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# Recrystallisation of thin 4H-SiC films deposited by PVD

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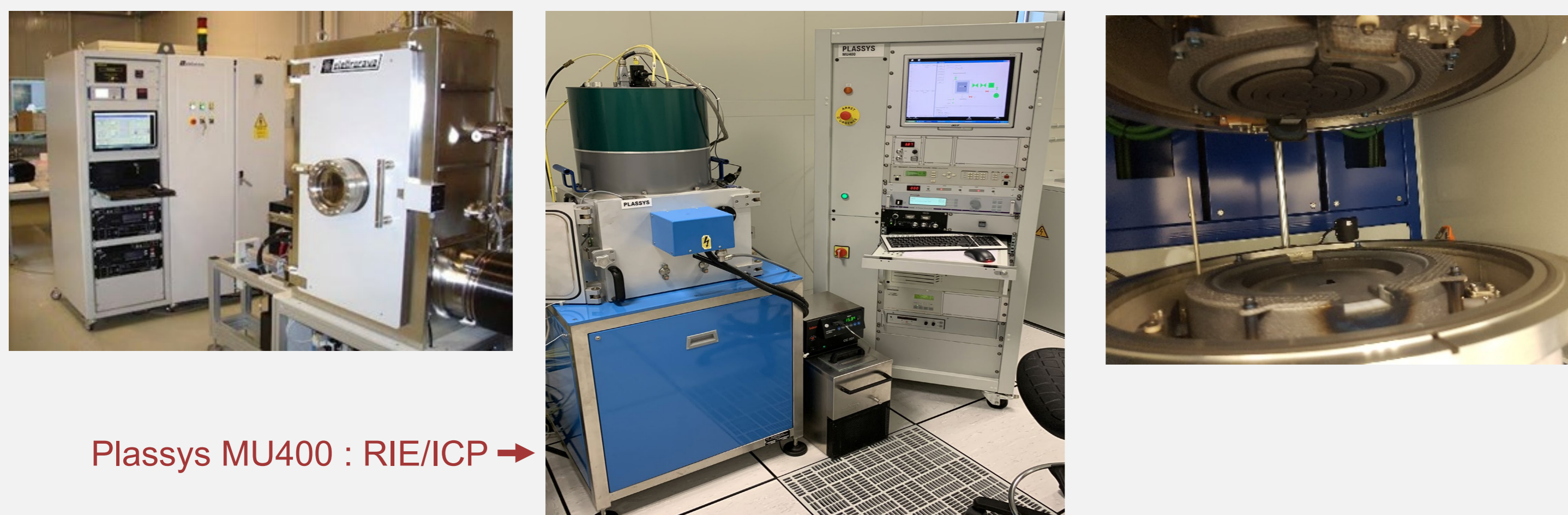
## 1 Introduction

Bulk and homo-epitaxial growth of SiC crystals is quite expensive and time consuming [1]. This project presents **high quality 4H-SiC layers** obtained by more classic **physical vapor deposition (PVD)** techniques. This opens a way to design new SiC devices exploiting these PVD thin films for power applications and also other emerging fields.

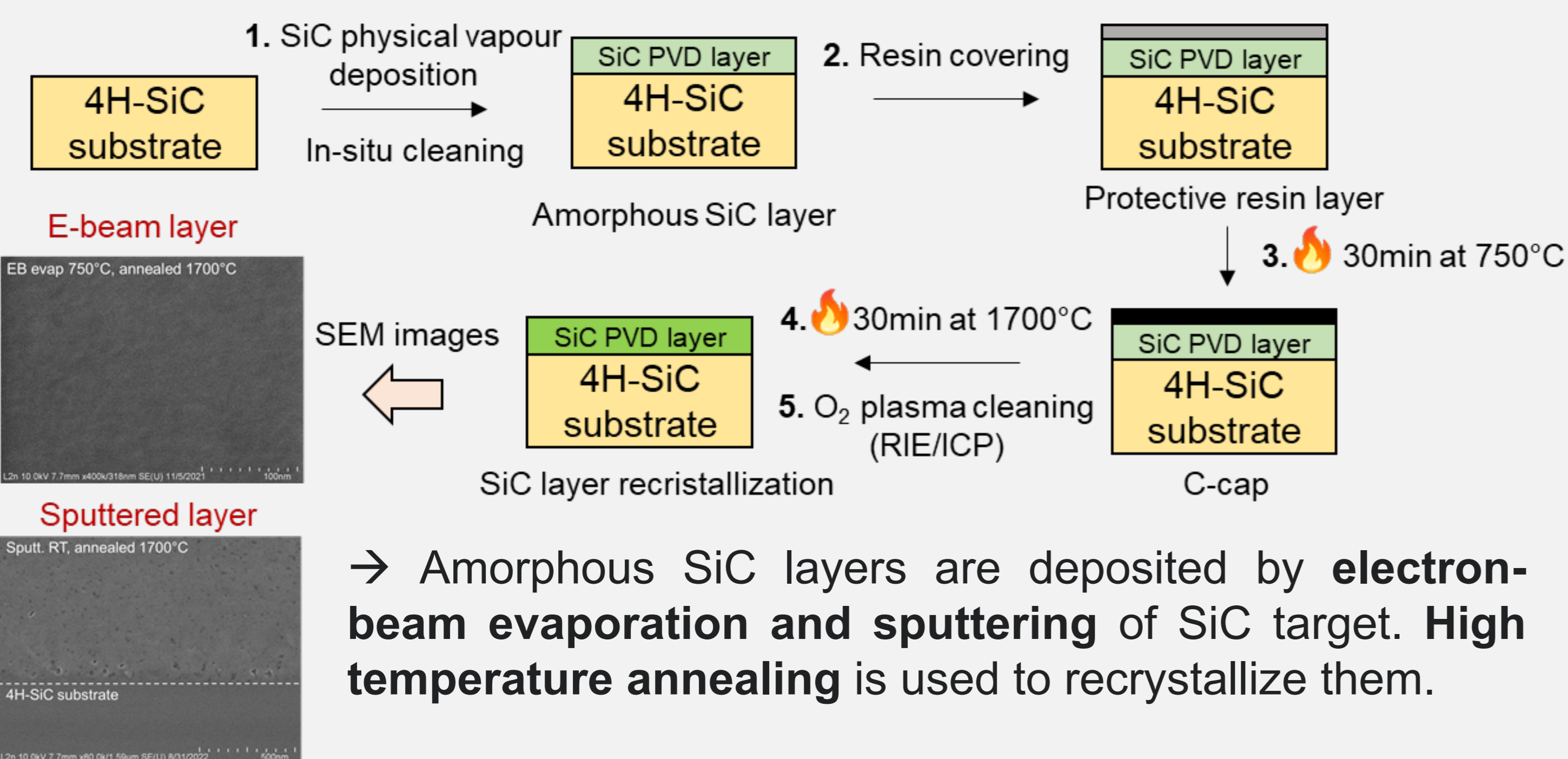
## 2 Method Overview

Elettrorava machine : PVD by evaporation

AET RTP graphite resistive furnace



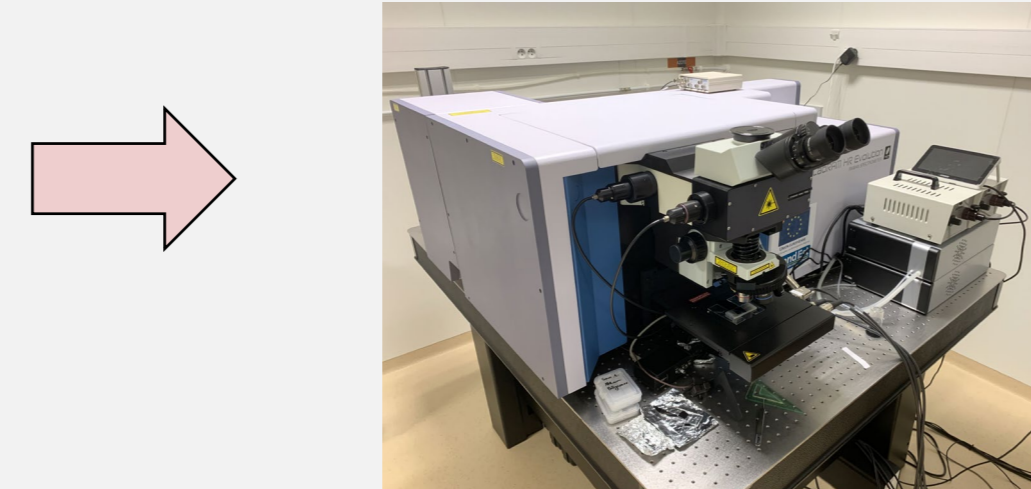
Plasys MU400 : RIE/ICP →



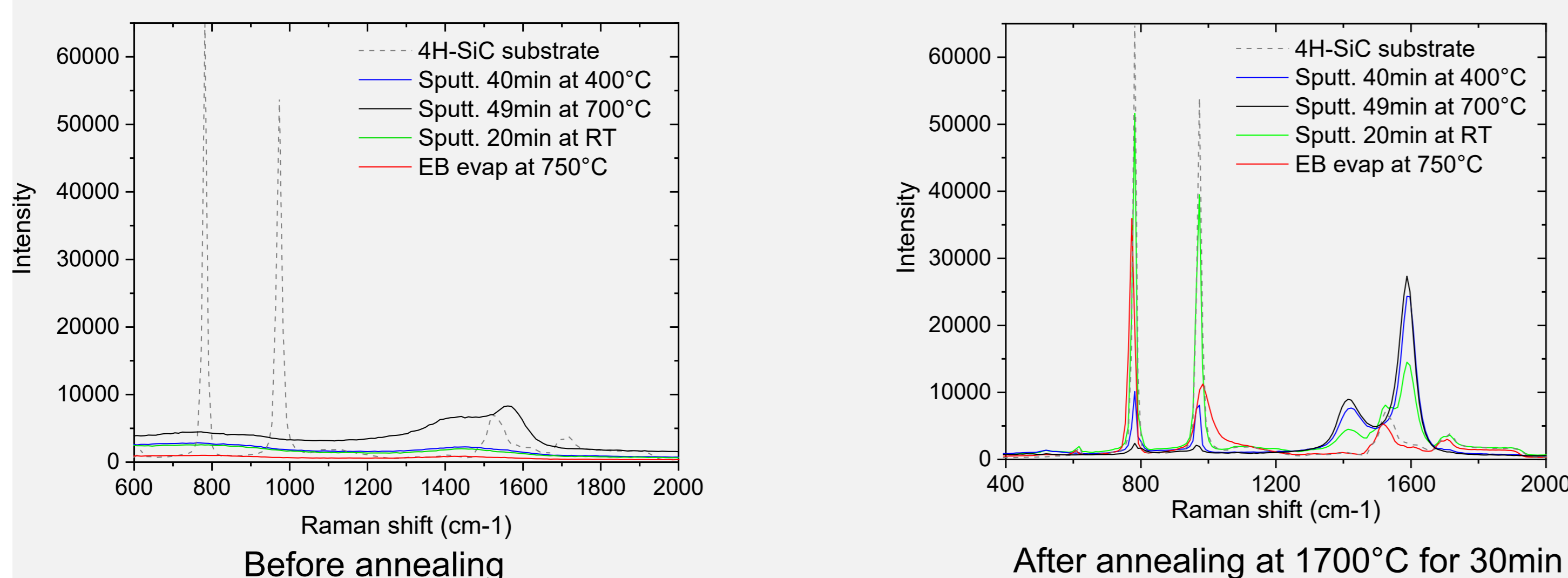
## 3 Crystallography of the SiC layers

→ Except for the one deposited by evaporation, the SiC layers are only **partially recrystallized** after annealing at 1700°C.

Raman spectrometer  
Wavelengths available :  
• Visible : 405, 532, 633nm  
• UV : 325nm  
• IR : 785nm



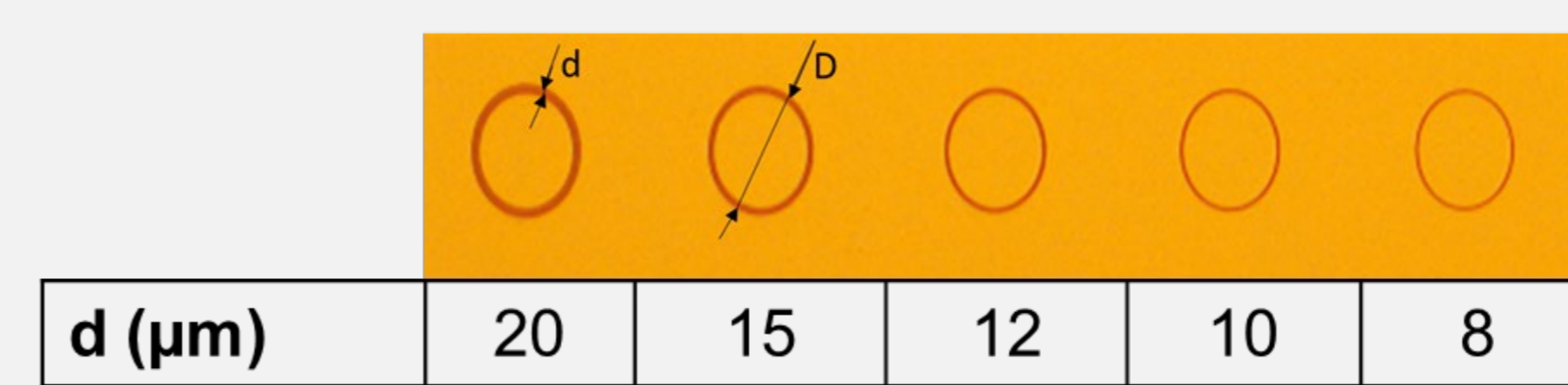
Raman spectra of SiC layers



## 4 Conductivity of the SiC layers

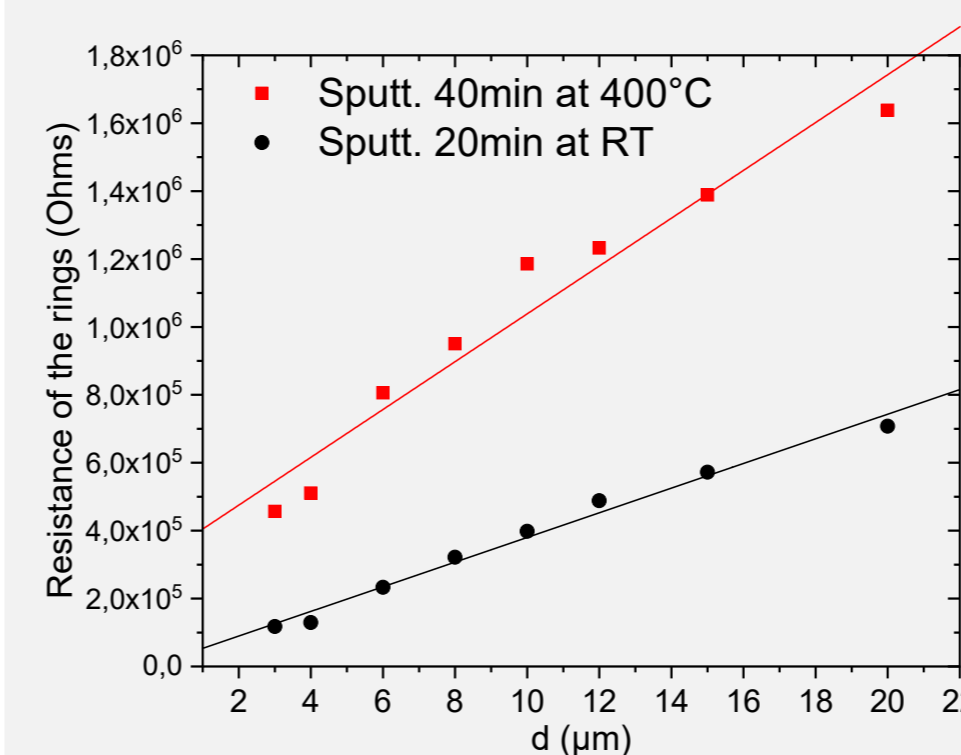
**Before annealing :**

→ To determine the sheet resistance of the PVD layers, **circular transfer length method (CTLM)** structures were fabricated [2].



$$R = \frac{R_{sh}}{\pi D} (d + 2 L_T).$$

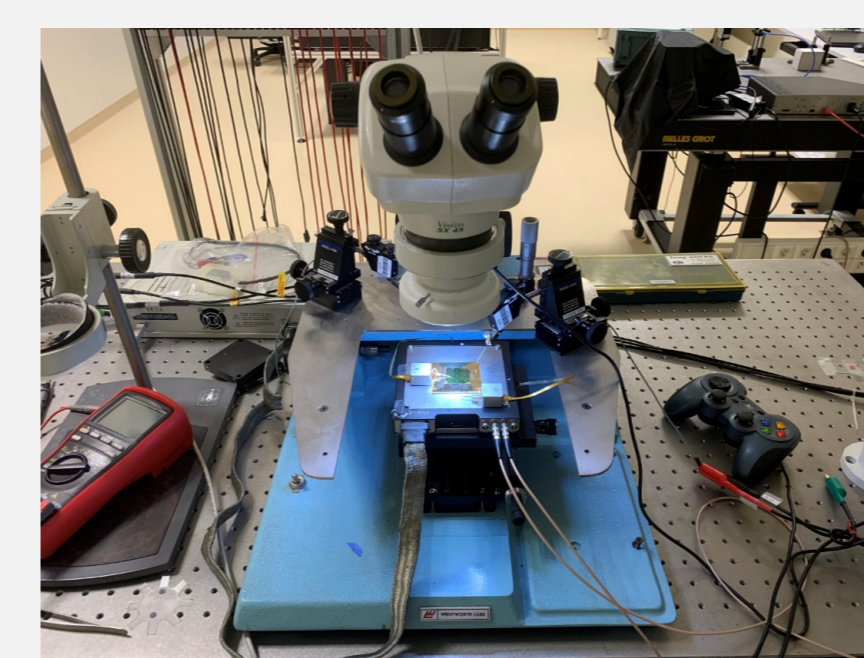
Resistance of the PVD layers in function of the CTLM width



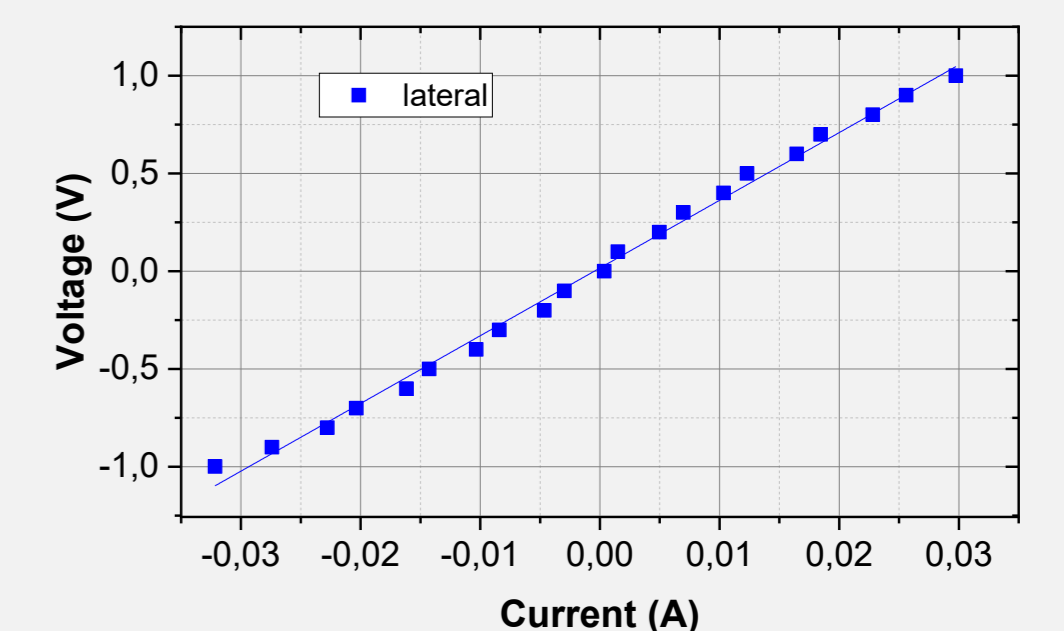
Sputtered PVD layers	20min at RT	40min at 400°C
Slope of the curve [Ω/μm]	36 308	70 433
Interception with the y-axis - 2×R <sub>c</sub> [kΩ]	16.9	334.2
Fitting parameter (COD)	0.99	0.95
Sheet resistance [MΩ/square]	<b>11.4</b>	<b>22.1</b>

**After annealing at 1700°C :**

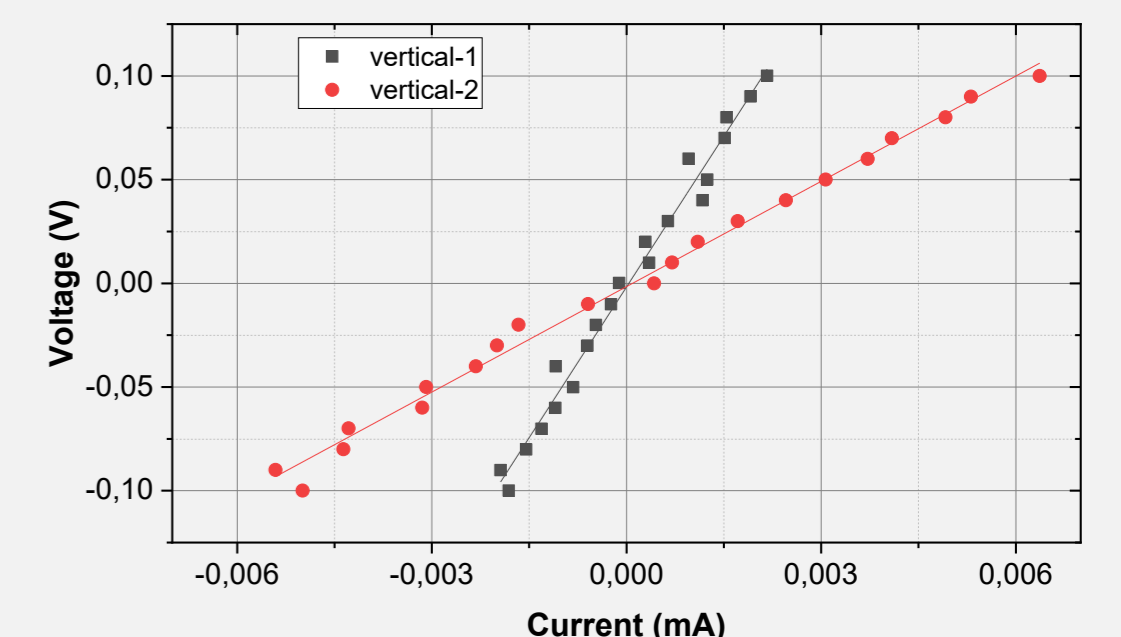
→ Electrical measurements with two-points probe station of sputtered PVD layers.



Lateral configuration



Vertical configuration



## 5 Conclusion

- **E-beam** evaporation allows a **better recrystallization** for thin layers compared to sputtered layers. 4H-SiC polytype is confirmed by Raman spectroscopy. Thus, EB-PVD of SiC allows us to form **homo-epitaxial layers** on a 4H-SiC substrate at **lower cost** compared to the CVD methods currently used.
- The **sputtered** layers have a **higher conductivity** than the EB ones offering the perspective to fabricate low-cost SiC substrates on an **industrial scale**.
- The quality of the sputtered layers still needs improvements. We can also try to introduce defects or impurities into the e-beam evaporated layers to increase their conductivity.

## References

1. T. Kimoto, Bulk and epitaxial growth of silicon carbide, Progress in Crystal Growth and Characterization of Materials. 62, 329-351, 2016.
2. Dieter K. Schroder, Semiconductor Material and Device Characterization, 3rd Edition, pp. 840. ISBN 0-471-73906-5. Wiley-VCH, 2005.