

## Supplementary Information

### S1. Refractive Indices Measured by Ellipsometry for aluminum films with native oxide and ALD oxide on top.

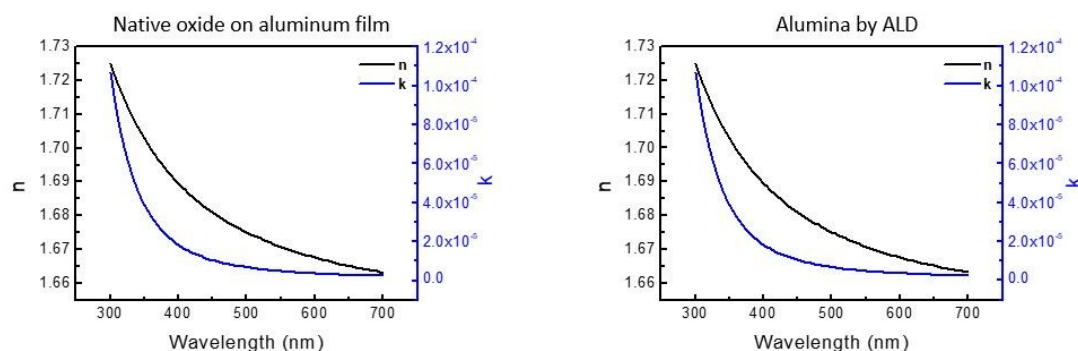


Figure S1. Refractive indices obtained by measurement with ellipsometry in the wavelength range of 300-700 nm for aluminum films with (a) native oxide and (b) ALD oxide on top.

### S2. Simulation of Calculated Energy-Density Distribution in ZnO Nanolaser with different Al<sub>2</sub>O<sub>3</sub> Layer Thickness

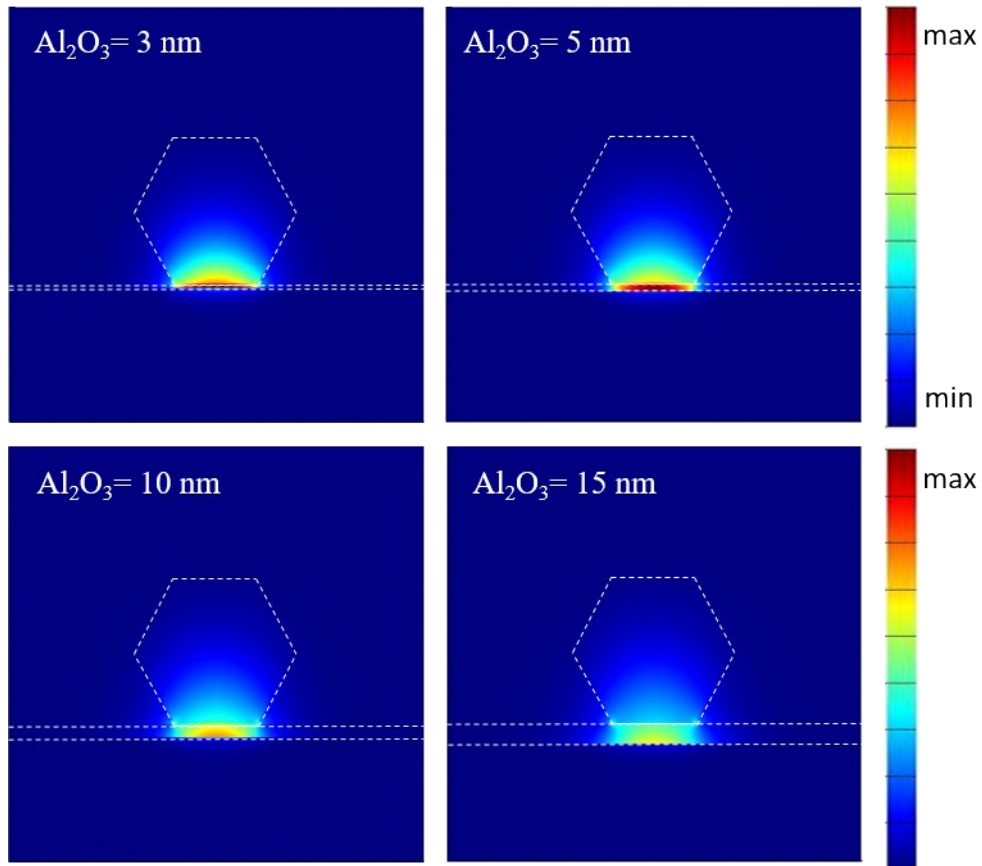


Figure S2. The energy-density distribution is calculated by the FDTD method for ZnO /Al<sub>2</sub>O<sub>3</sub>/ Al structures with different dielectric thickness at a wavelength of 378 nm. The white hexagons in the figures indicate the cross-section of ZnO nanowires. The side length of the ZnO nanowire was assumed to be 60 nm.

### S3. Calculated Effective Indices of ZnO Nanolaser with different ALD-Al<sub>2</sub>O<sub>3</sub> Thickness

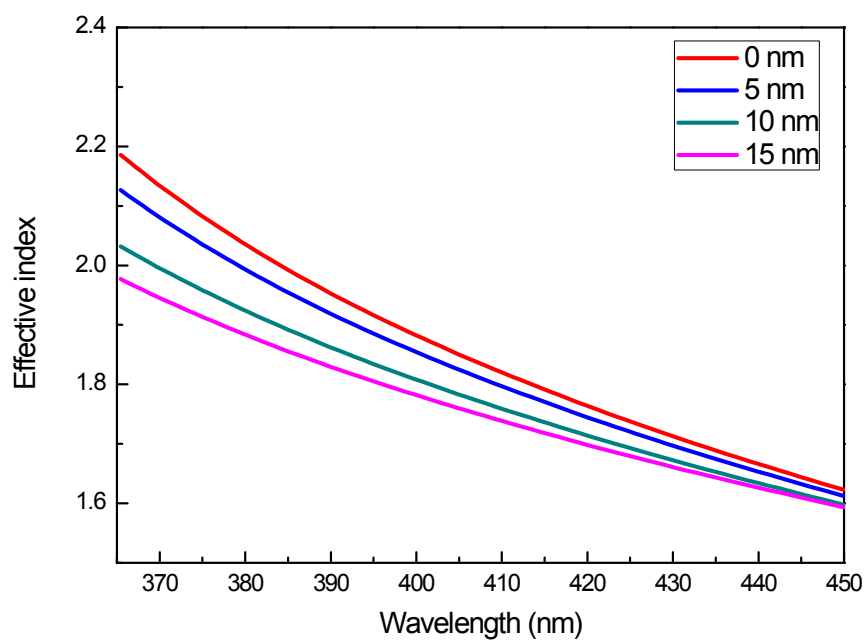


Figure S3. The simulated effective index from 365 nm to 450 nm of the ZnO SPP laser for different thickness of Al<sub>2</sub>O<sub>3</sub> with about 3 nm native oxide, derived by the FDTD method.