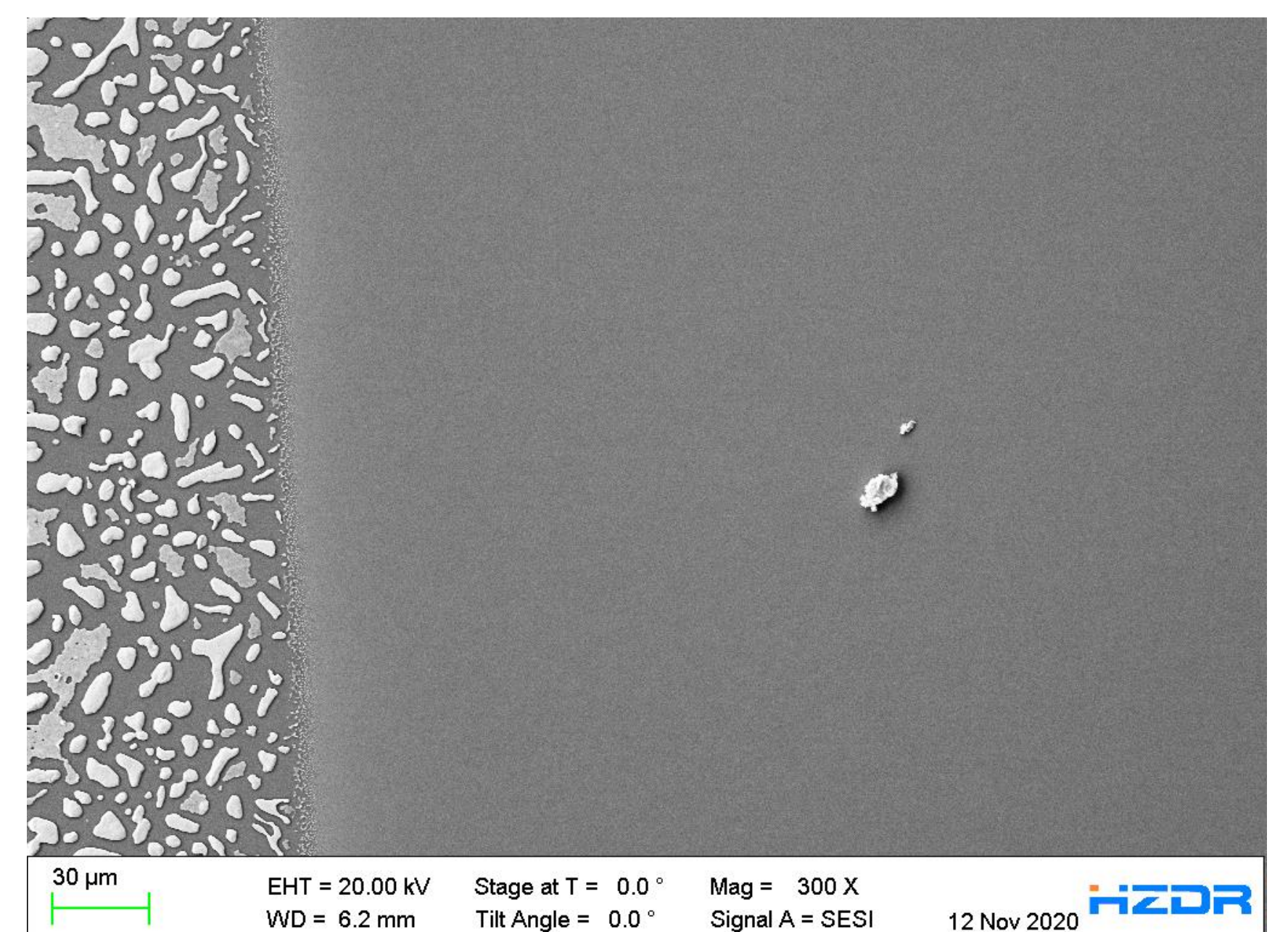


Fig. 5: SEM image of used GaN on silicon

### GaN on sapphire

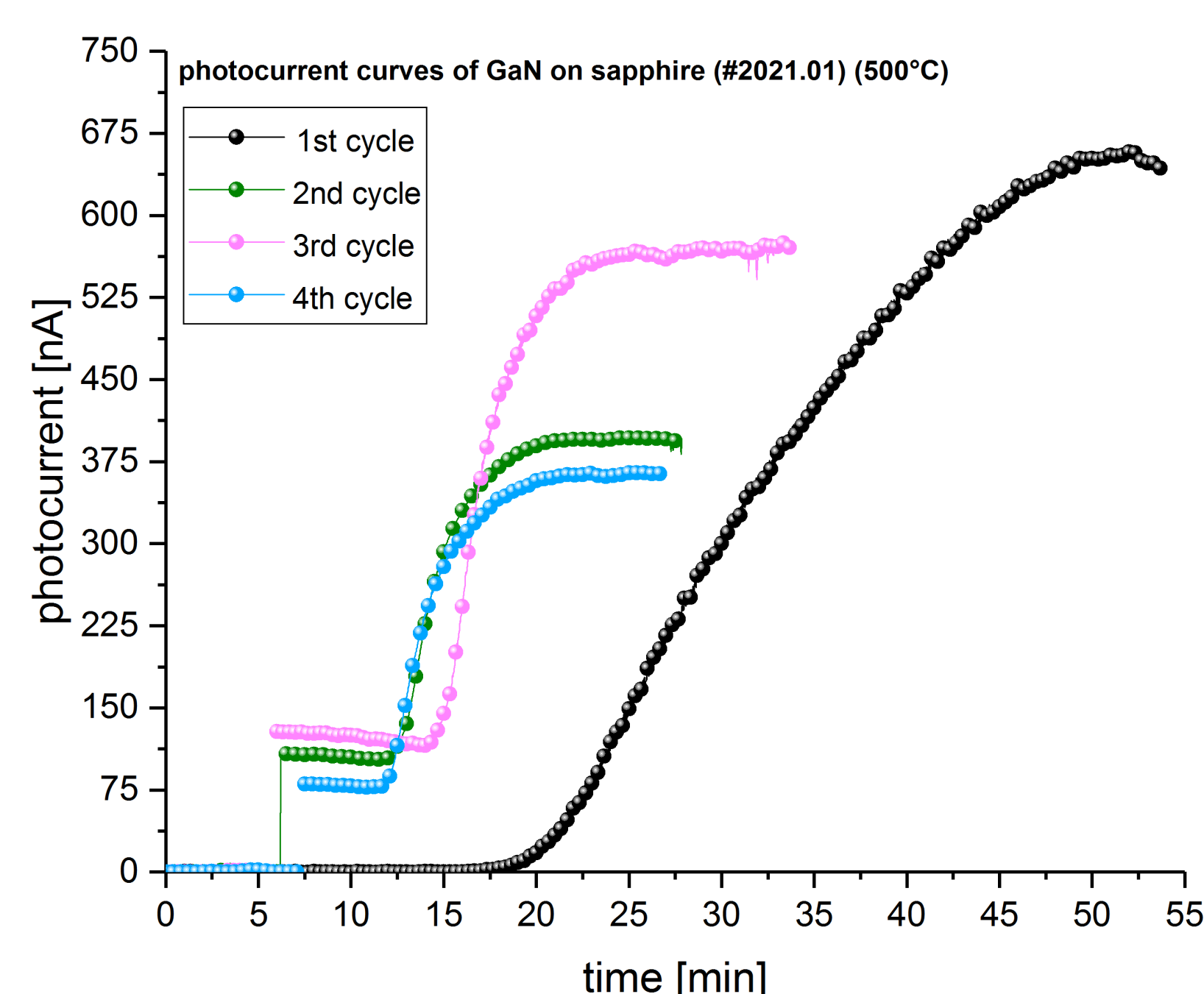


Fig. 6: photocurrent activation curves for GaN on sapphire

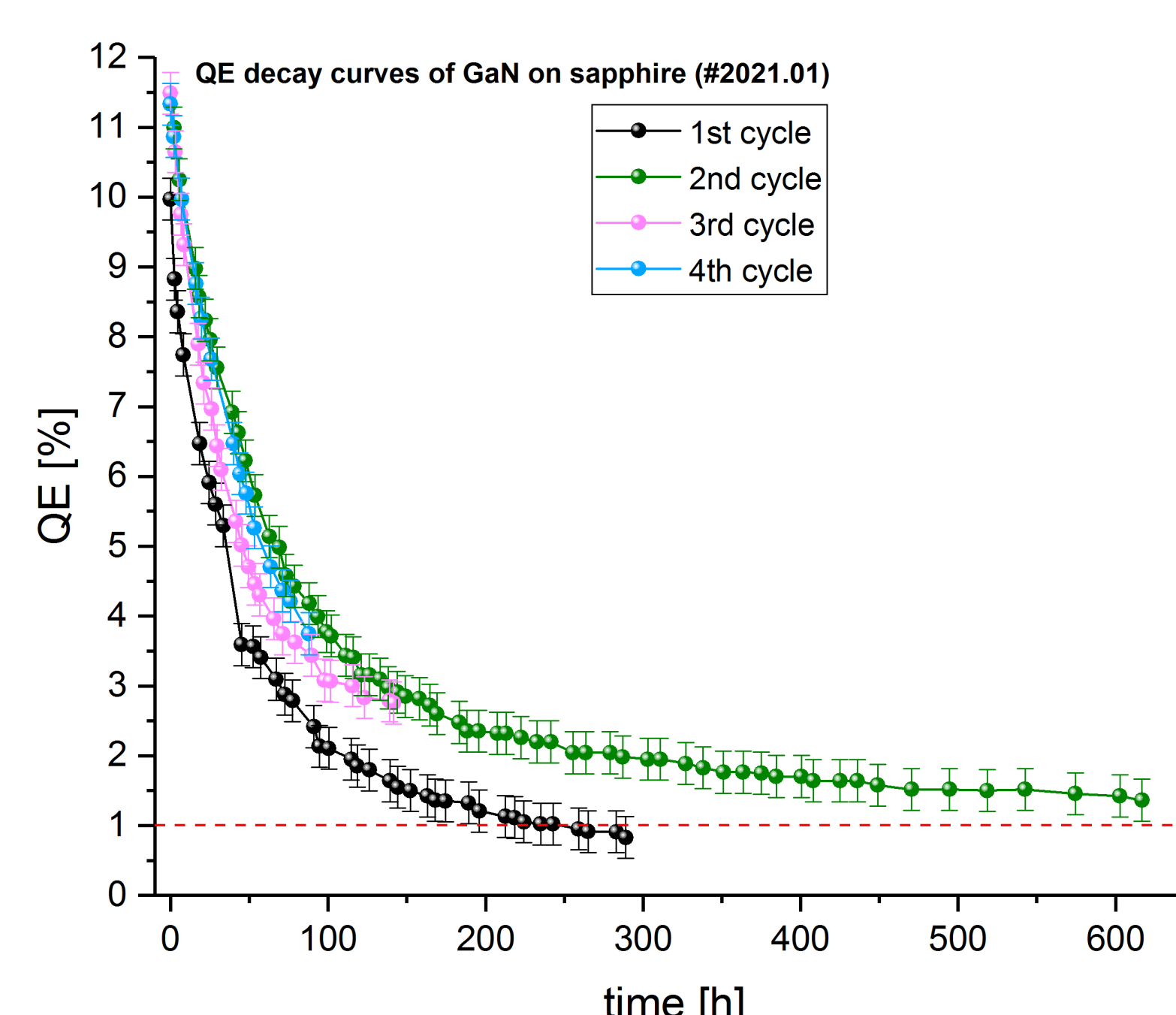


Fig. 7: QE tracking of GaN on sapphire

### QE Comparison

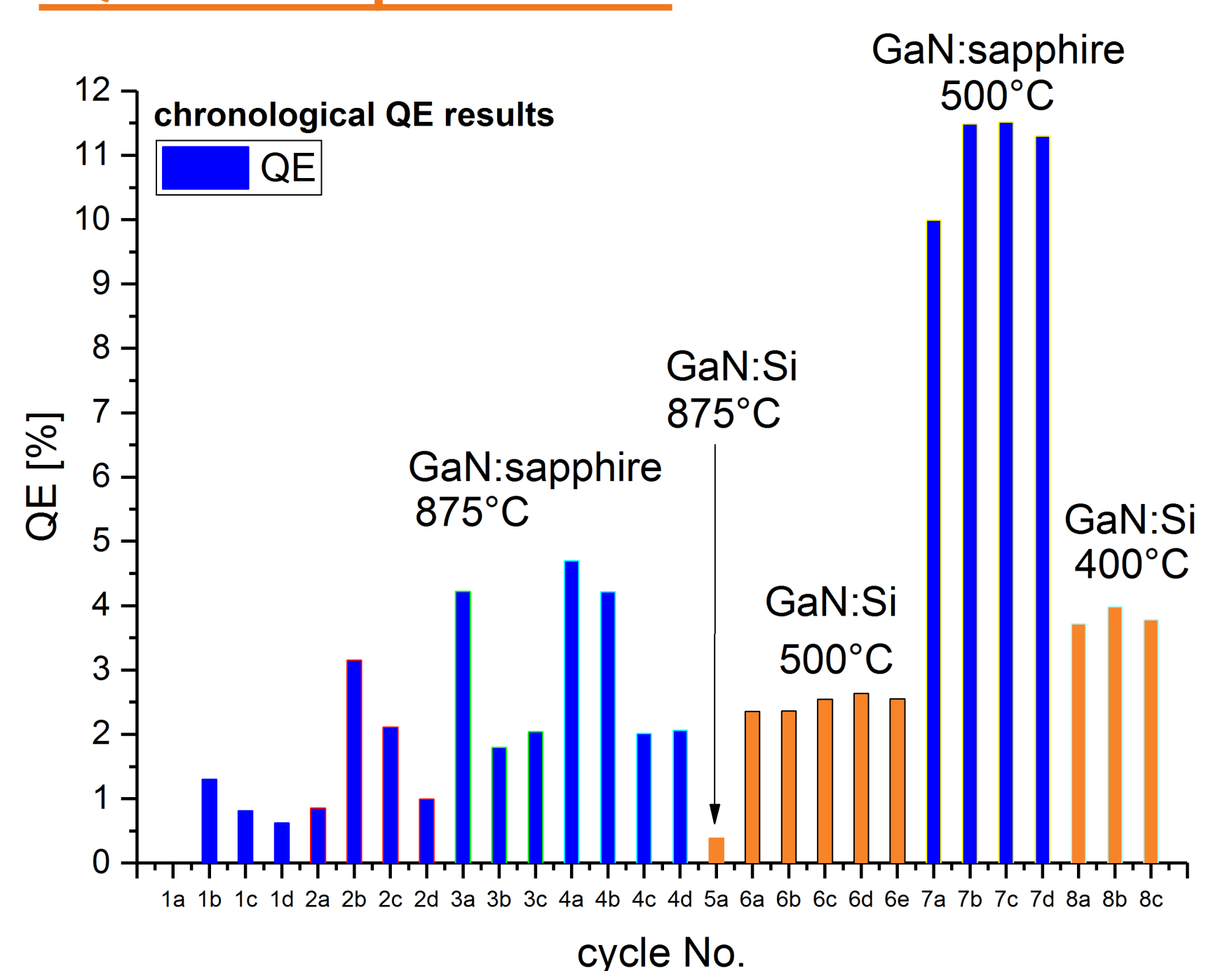


Fig. 8: QE comparison of all activated GaN samples

## Outlook

Activation of GaN with caesium and lifetime observation

- on other substrate (SiC)
- use better conductive samples (gold sputtering)
- compare to selfmade GaN (Uni Siegen)

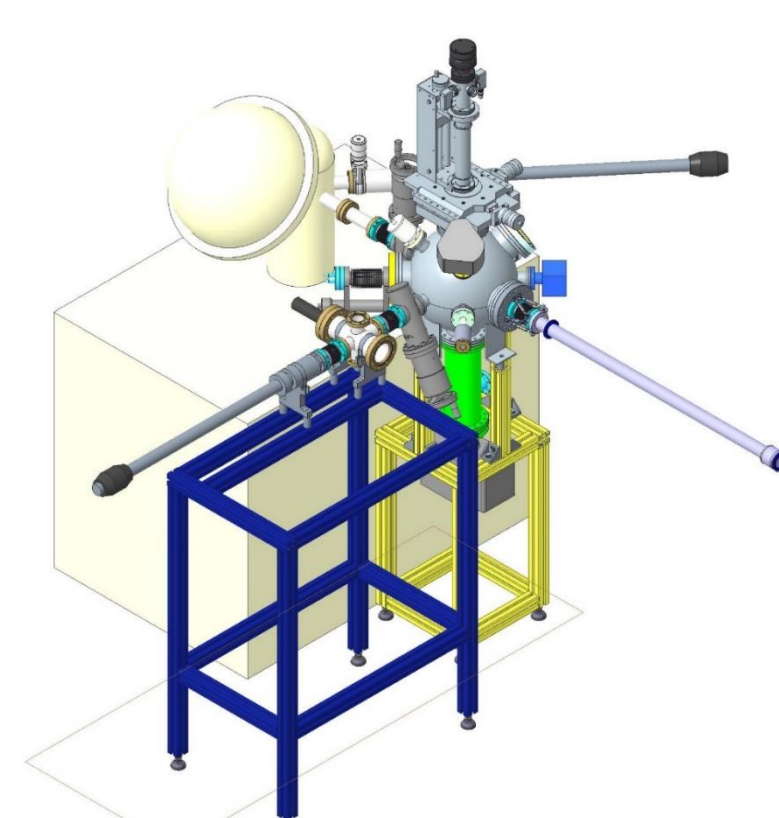


Fig. 9: combination of GaN chamber and XPS

Connection from activation chamber to XPS chamber to do qualitative and quantitative analysis

## Acknowledgement

We would like to thank all our colleagues at ELBE for their support in this work. We acknowledge the support of the German Federal Ministry of Education and Research grant 05K12CR1