Table S1: Overview of the different applied parameters for ZnO:Al NPs syntheses obtained by heating-up thermal decomposition.

Reagents / Name	ZnO-ST	2Al-ST	3Al-ST	5Al-ST	8Al-ST	10Al-ST	2Al-no	2Al-PD	2Al-TD	2Al-BAm	2Al-SAc	2Al-12OAc	2Al-12OAm
Dibenzyl ether	√	√	√	√	√	√	√	√	√	√	√	√	√
$Zn(acac)_2.xH_2O$	√	√	√	√	√	√	√	√	√	√	√	√	√
2 % $Al(acac)_3$	-	√	-	-	-	-	√	√	√	√	√	√	√
3 % $Al(acac)_3$	-	-	√	-	-	-	-	-	-	-	-	-	-
5 % $Al(acac)_3$	-	-	-	√	-	-	-	-	-	-	-	-	-
8 % $Al(acac)_3$	-	-	-	-	√	-	-	-	-	-	-	-	-
10 % $Al(acac)_3$	-	-	-	-	-	√	-	-	-	-	-	-	-
10 mmol 1,2-hexadecanediol	√	√	√	√	√	√	-	-	-	√	√	√	√
10 mmol 1,2-propanediol	-	-	-	-	-	-	-	√	-	-	-	-	-
10 mmol 1,2-tetradecanediol	-	-	-	-	-	-	-	-	√	-	-	-	-
6 mmol oleic acid	√	√	√	√	√	√	√	√	√	√	-	-	-
6 mmol oleyl amine	√	√	√	√	√	√	√	√	√	-	√	-	-
6 mmol benzyl amine	-	-	-	-	-	-	-	-	-	√	-	-	-
6 mmol stearic acid	-	-	-	-	-	-	-	-	-	-	√	-	-
12 mmol oleic acid	-	-	-	-	-	-	-	-	-	-		√	-
12 mmol oleyl amine	-	-	-	-	-	-	-	-	-	-	-	-	√

Table S2: Band assignment for the FTIR spectrum (Figure 4) of ZnO:Al suspensions (2AL-ST and 2AL-BAm).

Wave number (cm^{-1})	Assignment
3100-3020	ν CH=
3000-2850	$\nu_a CH_2$, $\nu_s CH_2$, $\nu_a CH_2$-COO^-, $\nu_a CH_3$, $\nu s CH_3$
1680-1620	ν C=C
1500-1400	$\nu_a COO^-$, $\nu_s COO^-$
800-500	ν Zn-O

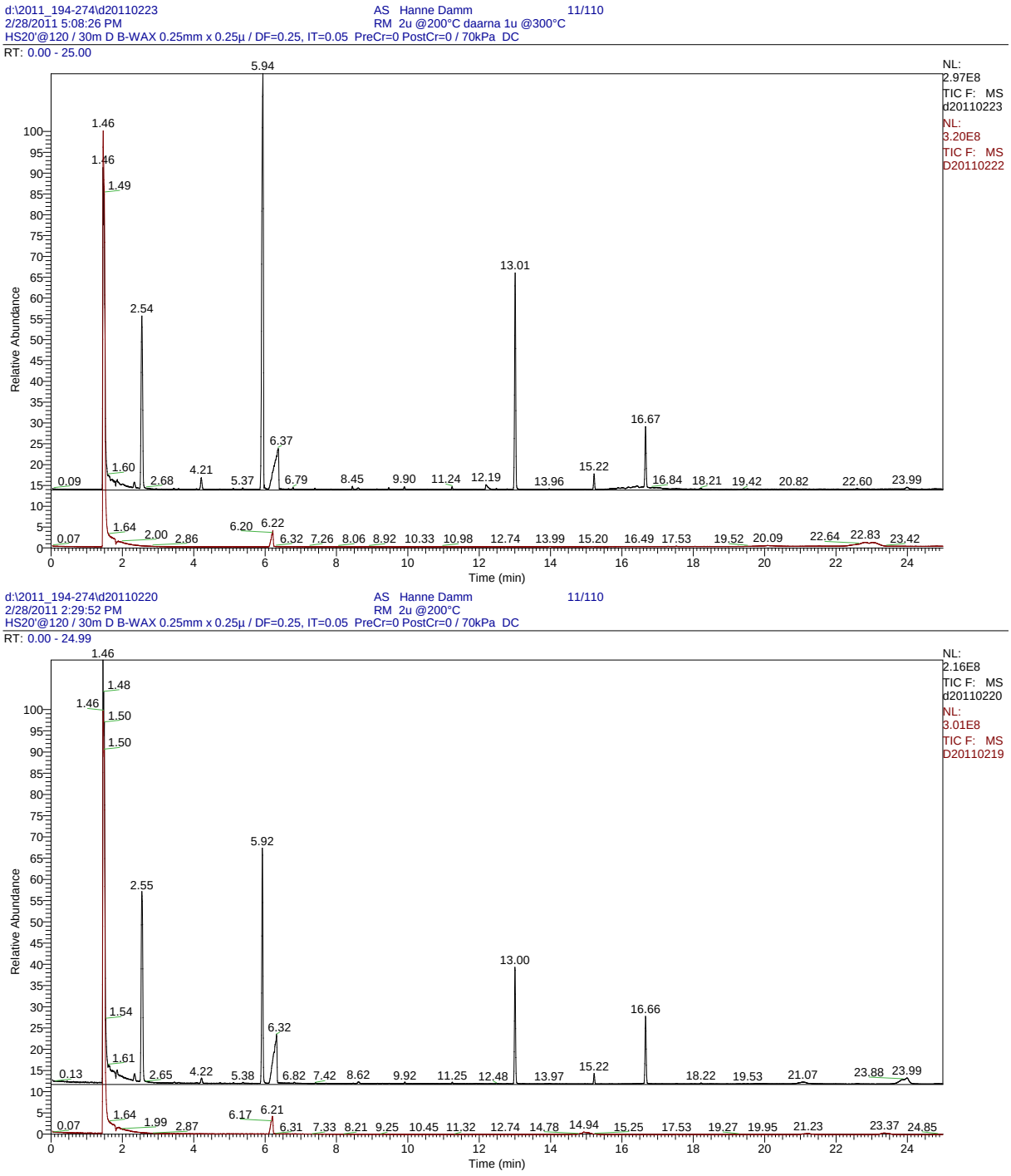

Figure S1: Chromatograms headspace GC-MS results

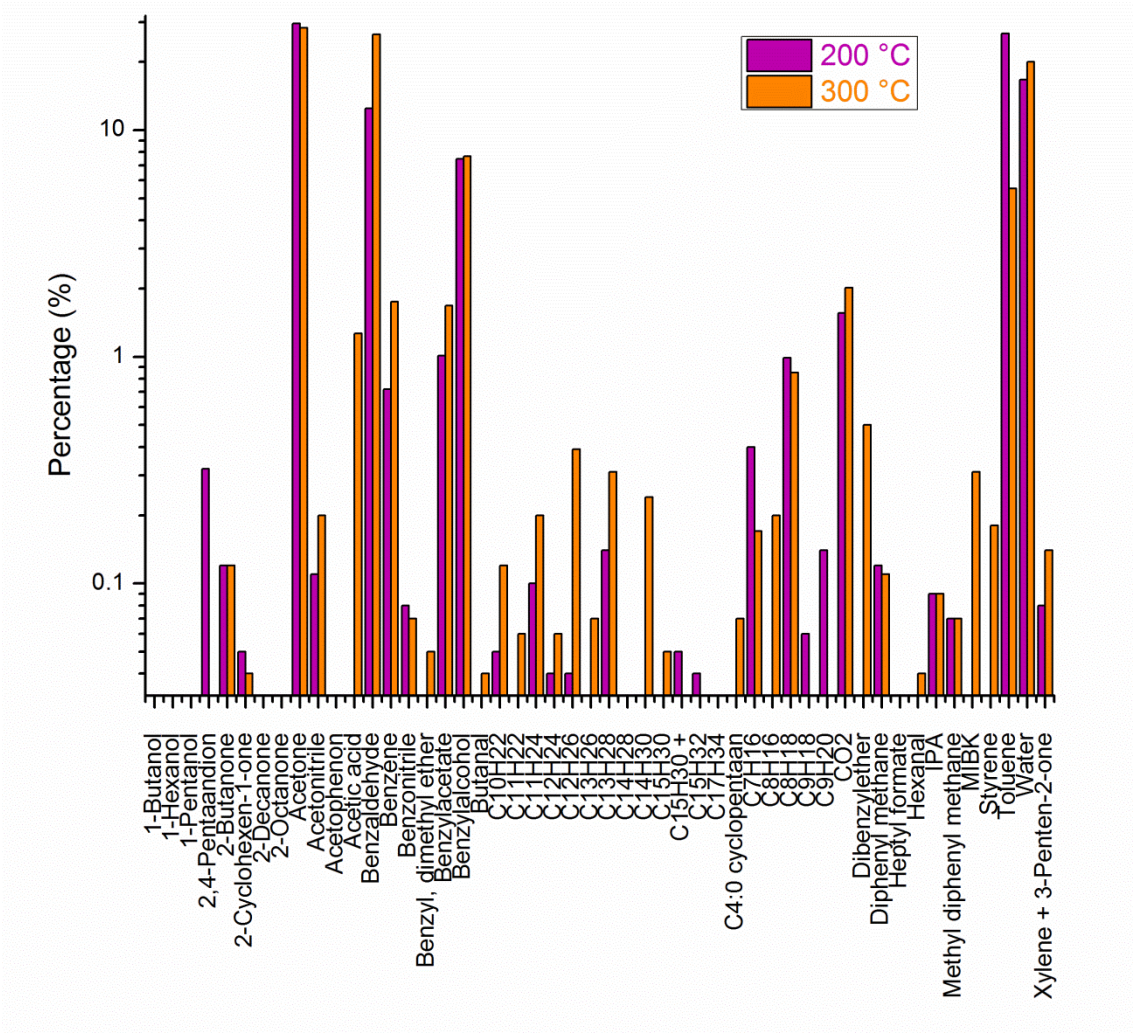

Figure S2: Detailed information of the released gases during the synthesis of ZnO:Al nanoparticles analysed with headspace GC-MS. The pink bars represent the released gases during the nucleation step at 200 °C, while the orange bars represent gases evolved during the growth step at 300 °C.

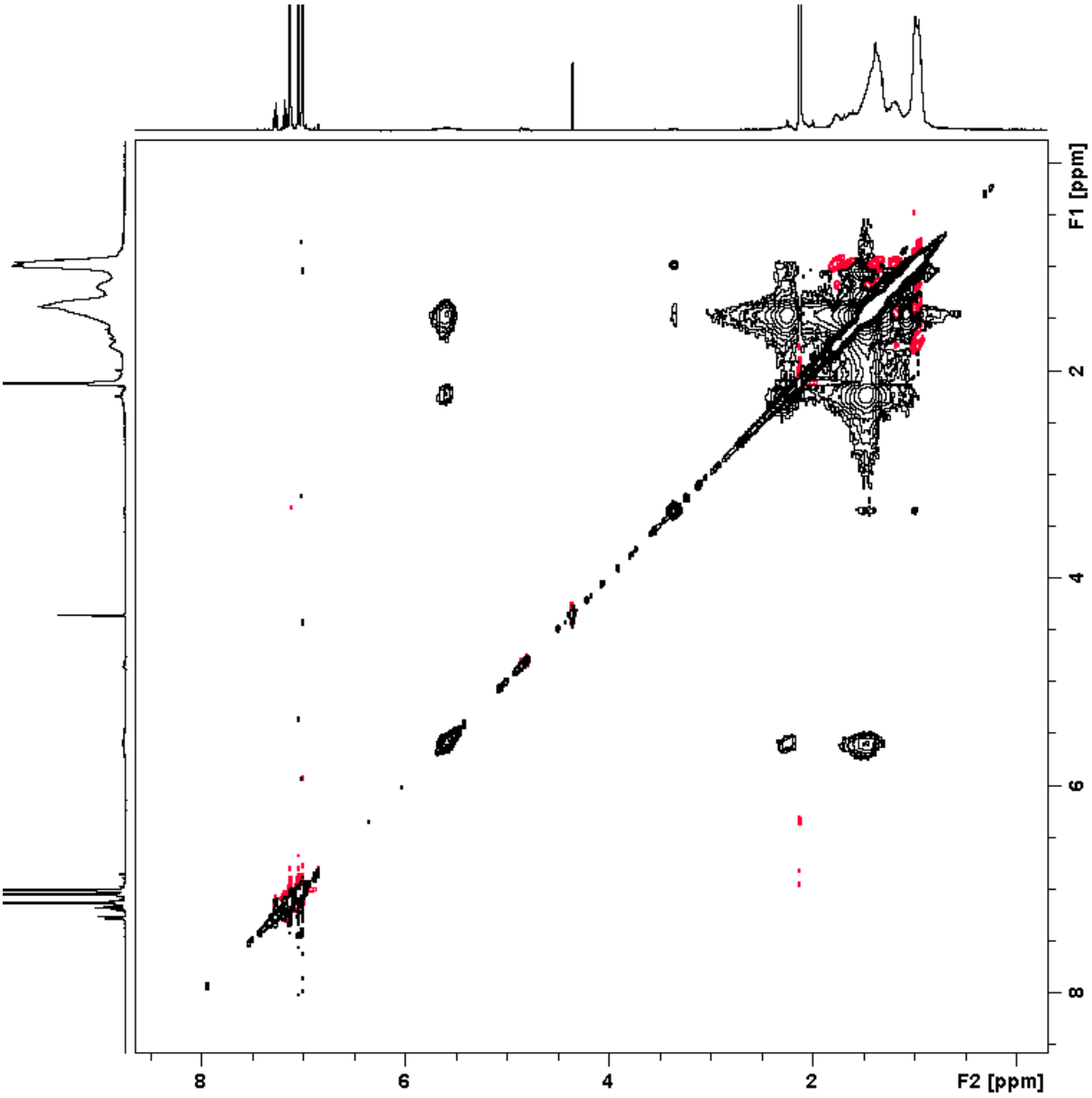

Figure S3: Negative NOE cross-peaks at the alkene resonance of 5.48 ppm indicate the interaction of oleic acid or oleylamine with the nanoparticle surface in 2Al-ST.

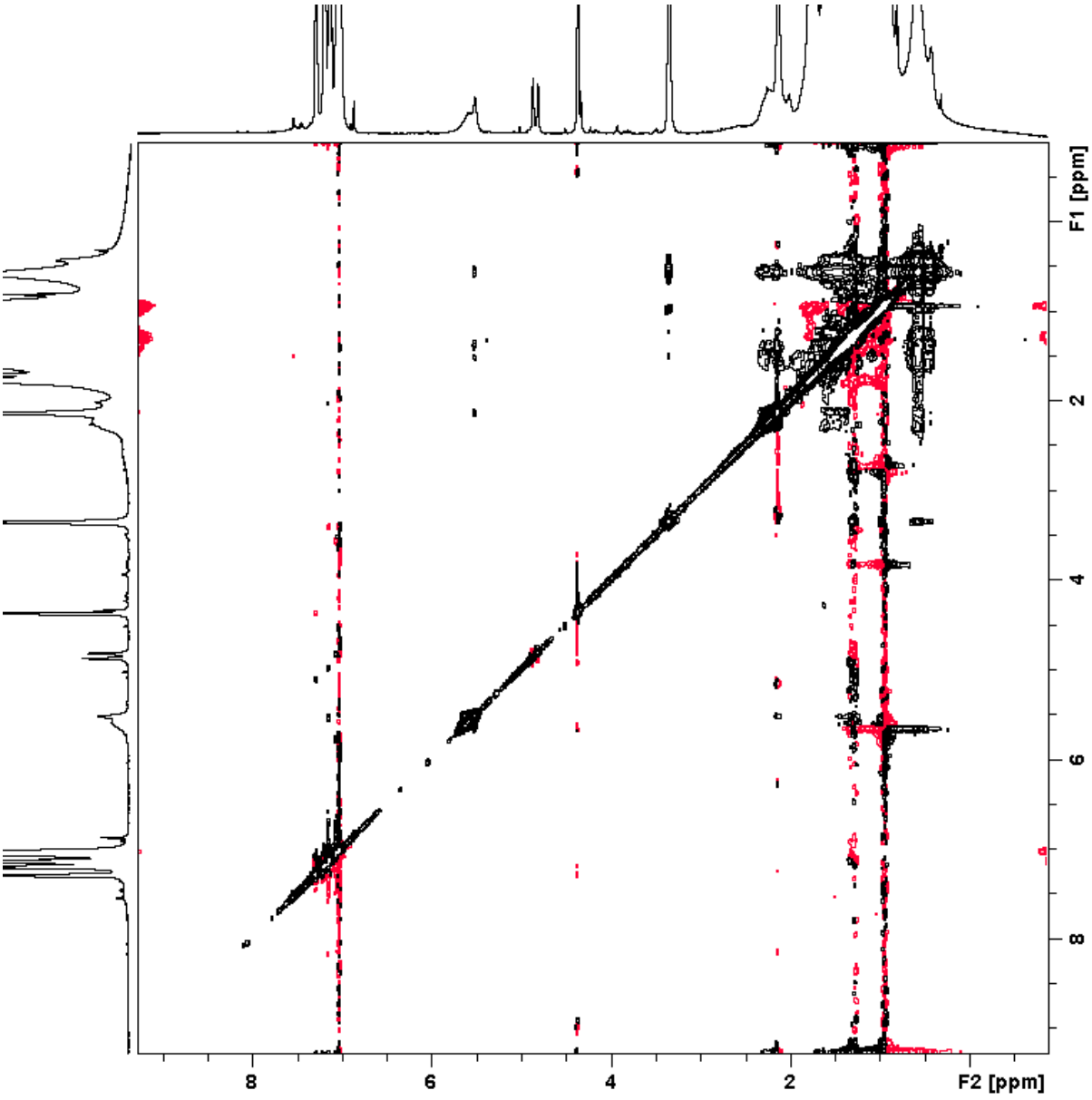

Figure S4: Negative NOE cross-peaks at the alkene resonance of 5.48 ppm indicate the interaction of oleic acid with the nanoparticle surface in 2Al-BAm.

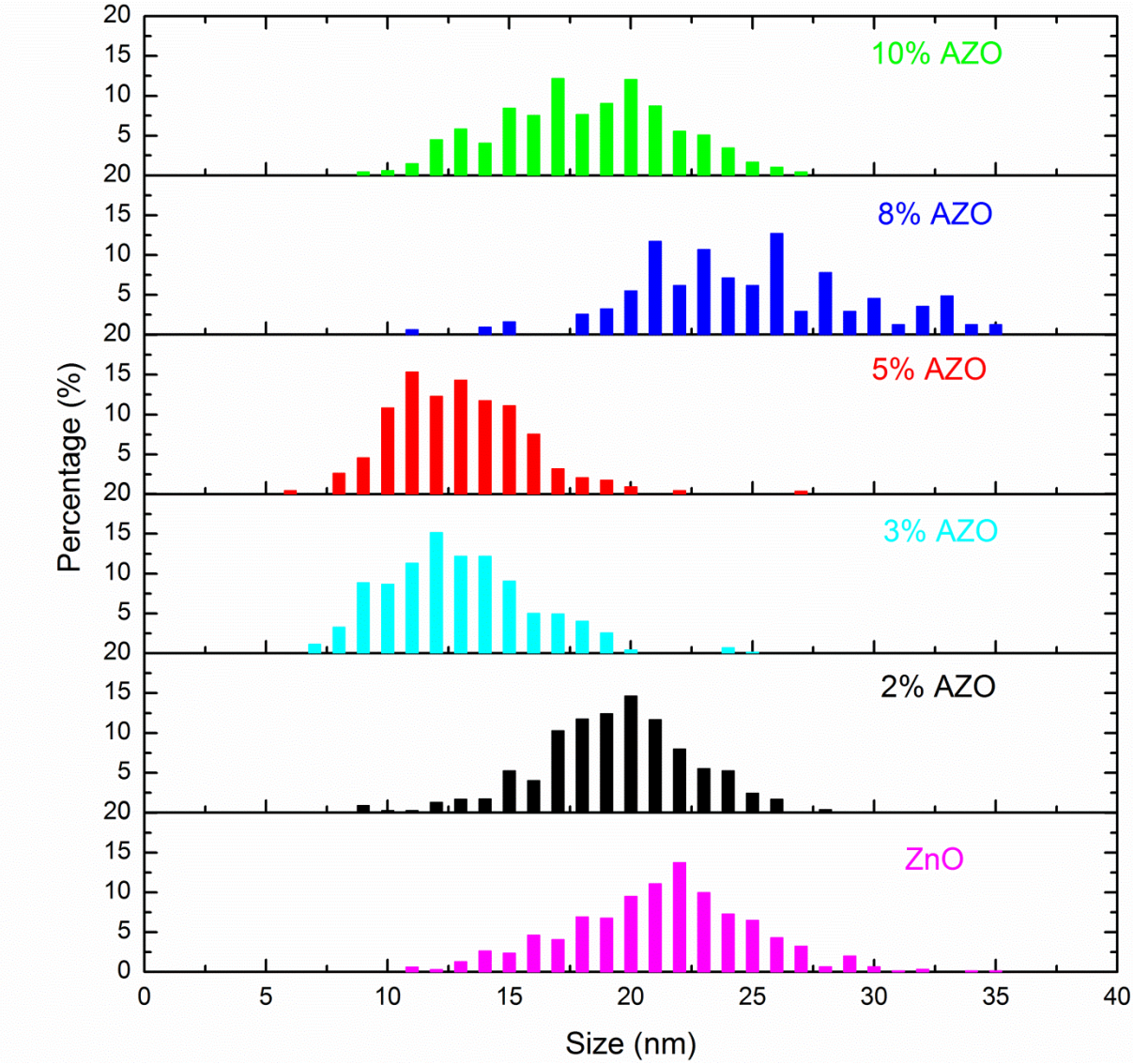

Figure S5: Analysis of the particles' size from the TEM images of the 0, 2, 3, 5, 8 and 10 at % ZnO:Al NPs. The average dry diameter of the 5 at % < 3 at % < 2 at % < 0 at % Al doping.

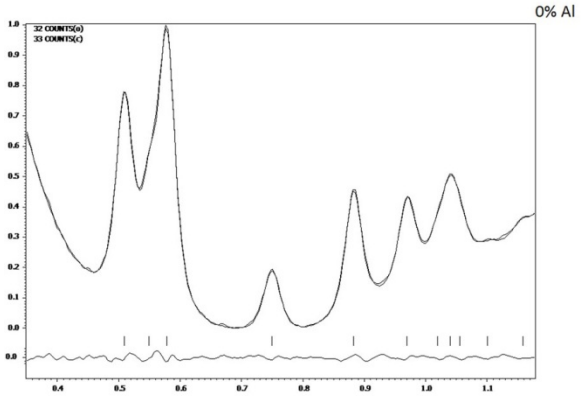

Figure S6a: profile of the precession ring diffraction pattern of ZnO:Al 0%, fitted with the ZnO wurtzite crystal structure.

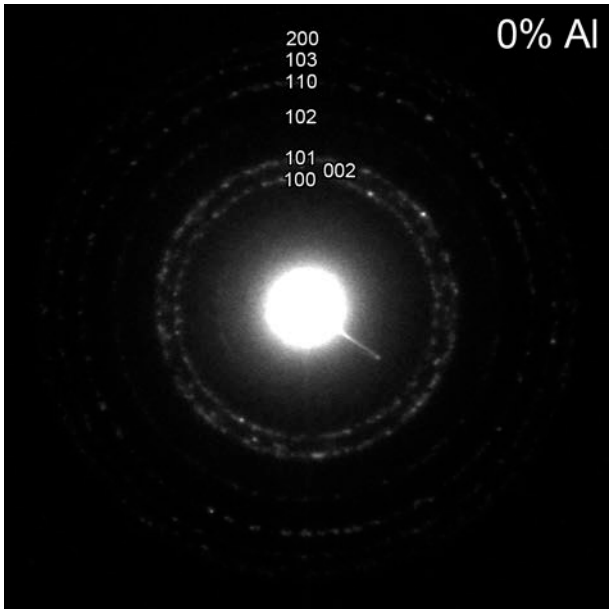

Figure S6b: precession ring diffraction pattern of ZnO:Al 0%. All the rings can be indexed with the ZnO wurtzite structure parameters.

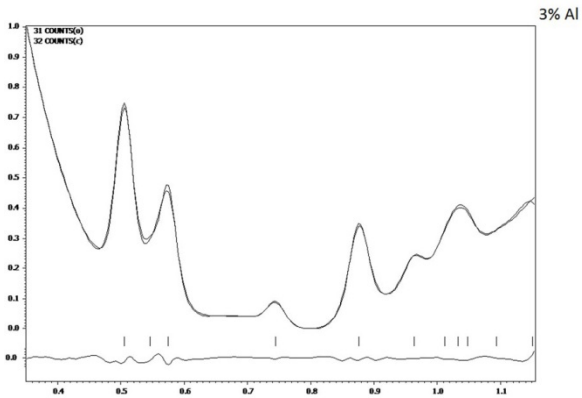

Figure S7a: profile of the precession ring diffraction pattern of ZnO:Al 3%, fitted with the ZnO wurtzite crystal structure.

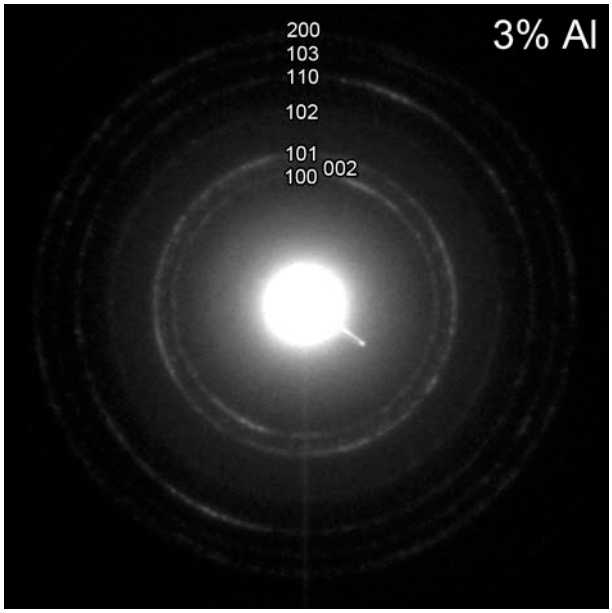

Figure S7b: precession ring diffraction pattern of ZnO:Al 3%. All the rings can be indexed with the ZnO wurtzite structure parameters.

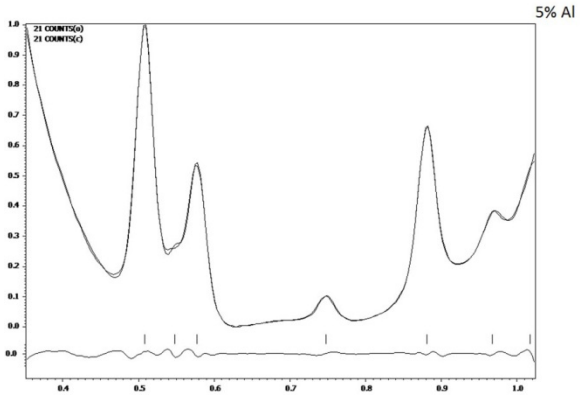

Figure S8a: profile of the precession ring diffraction pattern of ZnO:Al 5%, fitted with the ZnO wurtzite crystal structure.

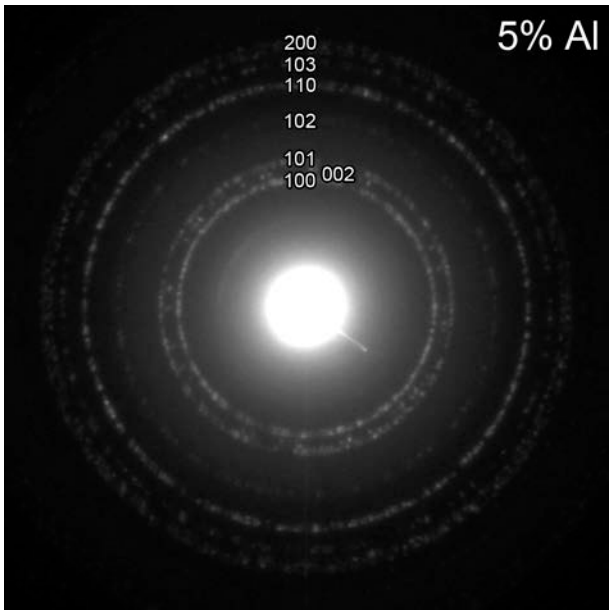

Figure S8b: precession ring diffraction pattern of ZnO:Al 5%. All the rings can be indexed with the ZnO wurtzite structure parameters.

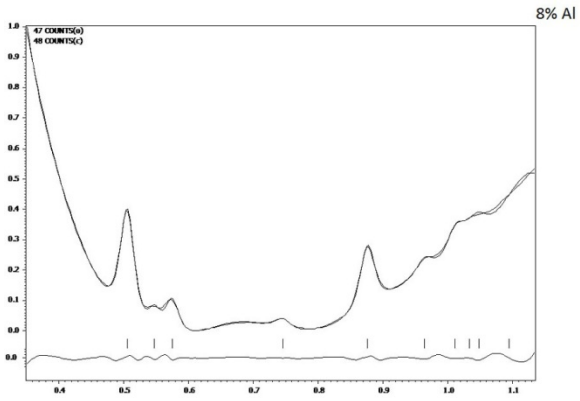

Figure S9a: profile of the precession ring diffraction pattern of ZnO:Al 8%, fitted with the ZnO wurtzite crystal structure.

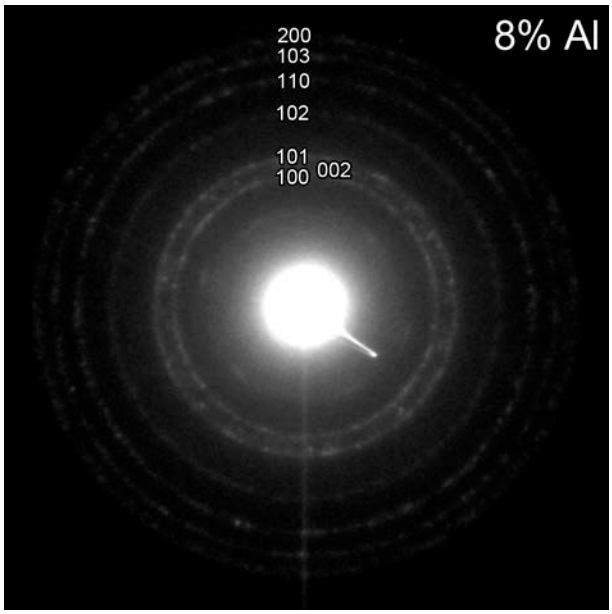

Figure S9b: precession ring diffraction pattern of ZnO:Al 8%. All the rings can be indexed with the ZnO wurtzite structure parameters.

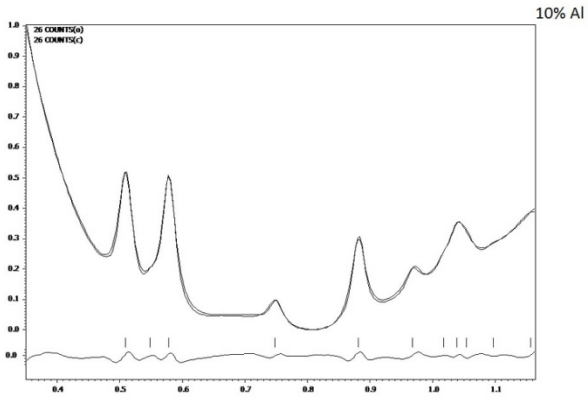

Figure S10a: profile of the precession ring diffraction pattern of ZnO:Al 10%, fitted with the ZnO wurtzite crystal structure.

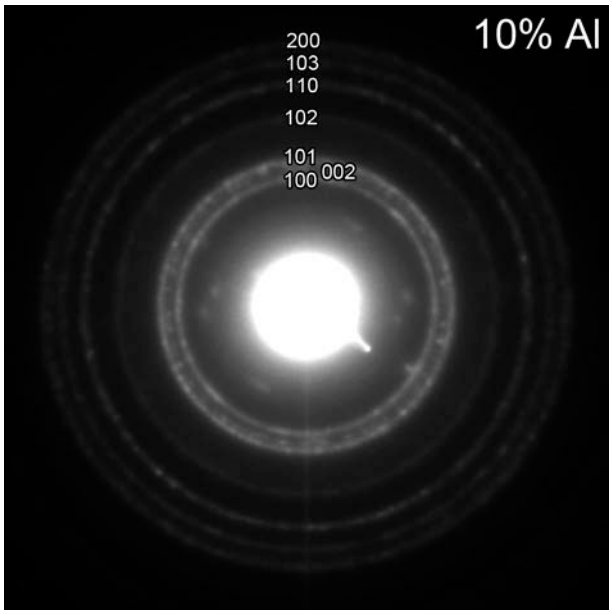

Figure S10b: precession ring diffraction pattern of ZnO:Al 10%. All the rings can be indexed with the ZnO wurtzite structure parameters.

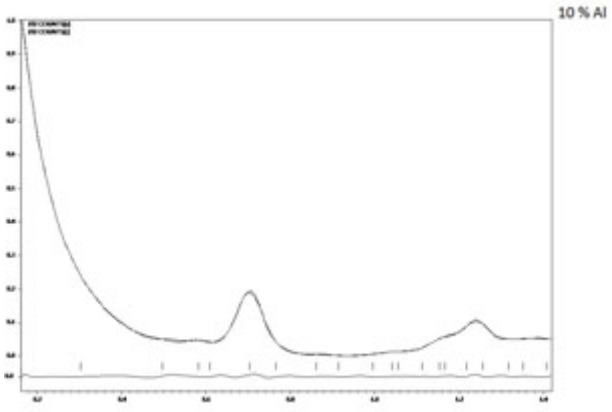

Figure S11a: profile of the precession ring diffraction pattern of ZnO:Al 10%, fitted with the gahnite crystal structure.

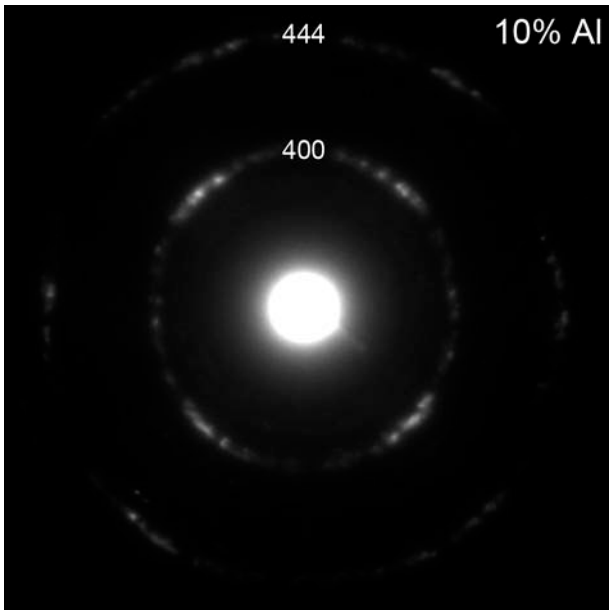

Figure S11b: precession ring diffractin pattern of ZnO:Al 10%. All the rings can be indexed with the gahnite structure parameters.

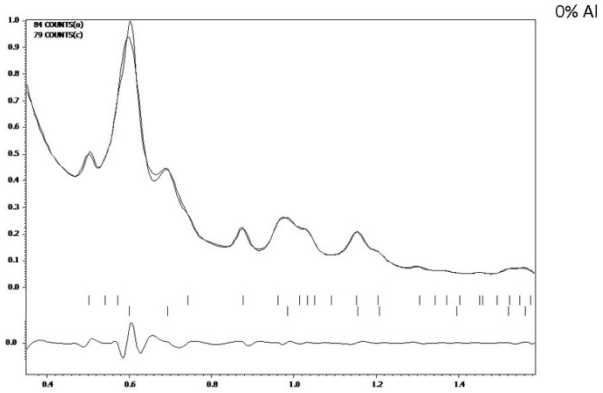

Figure S12: fitted profile of the precession ring diffraction pattern of ZnO:Al 0% and gold nanoparticles.

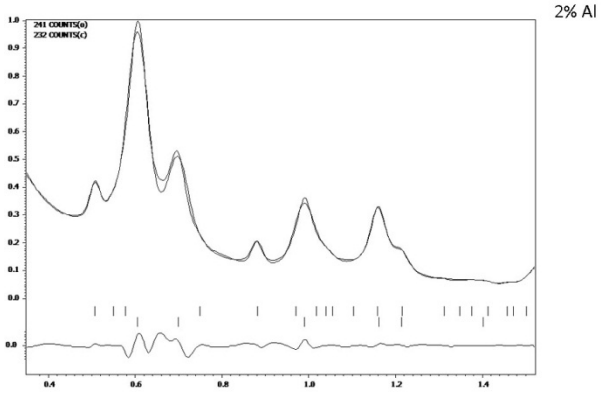

Figure S13: fitted profile of the precession ring diffraction pattern of ZnO:Al 2% and gold nanoparticles.

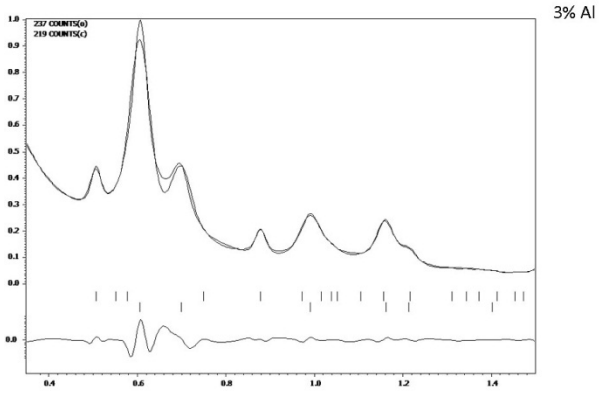

Figure S14: fitted profile of the precession ring diffraction pattern of ZnO:Al 3% and gold nanoparticles.

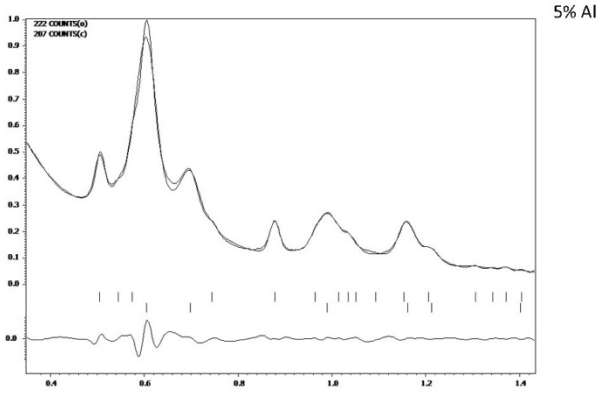

Figure S15: fitted profile of the precession ring diffraction pattern of ZnO:Al 5% and gold nanoparticles.

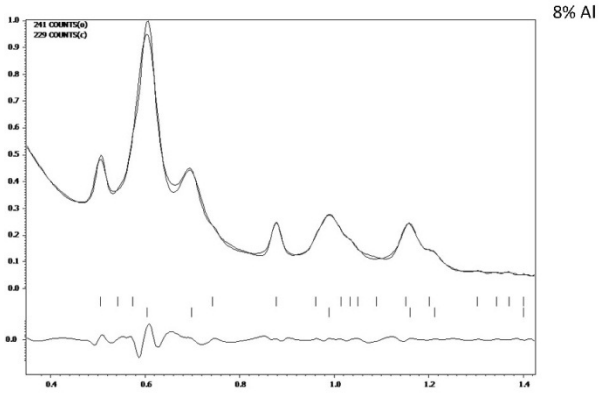

Figure S16: fitted profile of the precession ring diffraction pattern of ZnO:Al 8% and gold nanoparticles.

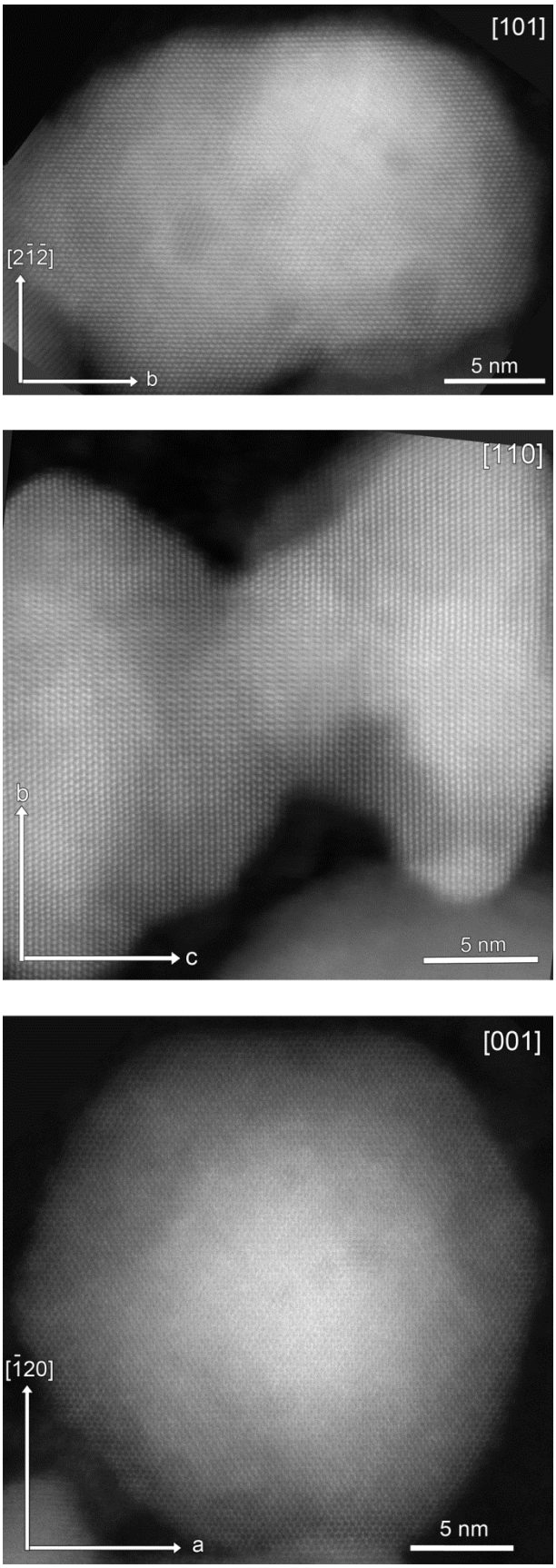

Figure S17: HRSTEM images of the main zones of 5 at % Al:ZnO (5AL-ST).