

Supporting information

## Low Thermal Conductivity of Al-doped ZnO with Layered and Correlated Grain

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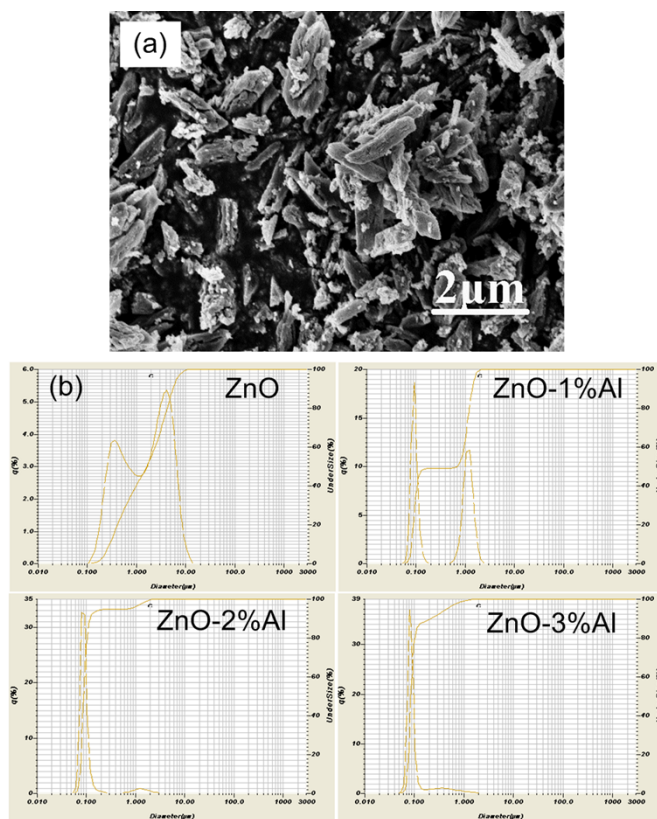


Figure. S1 (a) SEM micrographs from ZnO particles synthesized by sol-gel process; (b) Particle size distribution from ZnO-  $x\%$ Al ( $x=0, 1, 2, 3$ ) nanoparticles synthesized by sol-gel process.

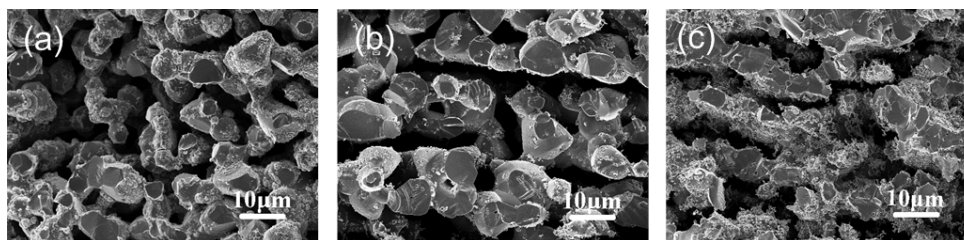


Figure. S2 Cross-sectional SEM micrographs of ZnO-Al bulk pellets after sintering under  $10^{-2}$  Torr (a) ZnO-1%Al, (b) ZnO-2%Al, (c) ZnO-3%Al.

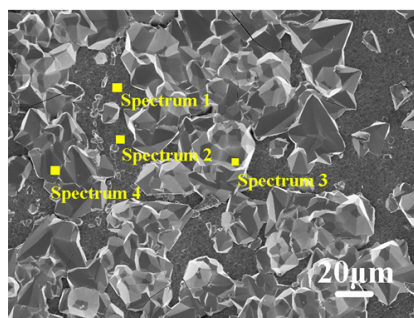


Figure. S3 SEM micrographs from inside surface of quartz tube ( $10^{-5}$  Torr,  $900^{\circ}\text{C}$ ) and corresponding elemental analysis is listed in Table 1.

Table S1 Elemental analysis from the inside surface of quartz tube ( $10^{-5}$  Torr,  $900^{\circ}\text{C}$ ) by EDS point scan. The image is shown in Figure S3.

Location	O (Atomic%)	Si (Atomic%)	Zn (Atomic%)
Spectrum 1	59.69	15.21	25.10
Spectrum 2	57.64	15.47	26.89
Spectrum 3	58.26	-	41.74
Spectrum 4	53.24	-	46.76

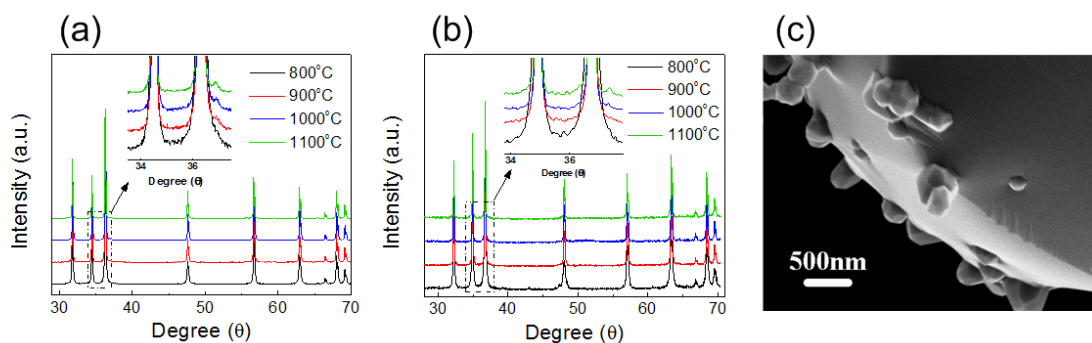


Figure. S4 XRD of ZnO-2%Al bulk pellets after sintering at 800, 900, 1000,  $1100^{\circ}\text{C}$  in (a)  $10^{-5}$  Torr, and (b) Nitrogen. The XRD data are normalized. (c) SEM micrographs of second phase nano-precipitates on the surface of ZnO grain (ZnO-2%Al bulk pellet).