

Figure S1. SEM imaging of the surface morphology with a variety of magnifications and operating voltage for ZnO implanted at 800 °C with 150 keV Yb ions to the fluence of $1 \times 10^{15} / \text{cm}^2$

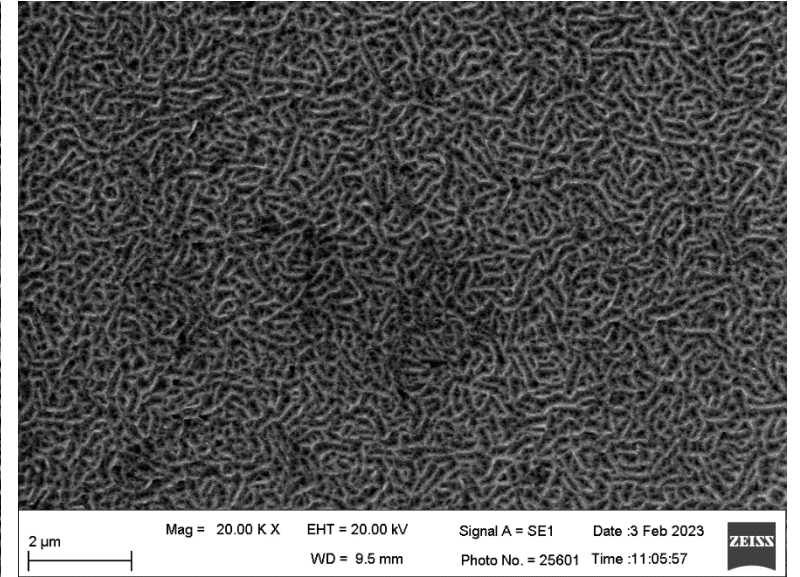
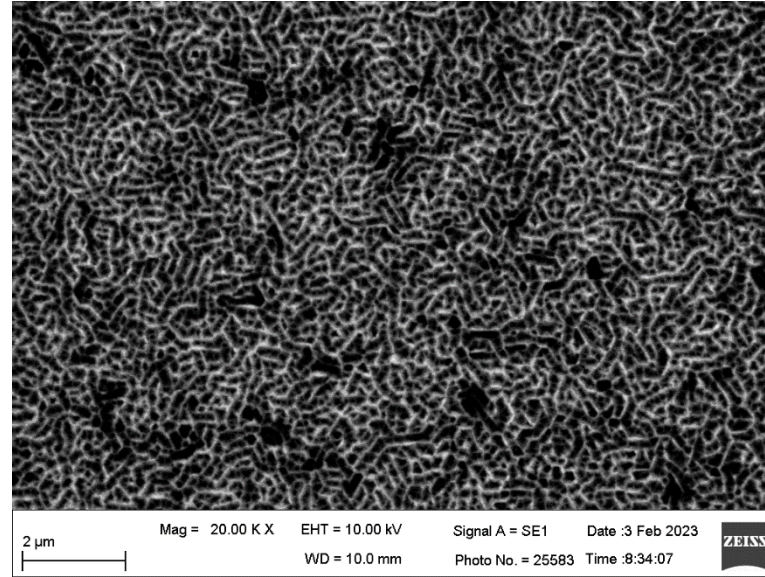
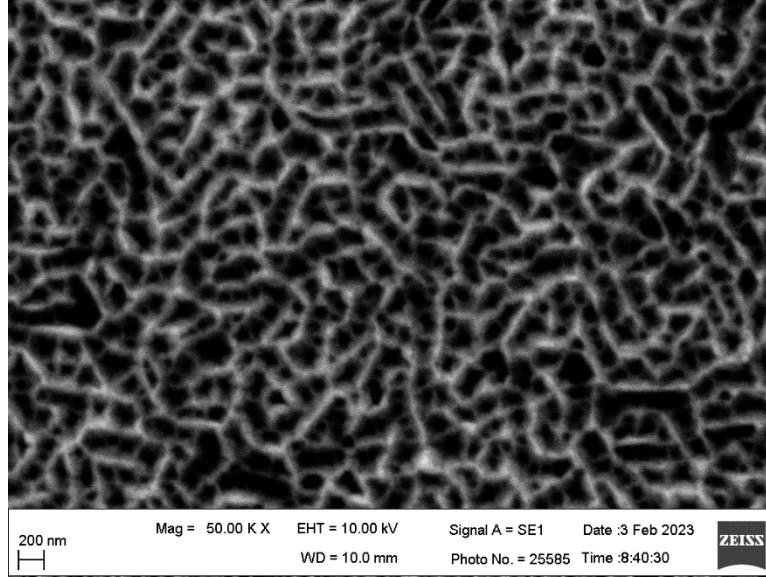


Figure S2. EDS mapping with a variety of magnifications and operating voltage for ZnO implanted at 800 °C with 150 keV Yb ions to the fluence of $1 \times 10^{15} / \text{cm}^2$

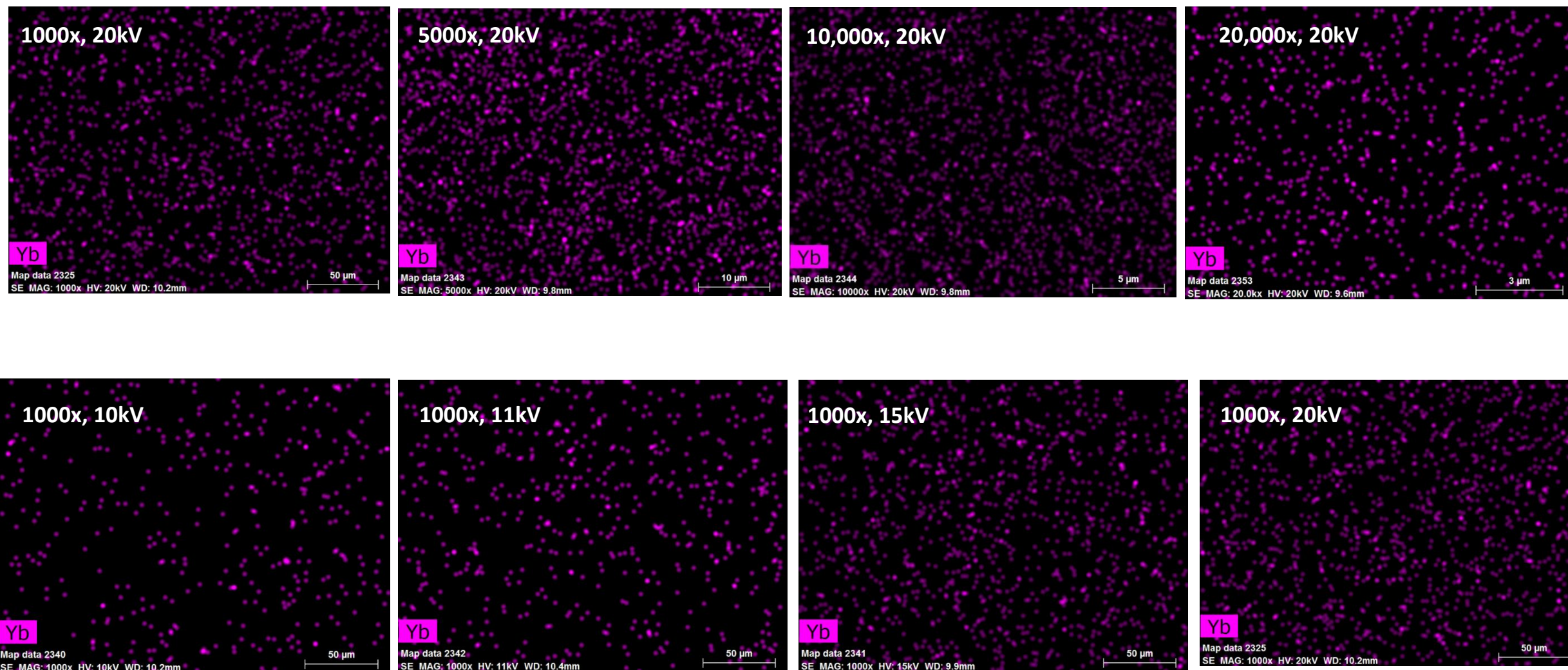


Figure S3. SEM imaging of the surface morphology for ZnO implanted with 150 keV Yb ions to the fluence of $1 \times 10^{15} / \text{cm}^2$ at different temperatures: 600 and 800 °C and RT and subsequently RTA-annealed for 10min at 800 °C in an oxygen atmosphere

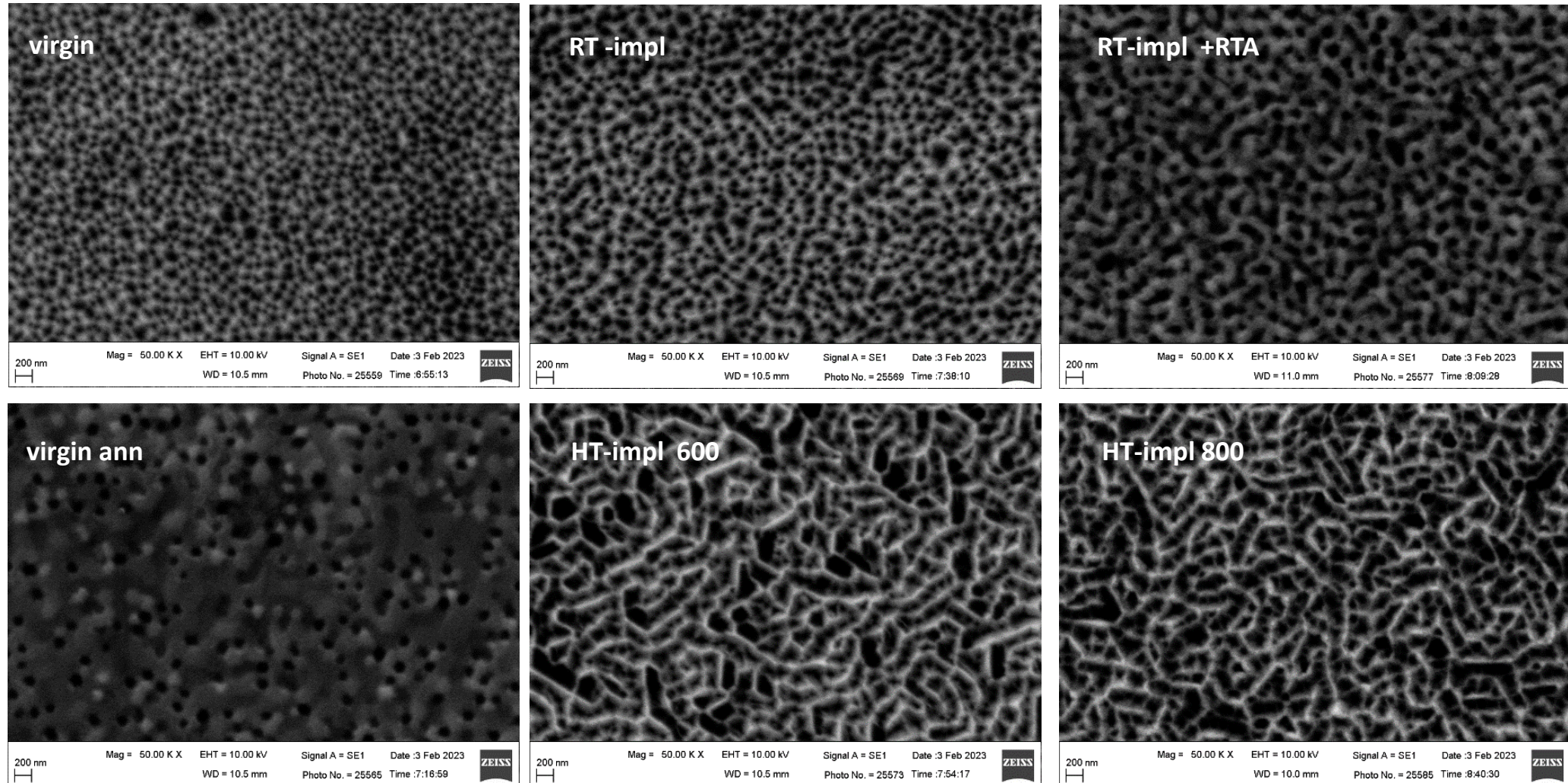


Figure S4. AFM imaging of the surface morphology for ZnO implanted with 150 keV Yb ions to the fluence of $1 \times 10^{15} / \text{cm}^2$ at different temperatures: 600 and 800 °C and RT and subsequently RTA-annealed for 10min at 800 °C in an oxygen atmosphere

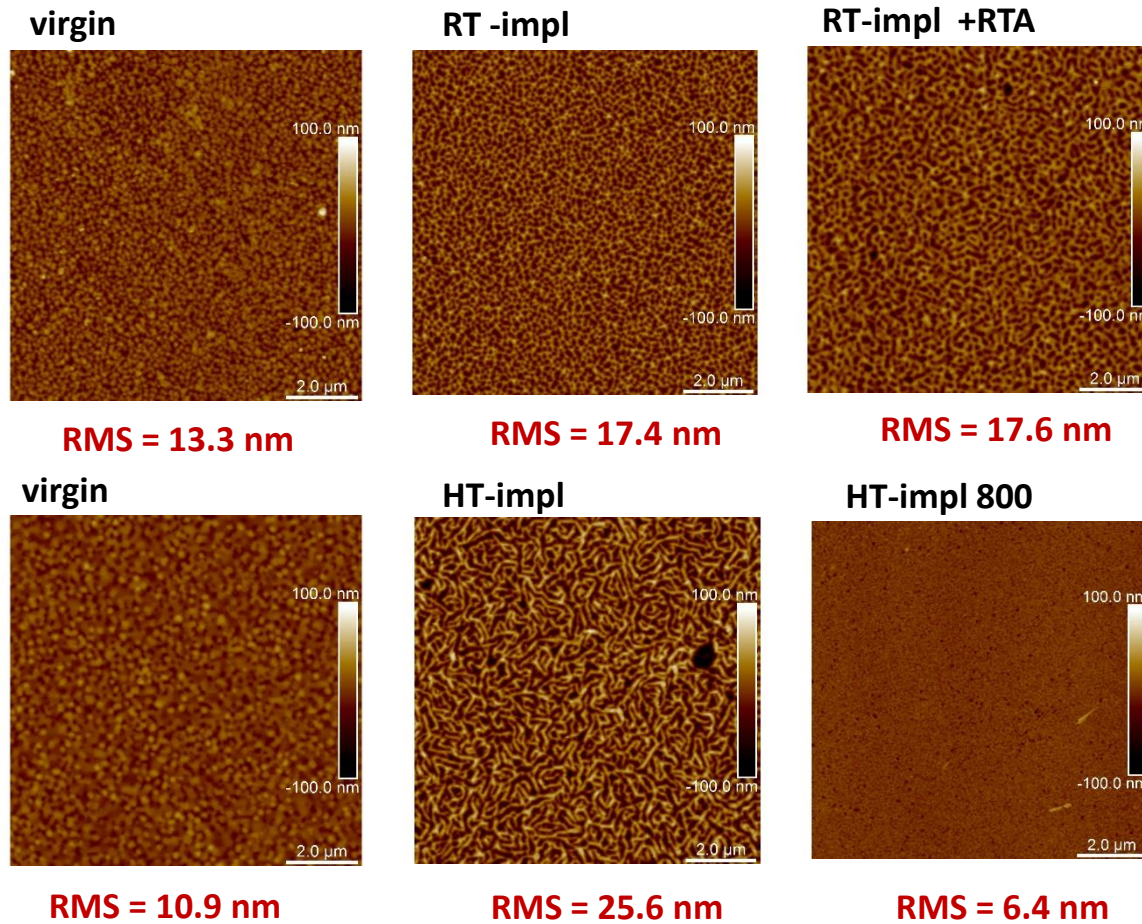
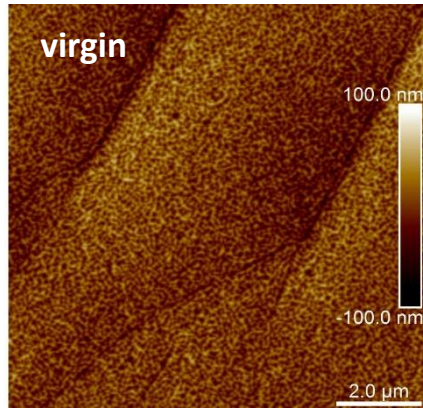
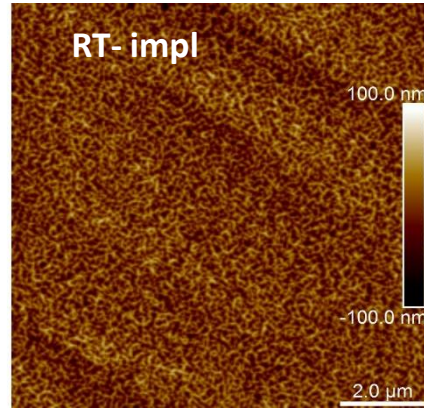


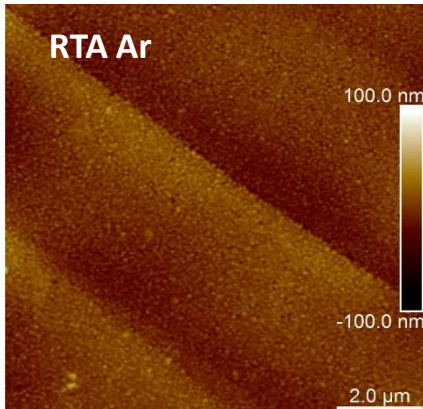
Figure S5. AFM imaging of the surface morphology for ZnO implanted with 150 keV Yb ions to the fluence $1 \times 10^{15} / \text{cm}^2$ and subsequently RTA-annealed for 10min at 800 °C in different atmospheres N_2 , Ar, O_2 .



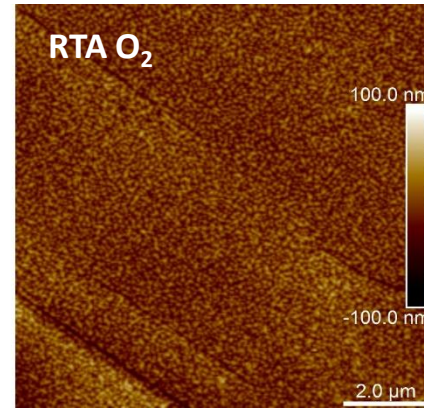
RMS = 18.3 nm



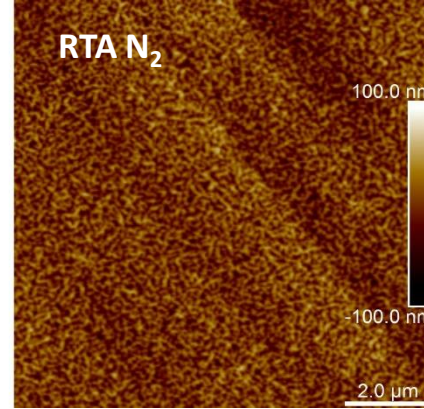
RMS = 18.9 nm



RMS = 11.3 nm



RMS = 14.4 nm



RMS = 17.8 nm