

## SUPPORTING INFORMATION

### LOW TEMPERATURE EPITAXY OF $\text{Fe}_3\text{O}_4$ THIN FILMS ON $\text{ZNO}(0001)$ AND RELATED INTERFACE STUDY

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HRTEM image taken along  $[11\bar{2}]$   $\text{Fe}_3\text{O}_4$  of the sample grown at  $260^\circ\text{C}$  under  $p\text{O}_2=1\times 10^{-6}$  Torr is displayed in figure 1(a). It reveals a flat interface  $\text{Fe}_3\text{O}_4/\text{ZnO}$ . The corresponding FFT (figure 1.(b)) confirms the  $\text{Fe}_3\text{O}_4[11\bar{2}]/\text{ZnO}[10\bar{1}0]$  orientation that was established with RHEED analysis.

In order to study the film relaxation, we study the deformation along  $[1\bar{1}0]$  axis of  $\text{Fe}_3\text{O}_4$  using geometrical phase analysis GPA method <sup>1</sup>. We construct the phase image represented in figure 1.(c) by selecting the two reflections  $\text{Fe}_3\text{O}_4(4\bar{4}0)$  and  $\text{ZnO}(110)$  indicated by yellow circle on the FFT image. Green rectangle represents the area selected as GPA measurements reference.

We present the obtained deformation map in figure 1(d), on which we distinguish two homogeneous regions: (i) green regions corresponds to ZnO substrate, (ii) blue region corresponds to the  $\text{Fe}_3\text{O}_4$  film; which are separated by a clear interface containing periodic orange spots indicated with red arrows, these dots correspond to a local deformations around misfit dislocations.

Figure 1(e) represents the deformation profile integrated over  $\sim 10\text{nm}$  width. The deformation between the film and the substrate is estimated to be  $\sim 8.5\%$ , which corresponds perfectly to the nominal mismatch between  $\text{Fe}_3\text{O}_4(111)$  and  $\text{ZnO}(0001)$ . The sharp deformation at the interface suggests that the film grows *fully relaxed* since the first monolayers via the formation of misfit dislocations at the interface.

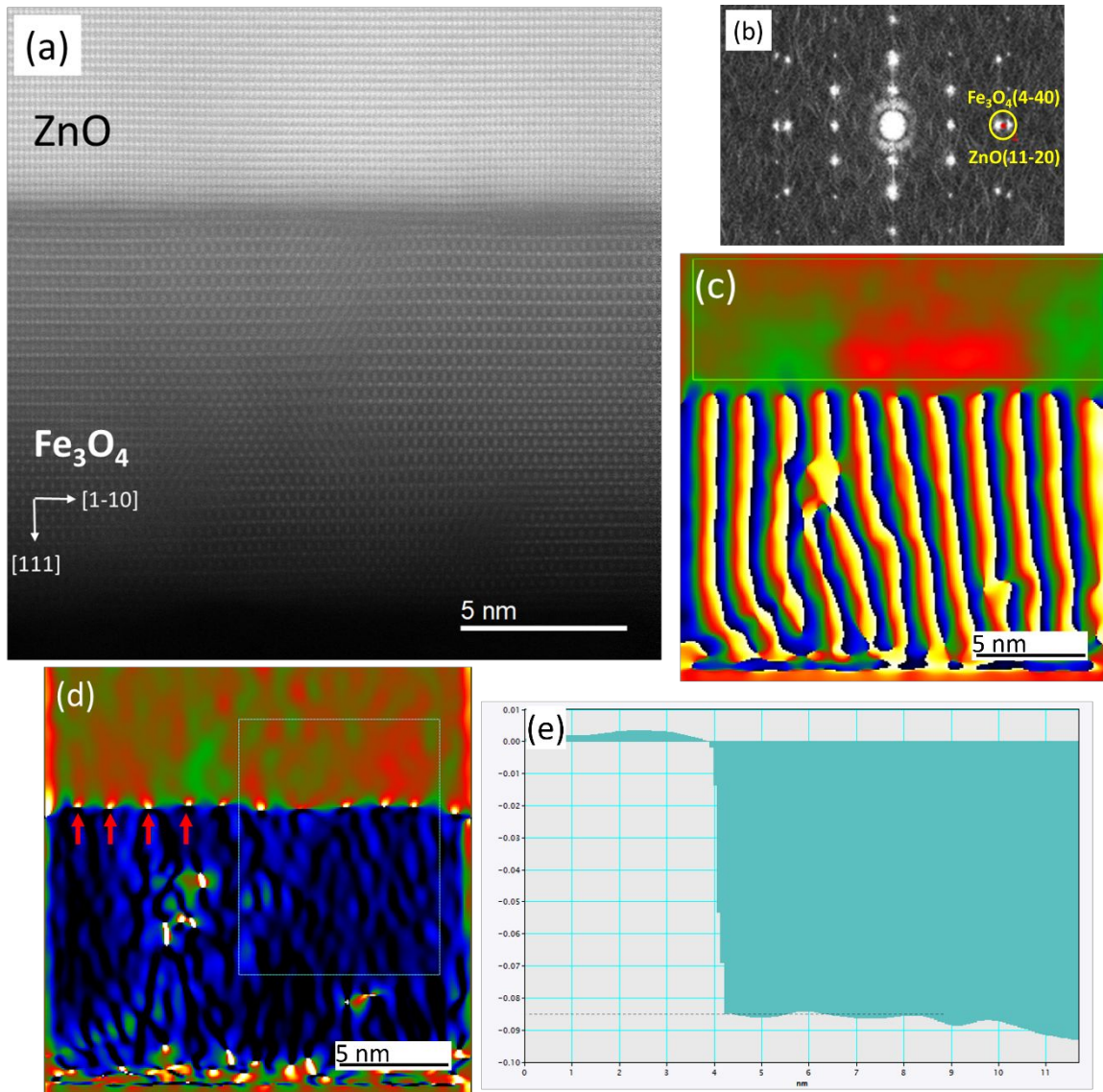


Figure 1. (a) cross-section HRTEM micrograph of the interface  $\text{Fe}_3\text{O}_4/\text{ZnO}$  taken along zone axis  $[11\bar{2}]$  of  $\text{Fe}_3\text{O}_4$ , (b) corresponding fast Fourier transform (FFT), the selected diffractions correspond to  $\text{Fe}_3\text{O}_4$ ,  $(4\bar{4}0)$  and  $\text{ZnO}(110)$ , (c) phase image constructed from the selected area around  $\text{Fe}_3\text{O}_4$ ,  $(4\bar{4}0)$  and  $\text{ZnO}(110)$  diffractions obtained using GPA taking the ZnO region as reference, (d) GPA deformation map, red arrows indicate deformations at the misfit dislocations, (e) integrated deformation profile across the interface

(1) Hÿtch, M. J. Geometric phase analysis of high-resolution electron microscope images.

