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# Influence of Bottom Electrodes on HZO Thin Films Features

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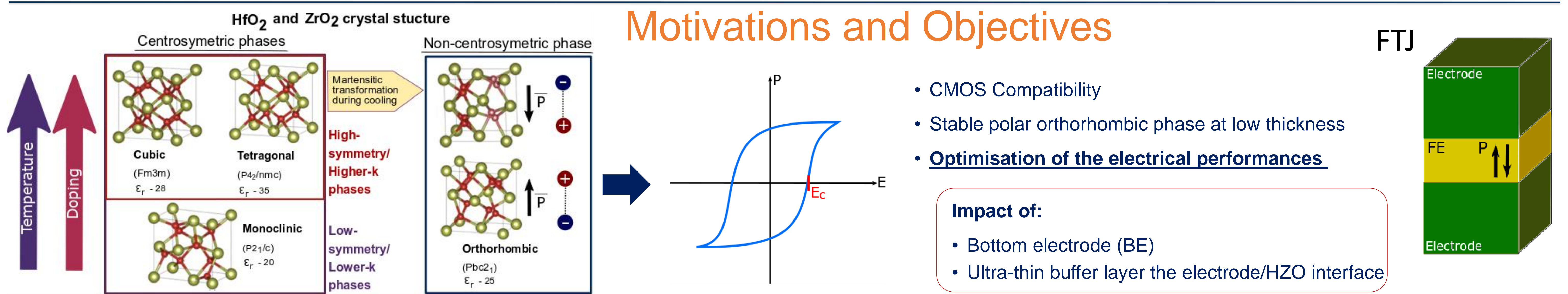
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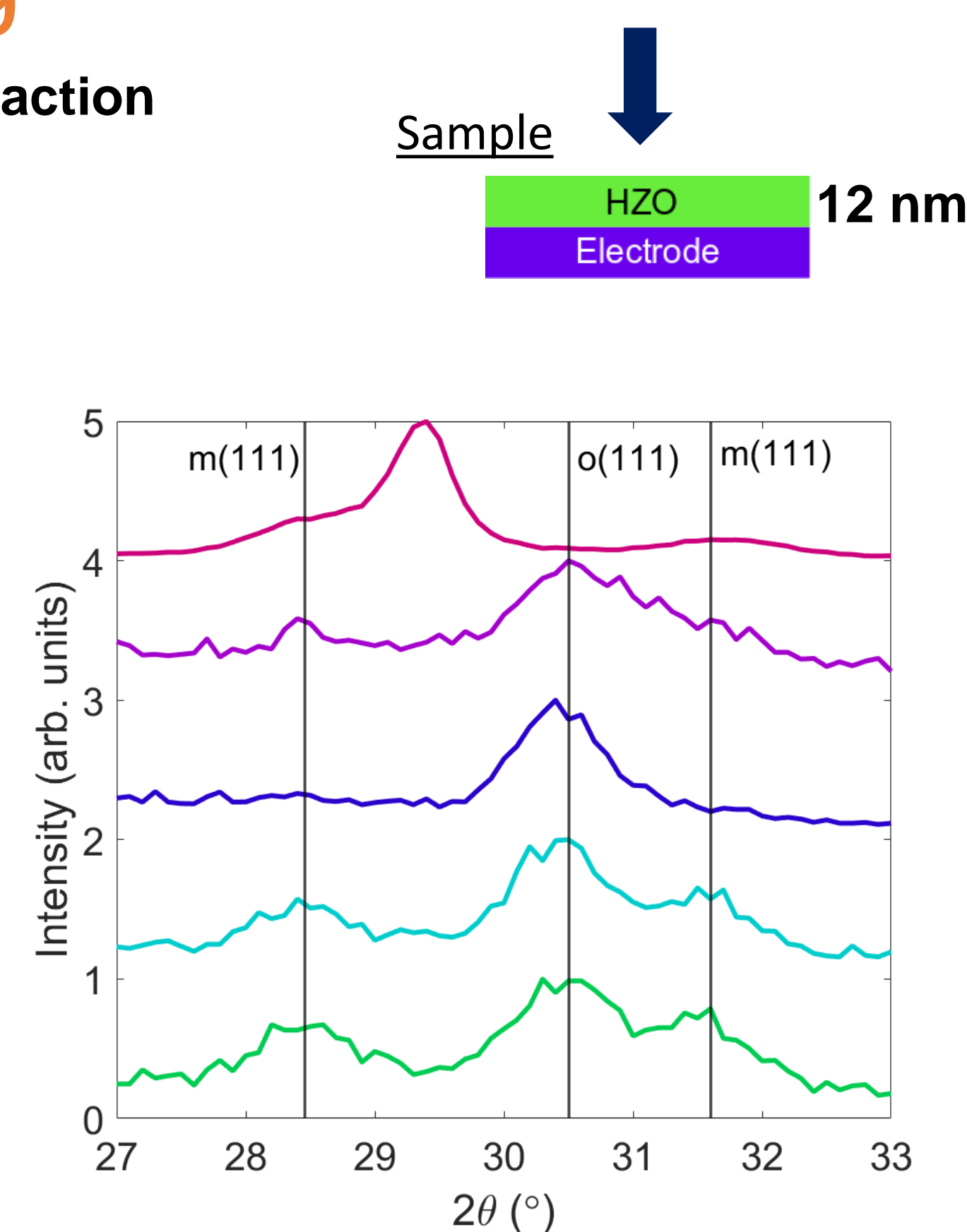
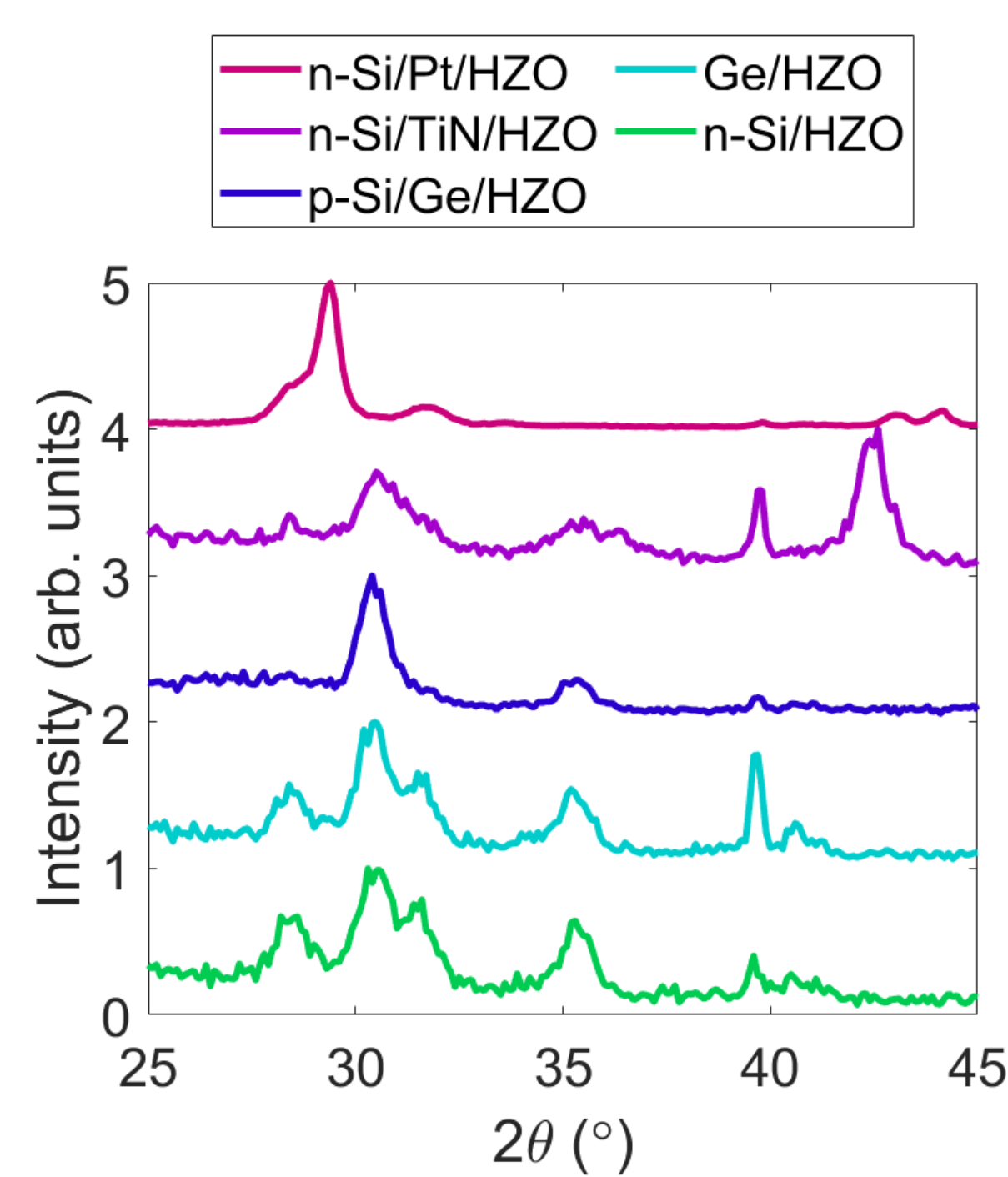
Neuromorphic computing is promising for the processing of massive data with an extremely low power consumption. After the discovery of memristors the research has been focused on the study and development of novel artificial neuromorphic devices, including ferroelectric-based ones.

Ferroelectric Tunnel Junction (FTJ) type memristors based on zirconium-doped hafnium oxide (HfZrO<sub>2</sub> or HZO) have shown synaptic learning capabilities. HZO processes are already integrated in Si CMOS industry and its ferroelectric properties allow to obtain oxide layers thinner than 10 nm. Nevertheless the endurance properties should be improved for industrial applications and the nucleation and stabilization of the ferroelectric phase (f-phase) is not yet well understood.



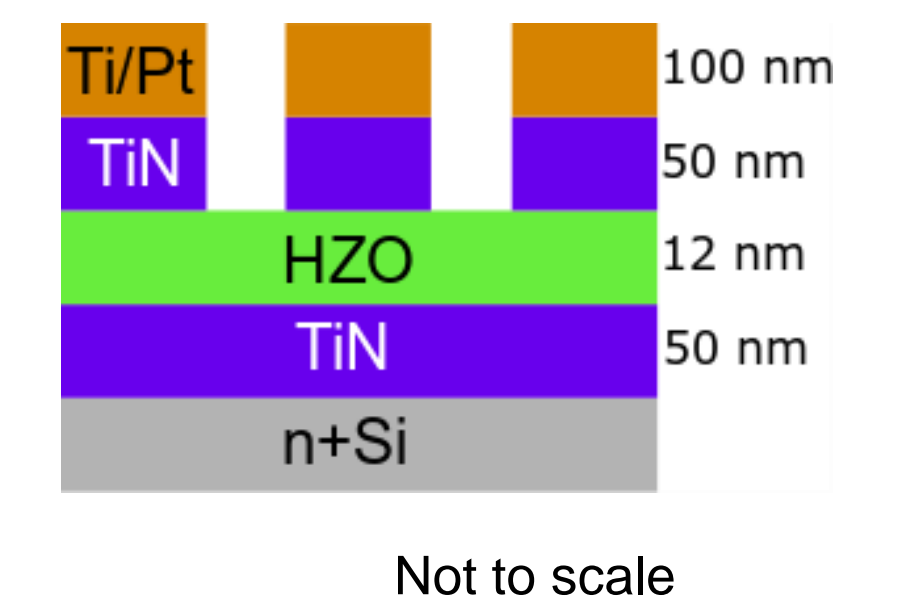
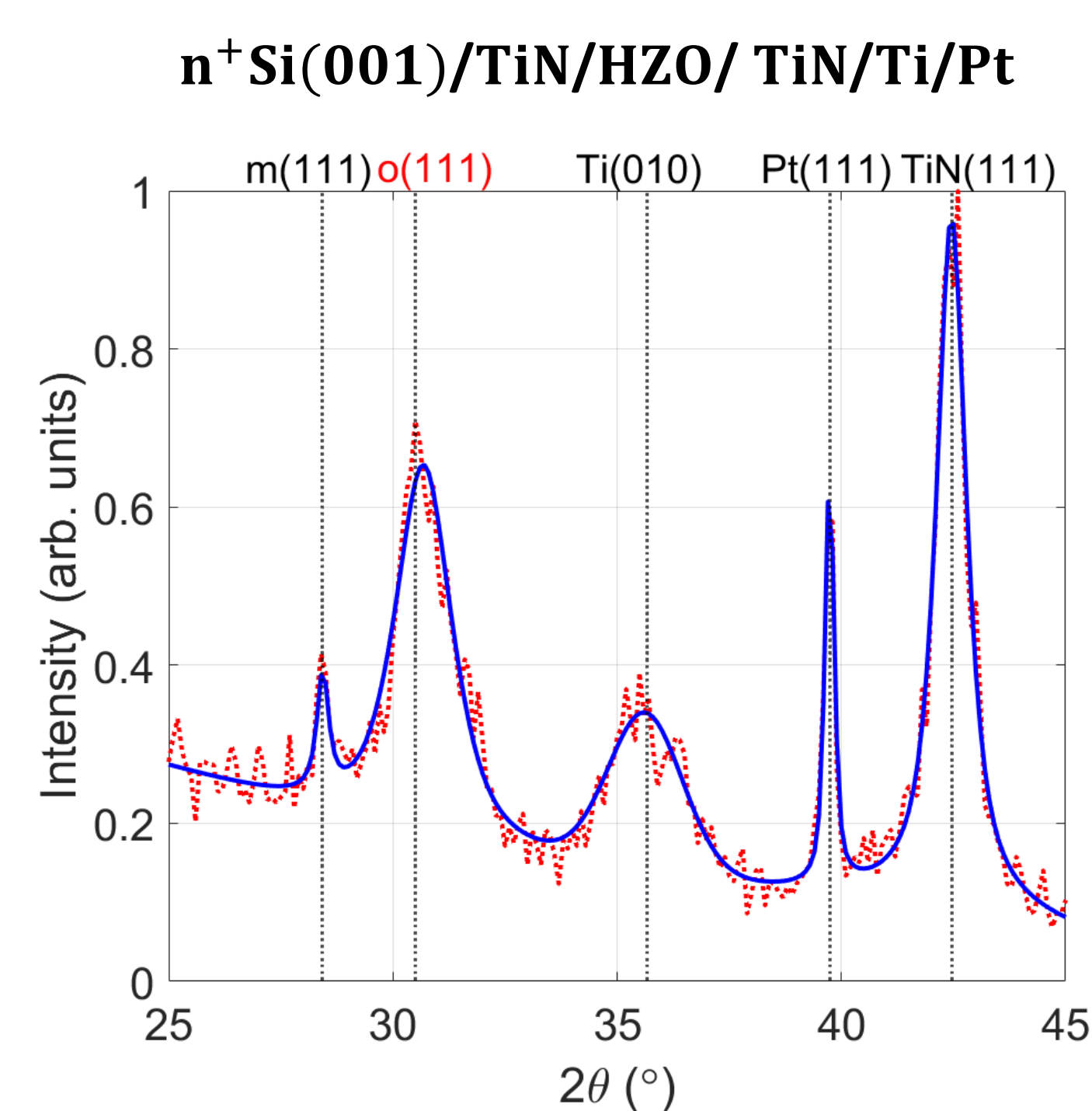
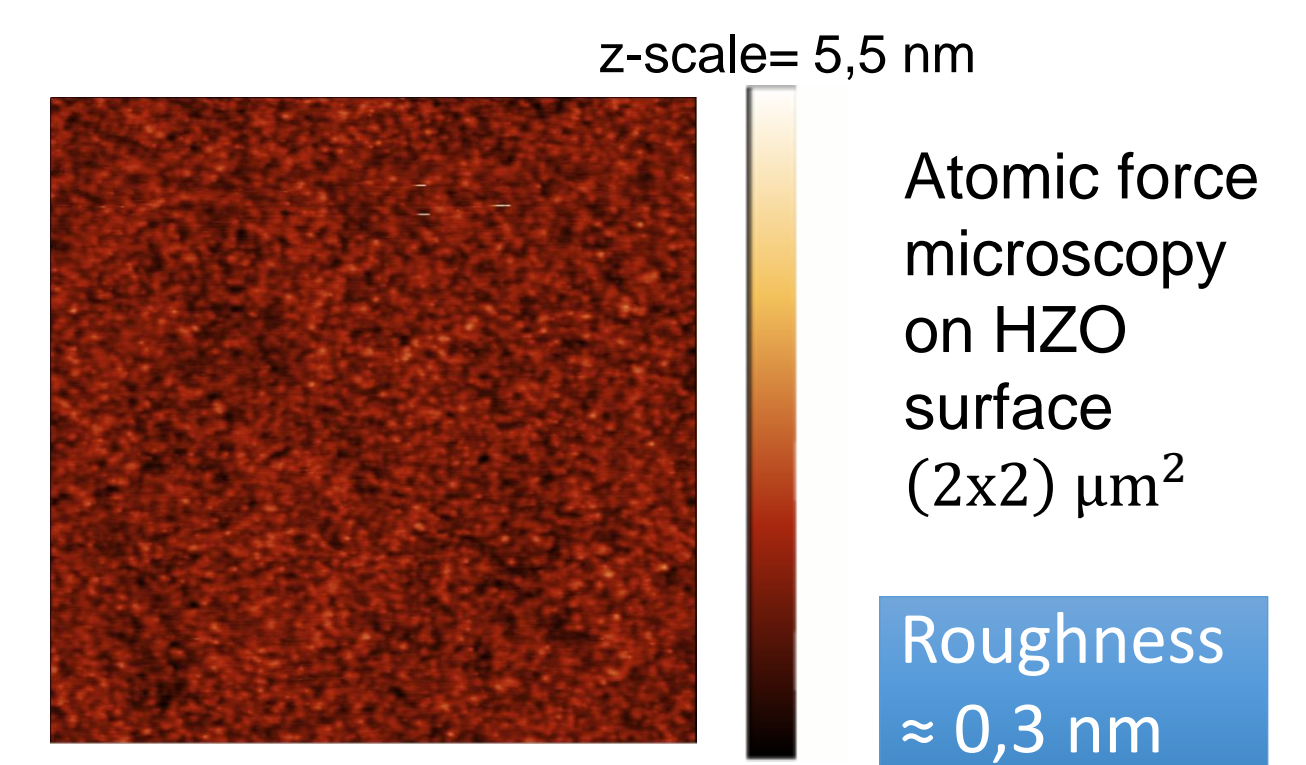
## Structural characterisation of HZO films deposited by sputtering

Post-annealing Grazing Incidence X-Ray Diffraction Characterisation:



### TiN bottom electrode (BE):

- Prevents degradation of ferroelectric phase
- Provides large ferroelectric polarization



## Impact of ultra-thin Ti buffer layer: structural analysis for different thicknesses of HZO

Ferroelectricity confirmed by electrical characterisation: PUND (Positive Up Negative Down) technique



Post-annealing the Ti turns into TiO<sub>2</sub> which:

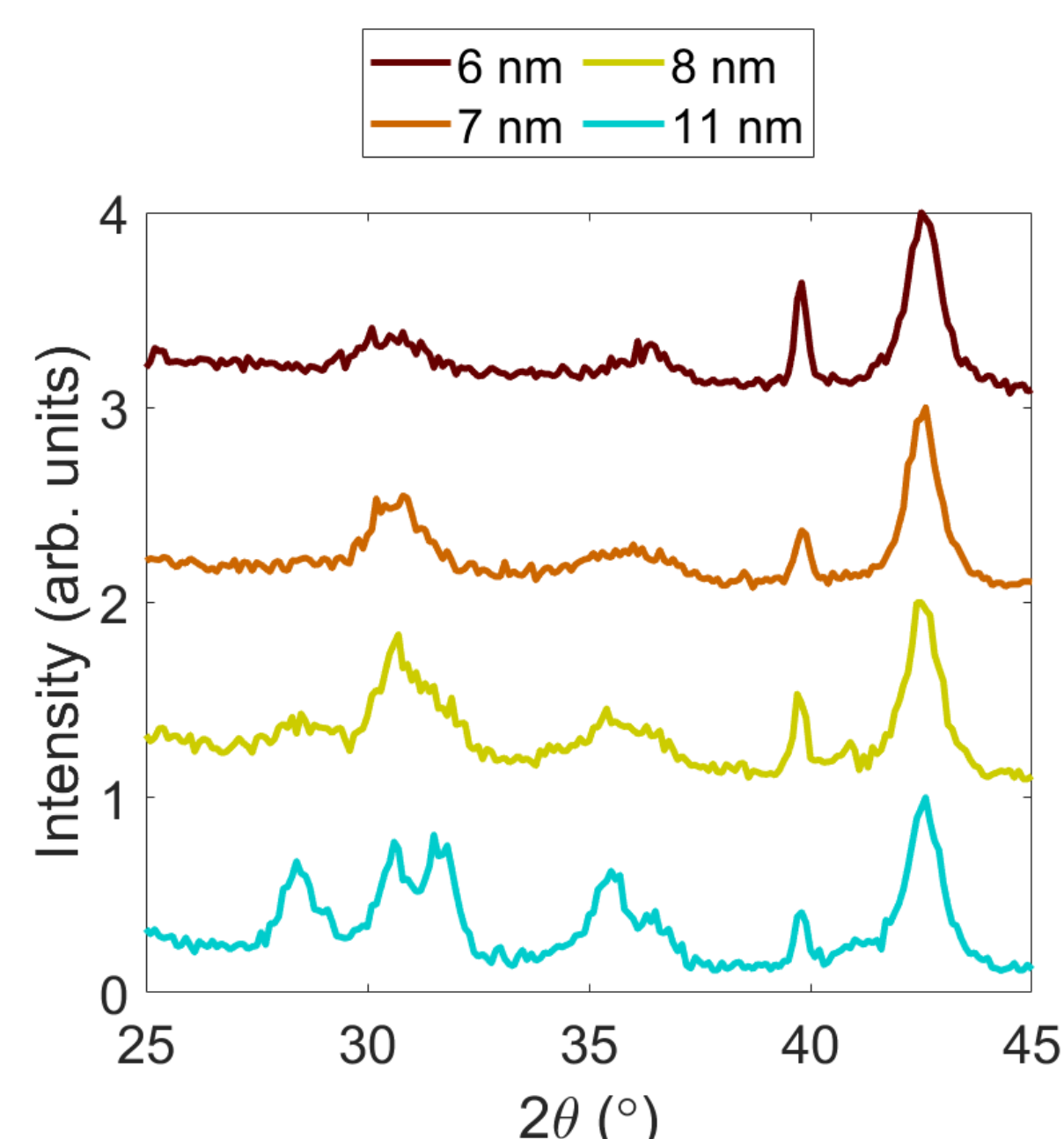
- Stabilize ferroelectric layer in HZO
- Increase oxygen vacancies in the HZO barrier
- Creates defects at the electrode/HZO interface

Increase of leakage current

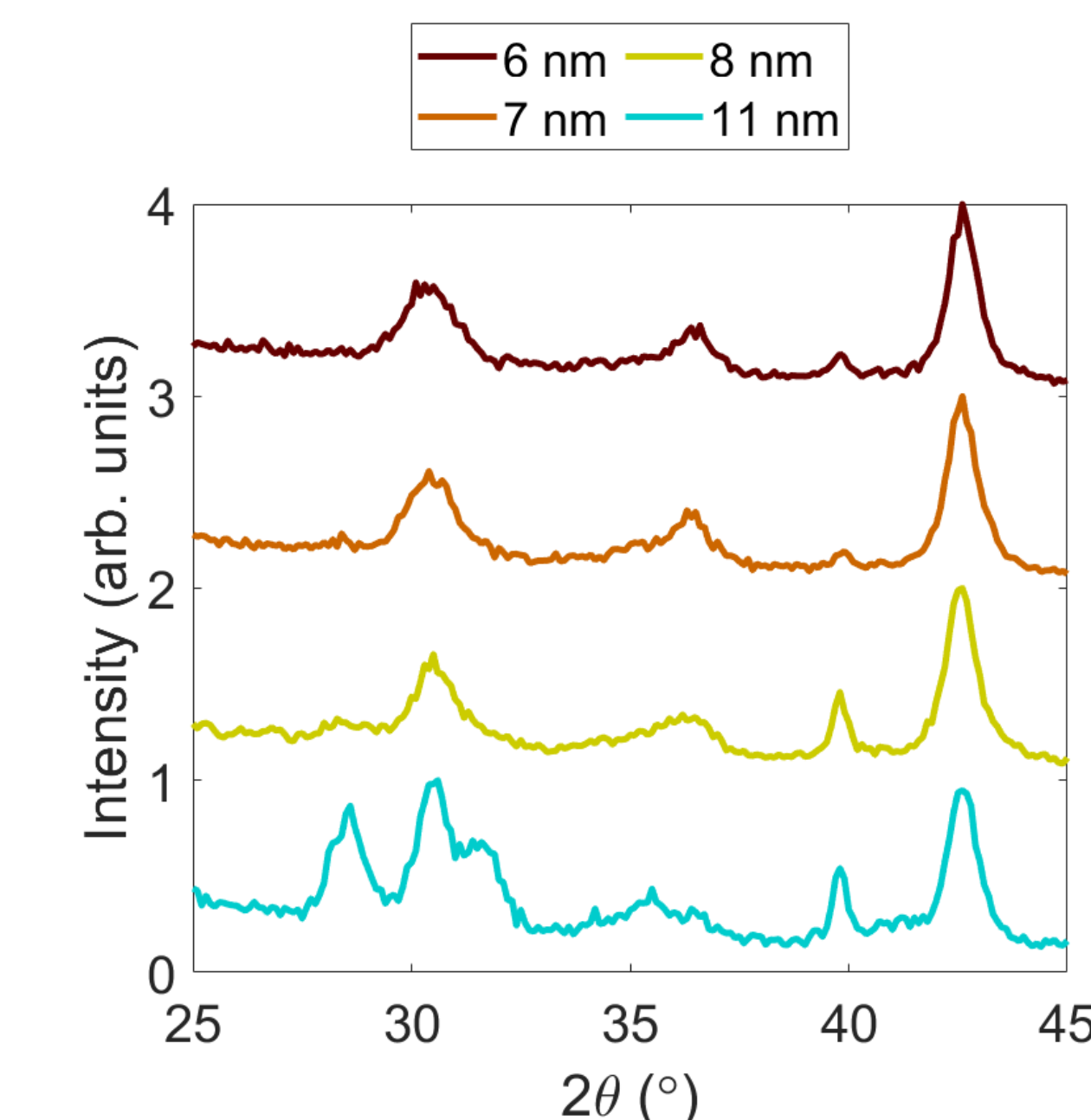
HZO ~ 11 nm

Ti layer	2P <sub>r</sub> ( $\mu\text{C.cm}^{-2}$ )	Cycling voltage (V)	Endurance (cycles)
No	20.33	4.5	10 <sup>6</sup>
Yes	28.12	4.5	10 <sup>6</sup>

n<sup>+</sup>Si(001)/TiN/HZO/TiN/Ti/Pt



n<sup>+</sup>Si(001)/TiN/Ti/HZO/TiN/Ti/Pt



## Conclusions

- ✓ Realisation of thin ferroelectric layers by magnetron sputtering
- ✓ Ultrathin buffer layer to promote ferroelectricity at low thickness
- ✓ Positive impact of the buffer layer on the electrical performances