

## **Supplementary Material**

### **ZnO Thin Films Growth Optimization for Piezoelectric Application**

V. Polewczyk <sup>1, \*</sup>, R. Magrin Maffei <sup>2,3</sup>, G. Vinai <sup>1</sup>, M. Lo Cicero <sup>4</sup>, S. Prato <sup>4</sup>, P. Capaldo <sup>1,5</sup>, S. Dal Zilio <sup>1</sup>,  
A. di Bona <sup>2</sup>, G. Paolicelli <sup>2</sup>, A. Mescola <sup>2</sup>, S. D'Addato <sup>2,3</sup>, P. Torelli <sup>1</sup> and S. Benedetti <sup>2,\*</sup>

<sup>1</sup> *Istituto Officina dei Materiali (IOM)-CNR, Laboratorio TASC, 34149 Trieste, Italy*

<sup>2</sup> *Istituto Nanoscienze-CNR, via Campi 213/a, 41125 Modena, Italy*

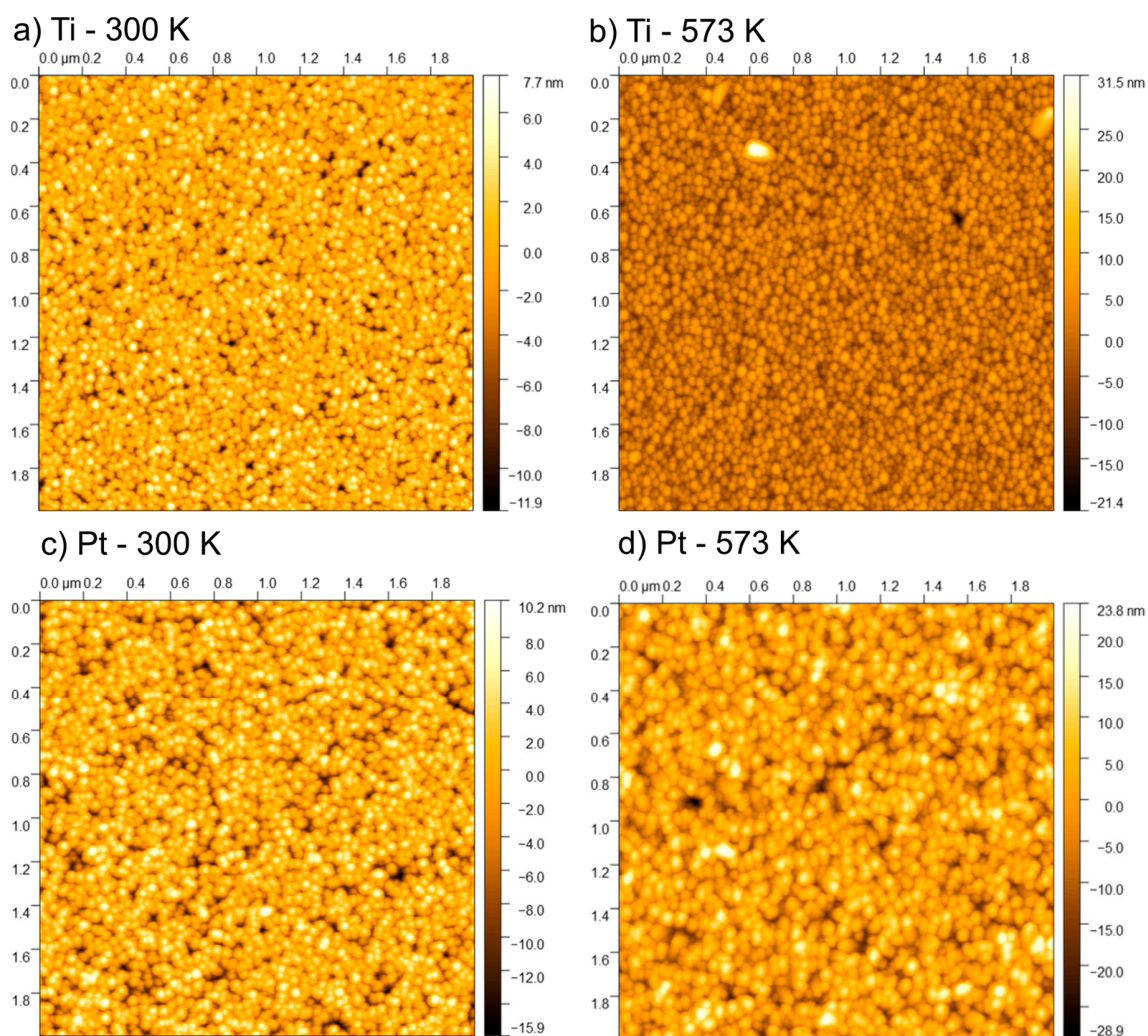
<sup>3</sup> *Dipartimento di Scienze Fisiche Informatiche Matematiche, Università di Modena e Reggio Emilia, via Campi 213/a, 41125 Modena, Italy*

<sup>4</sup> *A.P.E. Research srl, Area Science Park, Basovizza, ss14 Km 163.5, I-34149, Trieste, Italy*

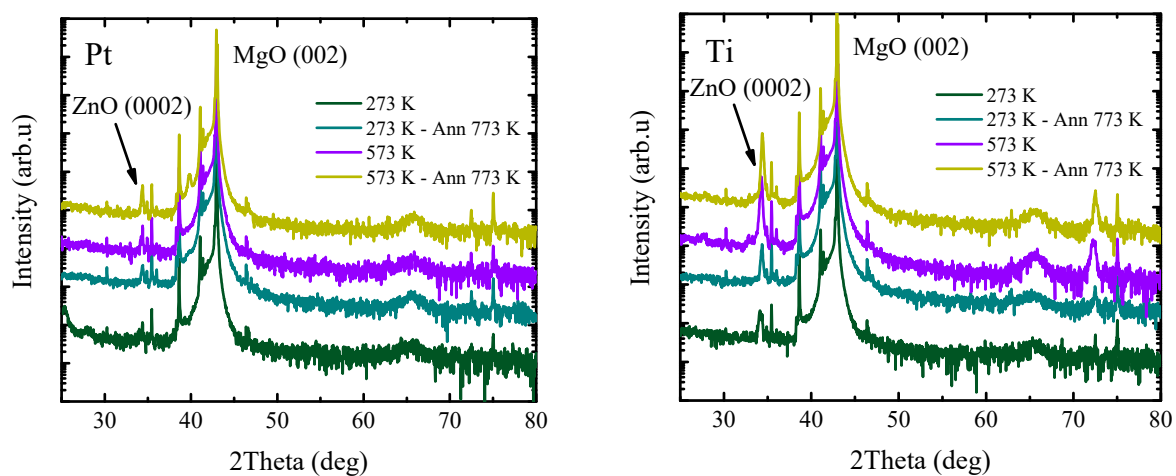
<sup>5</sup> *Dipartimento di Fisica e Astronomia, Università di Padova, via F Marzolo 8, I-35131, Padova, Italy*

\* stefania.benedetti@nano.cnr.it

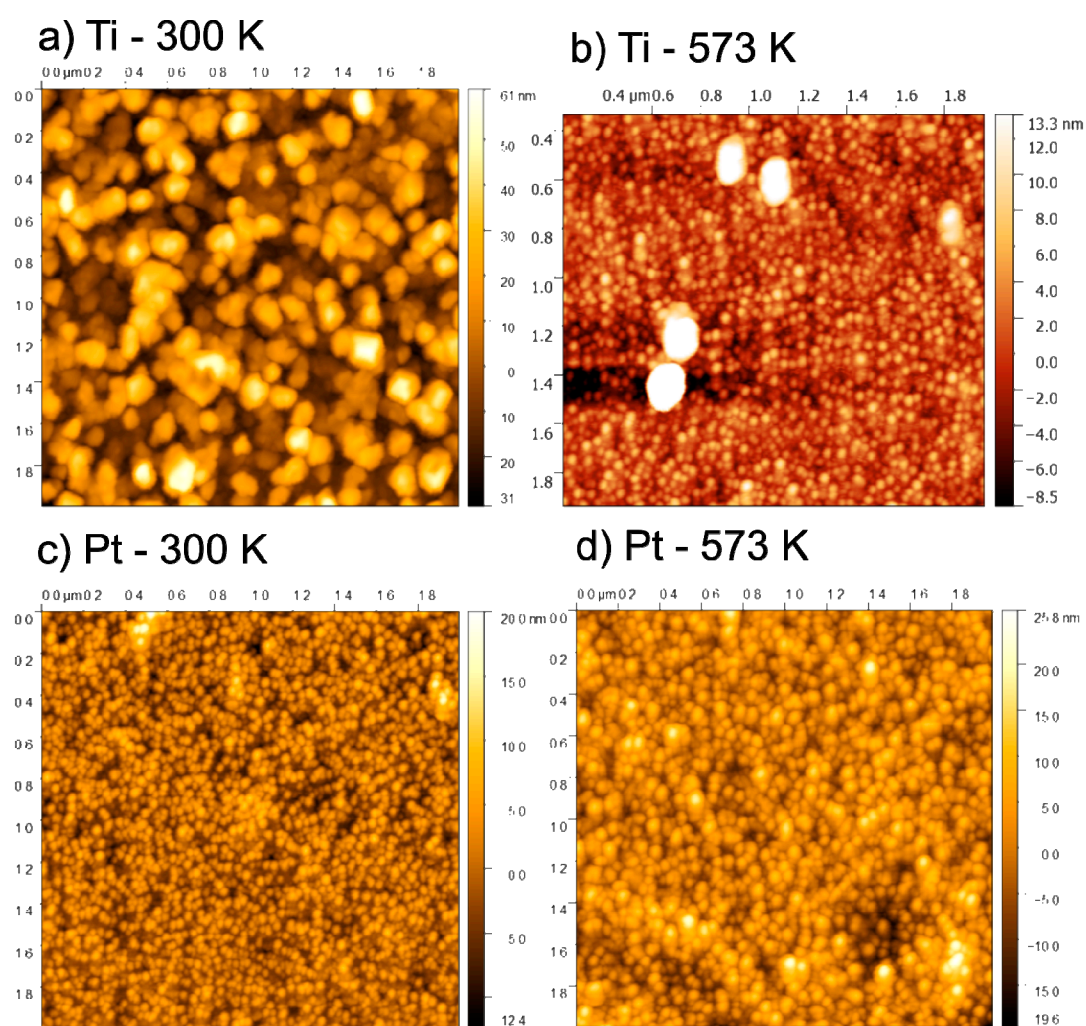
\* polewczyk@iom.cnr.it



**Figure S1.** AFM  $2 \times 2 \mu\text{m}^2$  images of 300 nm ZnO grown on a,b) 25 nm Ti and c,d) 25 nm Pt on MgO(001) at (a,c) RT and (b,d) 573 K.

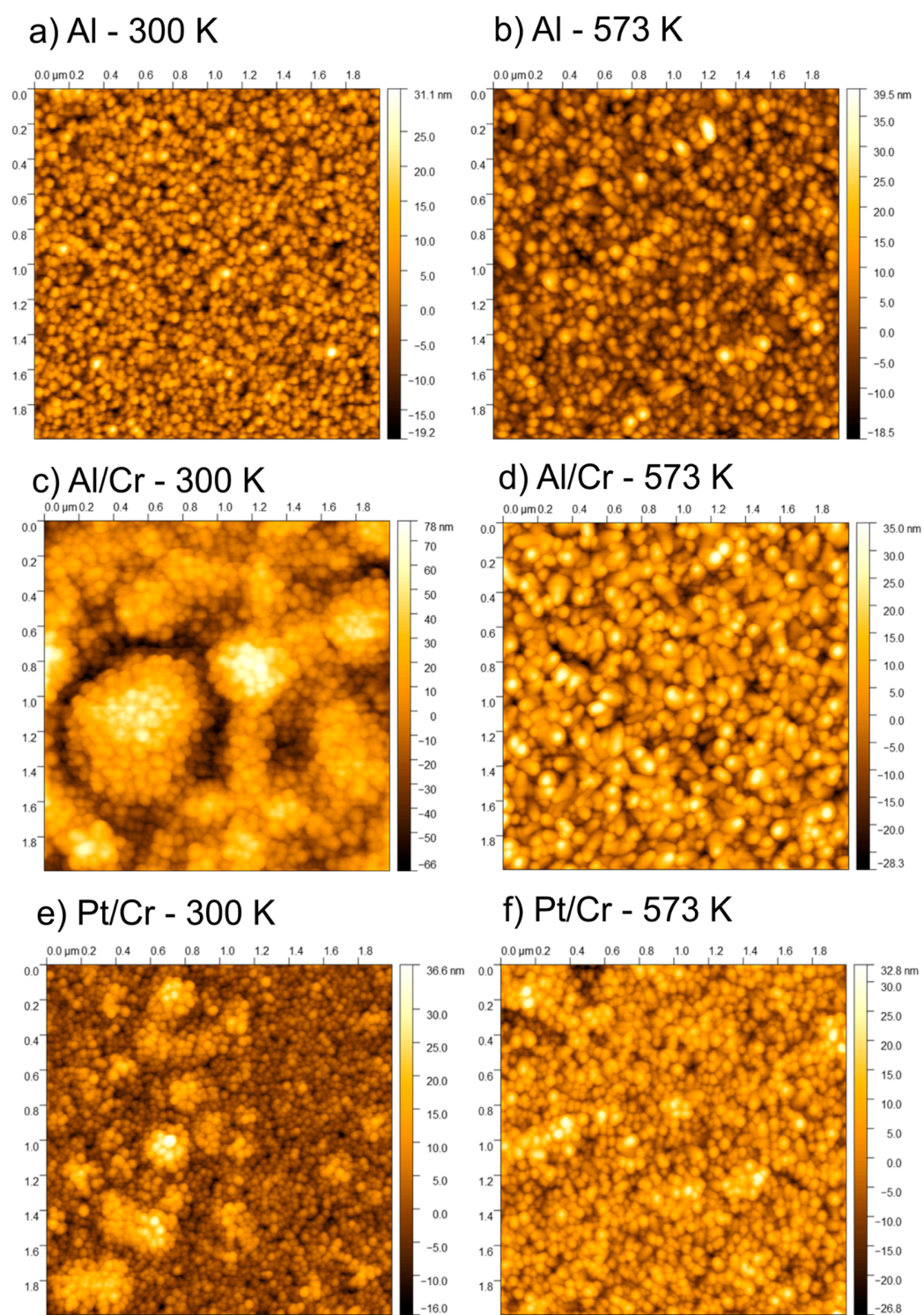


**Figure S2.** XRD  $\theta - 2\theta$  scans on 300 nm ZnO film on 25 nm Pt (left) and 25 nm Ti (right) on MgO(001).



**Figure S3.** AFM  $2 \times 2 \mu\text{m}^2$  images of 300 nm ZnO grown on electrodes as in Figure S1 after post-growth annealing at 773 K in 50%  $\text{O}_2$  and 50%  $\text{N}_2$ .



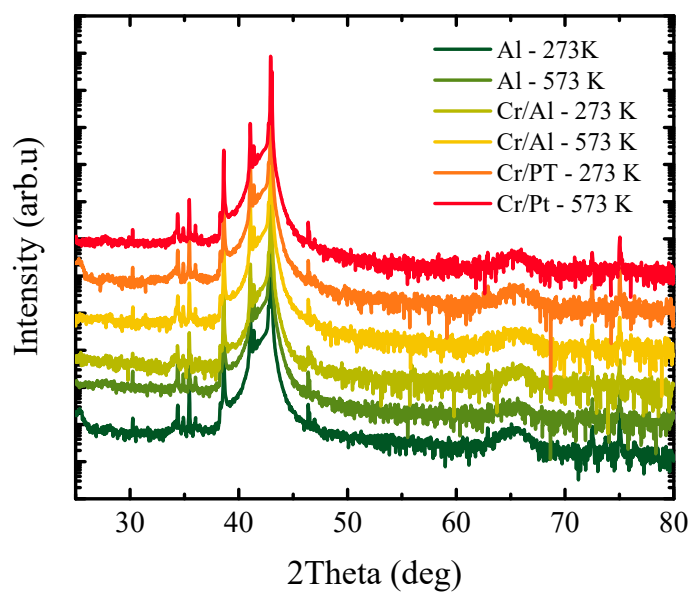


**Figure S4.** AFM  $2 \times 2 \mu\text{m}^2$  images of 300 nm ZnO grown on a,b) 25 nm Al, c,d) 20 nm Al/5 nm Cr, e,f) 20 nm Pt/5 nm Cr on MgO(001) at (a,c,e) RT and (b,d,f) 573 K.

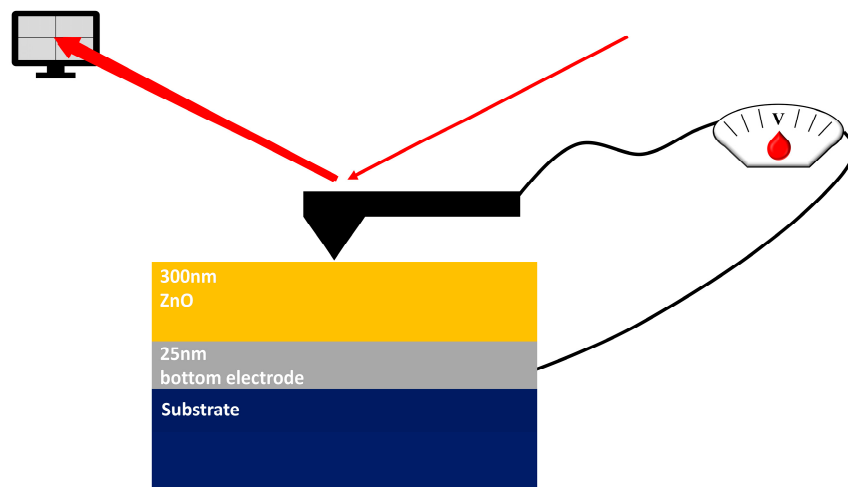


**Table S1.** Measured experimental parameters from AFM images of ZnO films on the different electrodes, deposited in 75% O<sub>2</sub> at RT and 573 K.

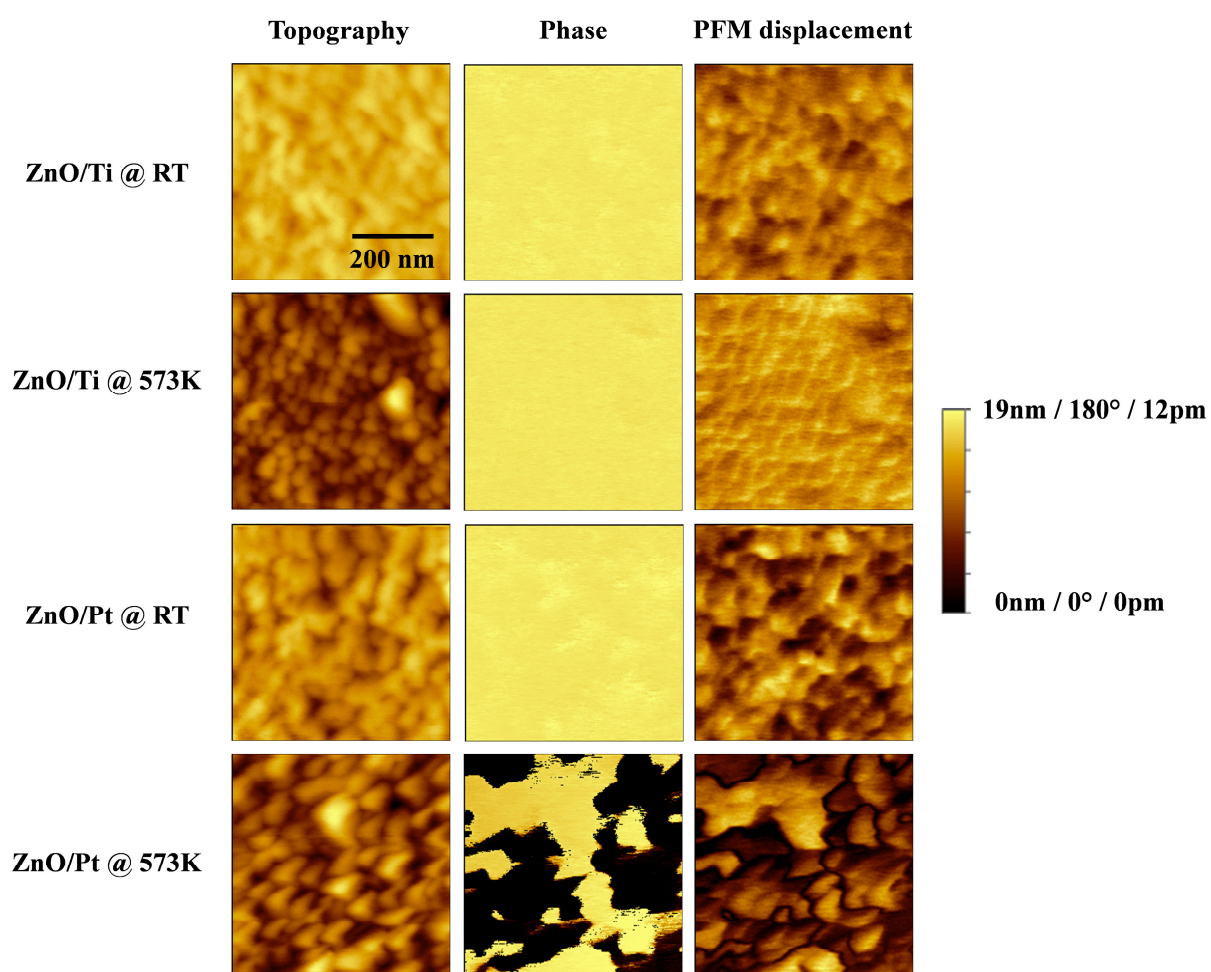
Sample (ZnO deposition temperature)	RMS roughness (nm)	Grain diameter (nm)
Al (RT)	13 ± 7	28 ± 2
Al (573 K)	6.7 ± 0.1	30 ± 4
Ti (RT)	2.3 ± 0.3	19 ± 2
Ti (573 K)	3.4 ± 0.2	21 ± 1
Pt (RT)	3.4 ± 0.5	24 ± 2
Pt (573 K)	6.0 ± 0.2	28 ± 3
Al/Cr (RT)	6.1 ± 0.2	27 ± 3
Al/Cr (573 K)	9.1 ± 0.6	34 ± 7
Pt/Cr (RT)	5.7 ± 0.8	22 ± 2
Pt/Cr (573 K)	7 ± 1	28 ± 3



**Figure S5.** XRD  $\theta - 2\theta$  scans on 300 nm ZnO film on Al, Al/Cr and Pt/Cr electrodes on MgO(001).



**Figure S6.** Sketch of PFM and film heterostructure.



**Figure S7.** Topography, phase and amplitude measured in PFM on ZnO films grown on Pt and Ti at RT and 573 K using a common scale between the different cases.