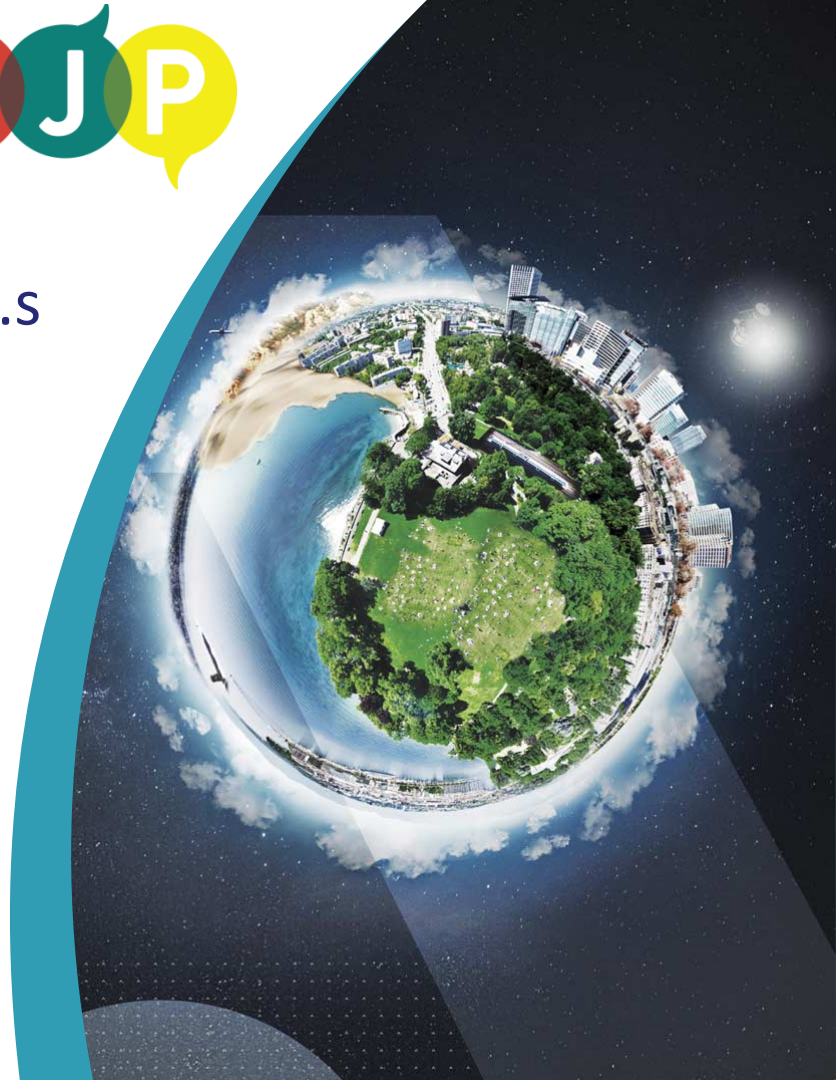


Rencontres des jeune physicien.ne.s

PtSe₂ films grown by molecular beam epitaxy for high frequency optoelectronics

Speaker : **Eva Desgué**



SUMMARY

Introduction : Why study PtSe₂ ?

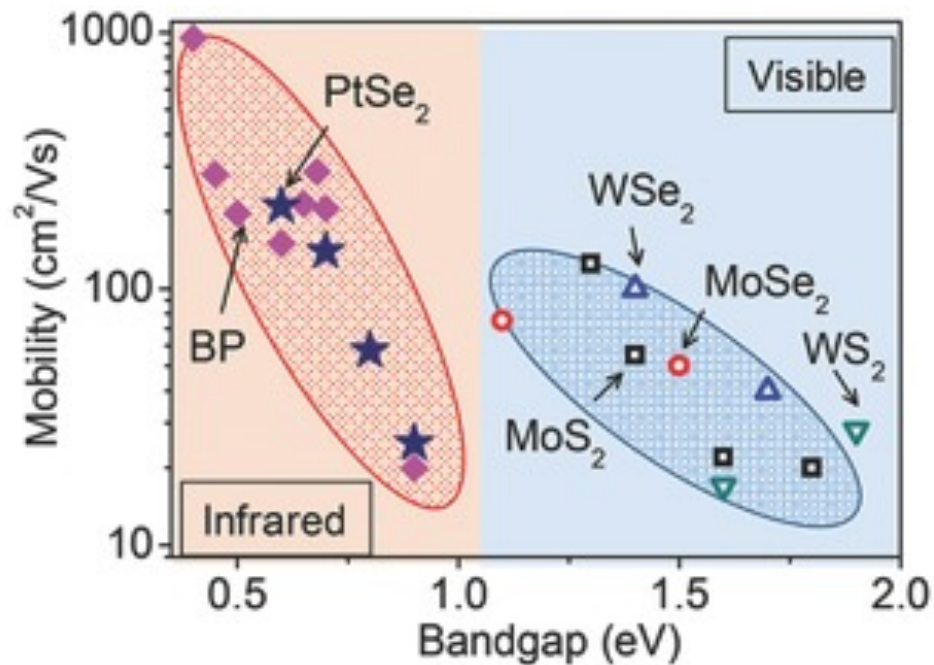
Results

- Synthesis of PtSe₂/Sapphire by MBE
- Impact of steps in the sapphire substrate

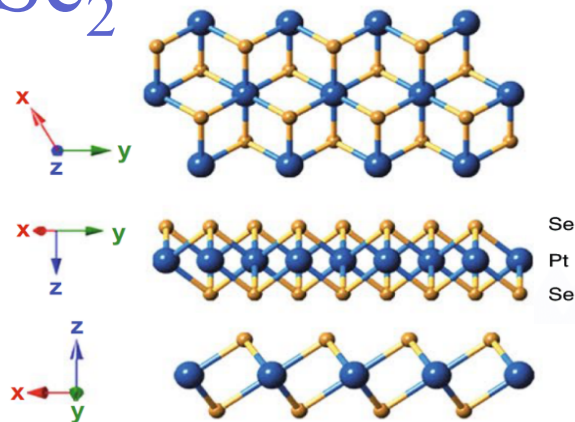
Application : IR photodetector

Conclusion

Why study PtSe_2 ? \rightarrow IR photodetection



PtSe_2

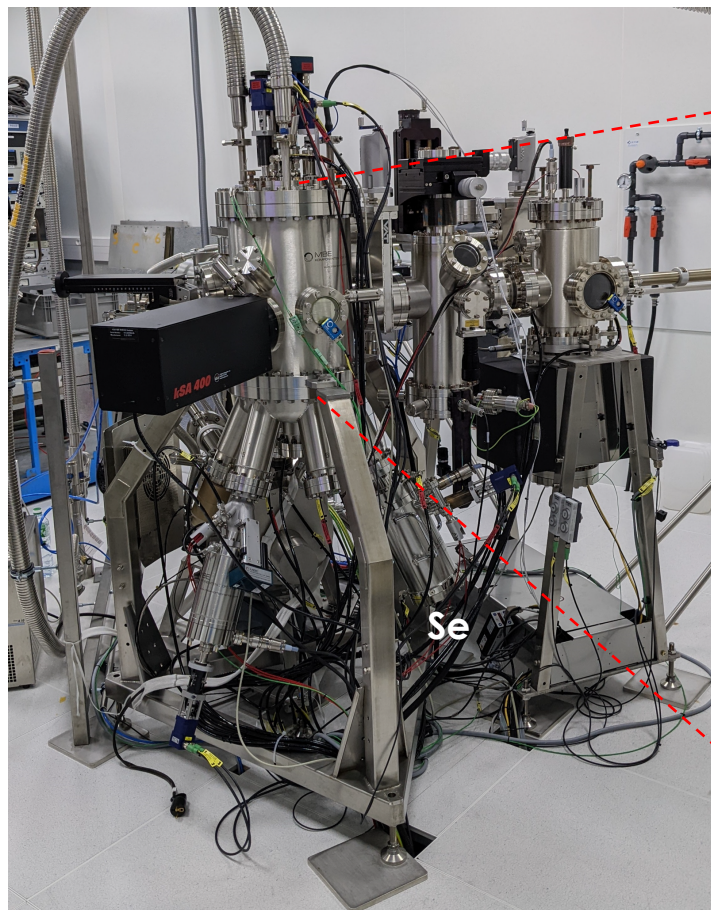


1.55 μm photodetection

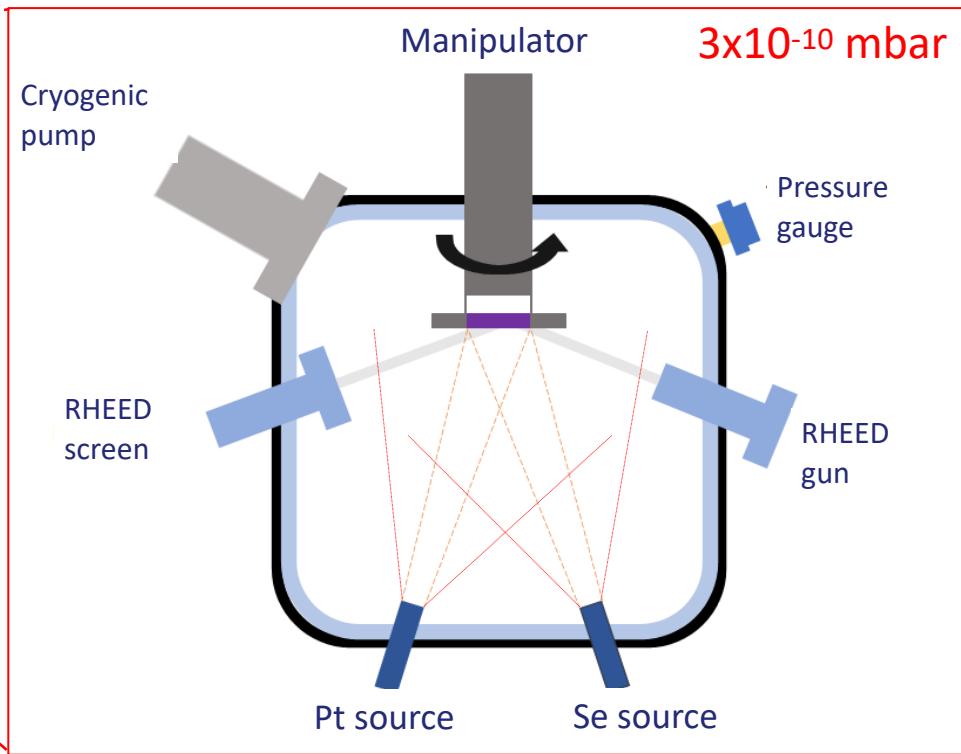
- Absorbs in IR
- High mobility
- Stability in air

Y.D. Zhao et al., Adv. Mater. 29(5), 1604230 (2017)

Growth of PtSe_2 by molecular beam epitaxy



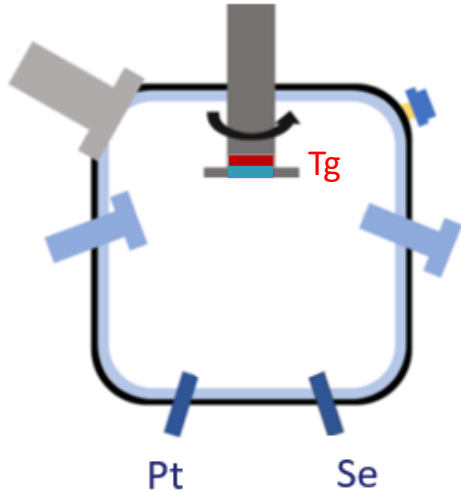
Growth chamber



Stages of PtSe₂ growth on sapphire(0001)

Substrate heating

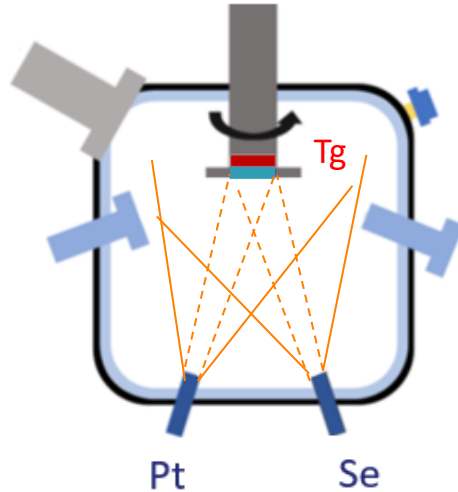
$T_g = 520^\circ\text{C}$



Sapphire

Simultaneous deposition

$\Phi(\text{Se})/\Phi(\text{Pt}) \sim 170$

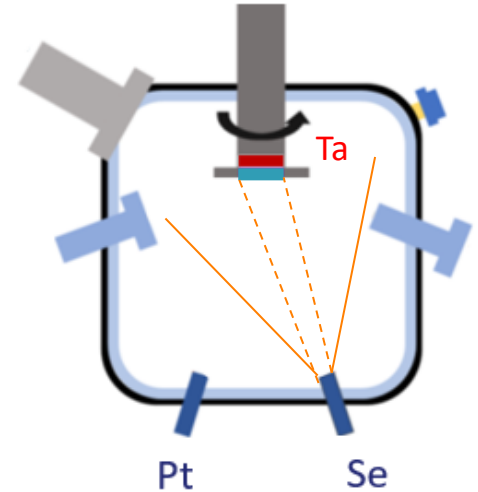


PtSe₂

Sapphire

Annealing of PtSe₂ film

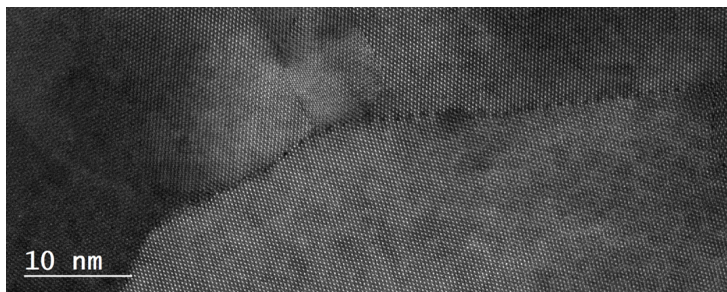
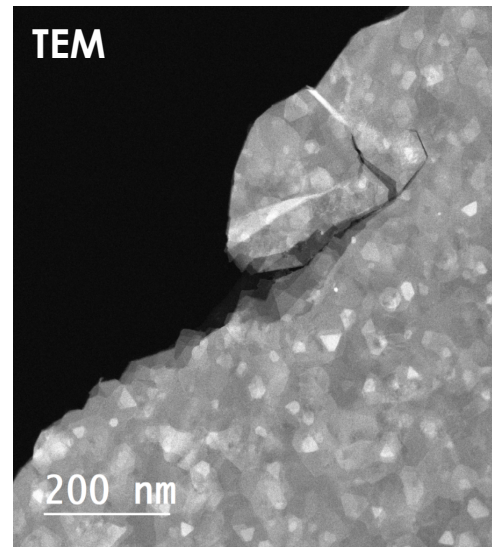
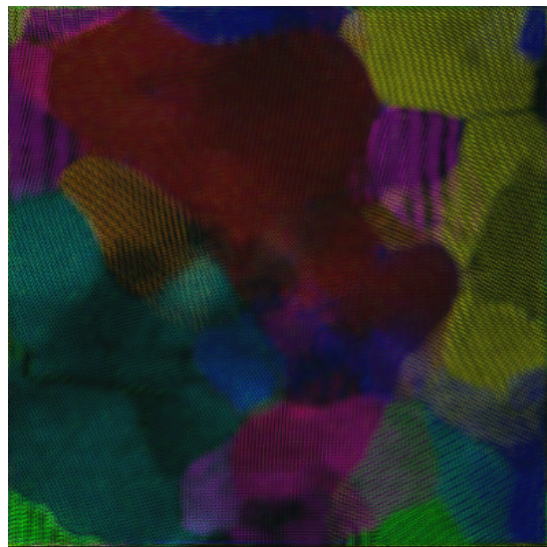
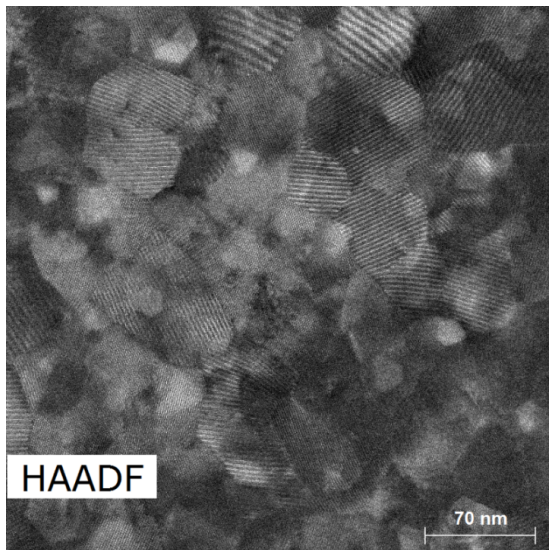
$T_a = 690^\circ\text{C}$



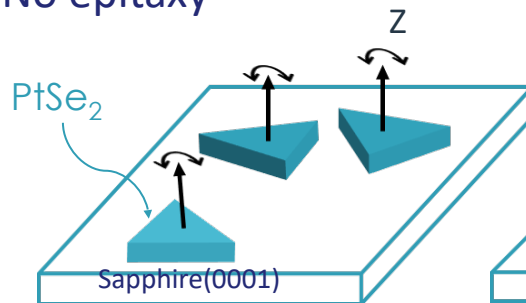
PtSe₂

Sapphire

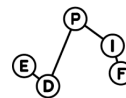
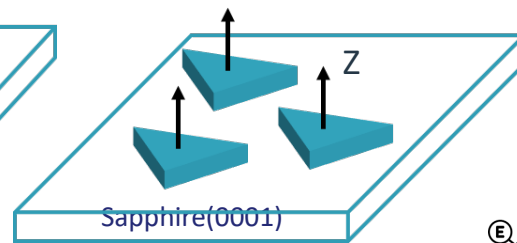
PtSe₂ films on sapphire(0001)



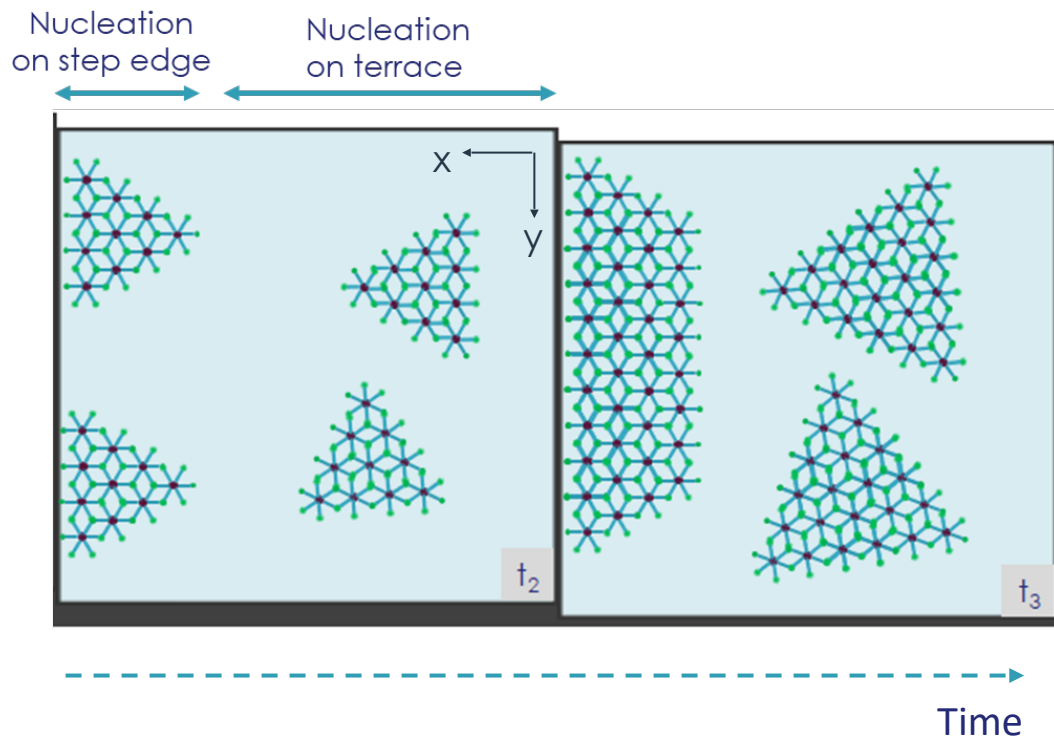
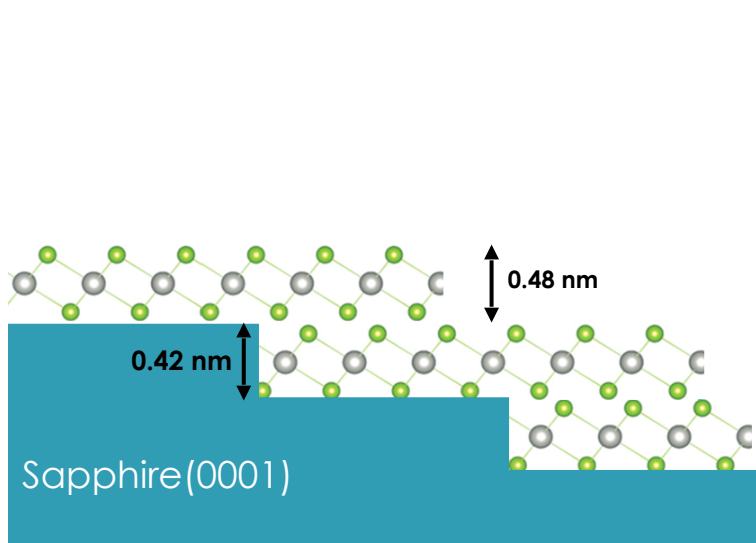
No epitaxy



Epitaxy



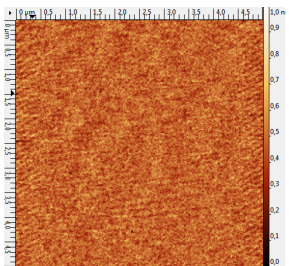
Stepped structures in the sapphire(0001)



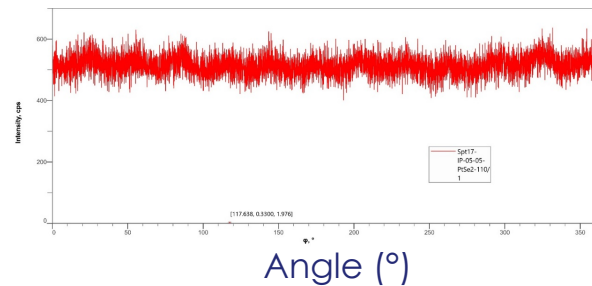
Dumcenco et al., ACS Nano 9, 4611 (2015)

No steps

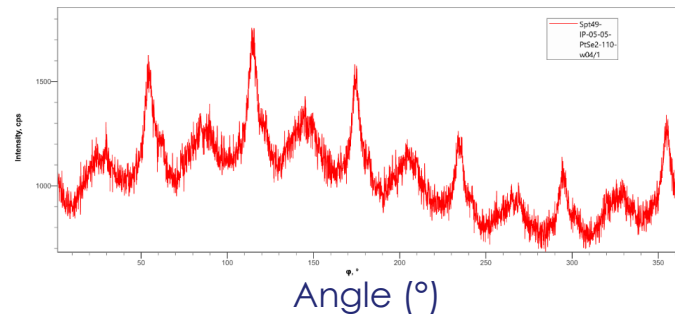
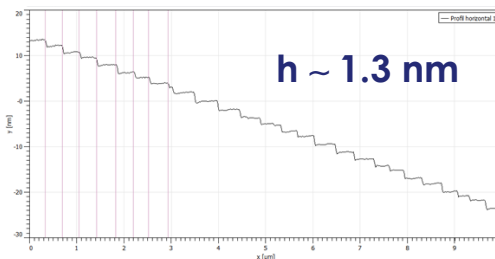
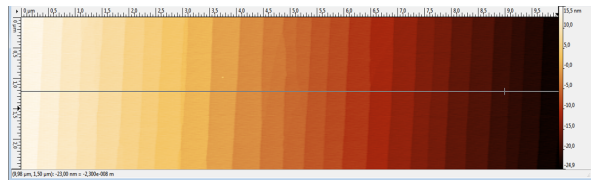
$$\mu_{\max} = 7.5 \text{ cm}^2/\text{V.s}$$



No epitaxy

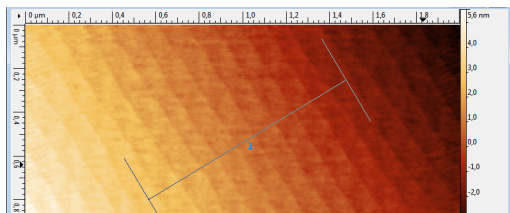


SPt49 : 1545°C 30min

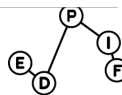
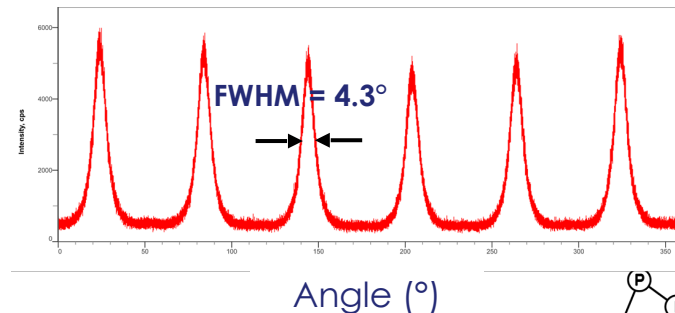
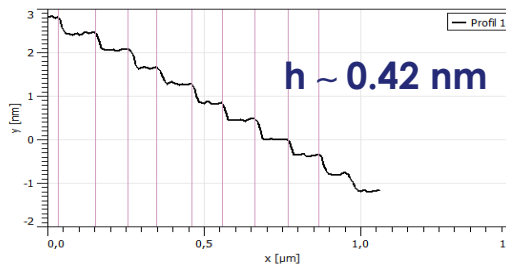


SPt71 : 1135°C 10min

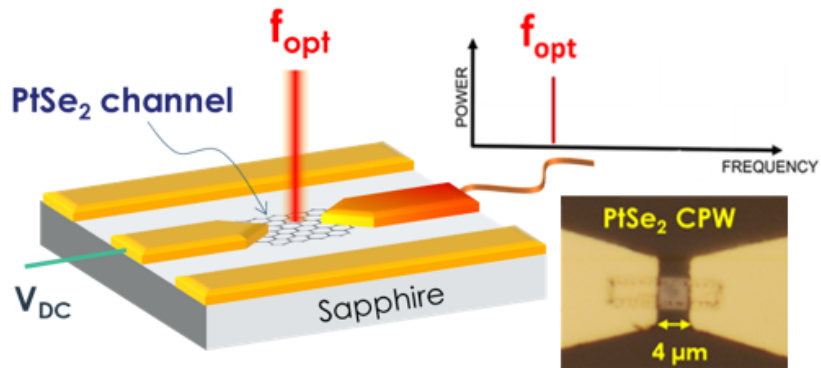
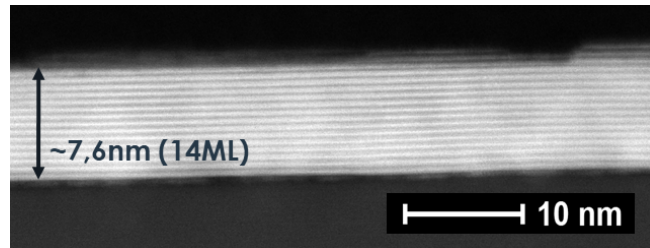
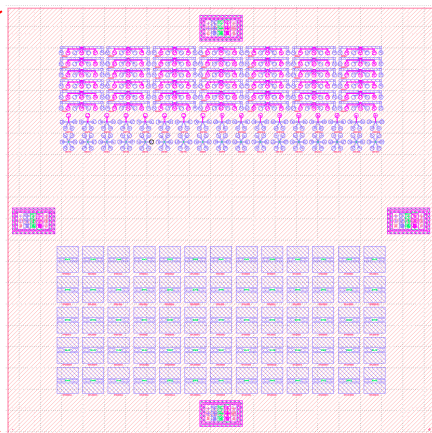
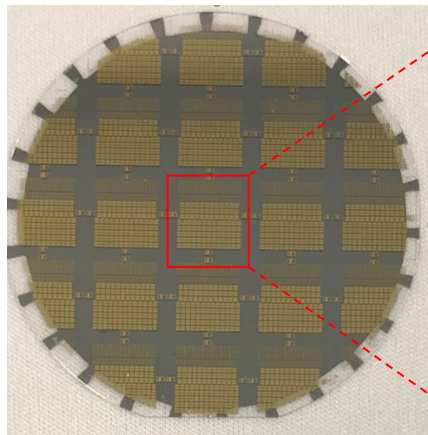
$$\mu = 11.6 \text{ cm}^2/\text{V.s}$$



Quasi epitaxy



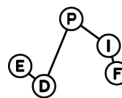
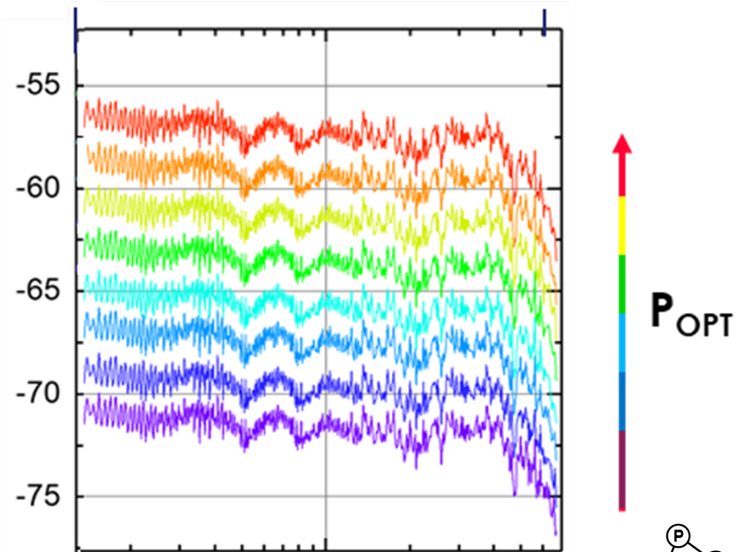
IR photodetector with a 8nm-thick PtSe₂ channel



P_{RF}
(dBm)

2 GHz

60 GHz

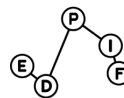


Conclusion

■ Obtaining high crystal quality PtSe₂ films is essential for electrical performances

↳ Stepped structures in sapphire(0001) substrate improve the epitaxy and the electrical mobility of the PtSe₂ films

■ PtSe₂-based IR photodetector with a 60GHz bandwidth



Thank you for your attention



Pierre LEGAGNEUX



Delphine POMMIER



Eva DESGUE



Ivan VERSCHUEREN