

The piezoresponse in WO₃ thin films due to N₂-filled nanovoids enrichment by Atom Probe Tomography

Supplemental Material 1

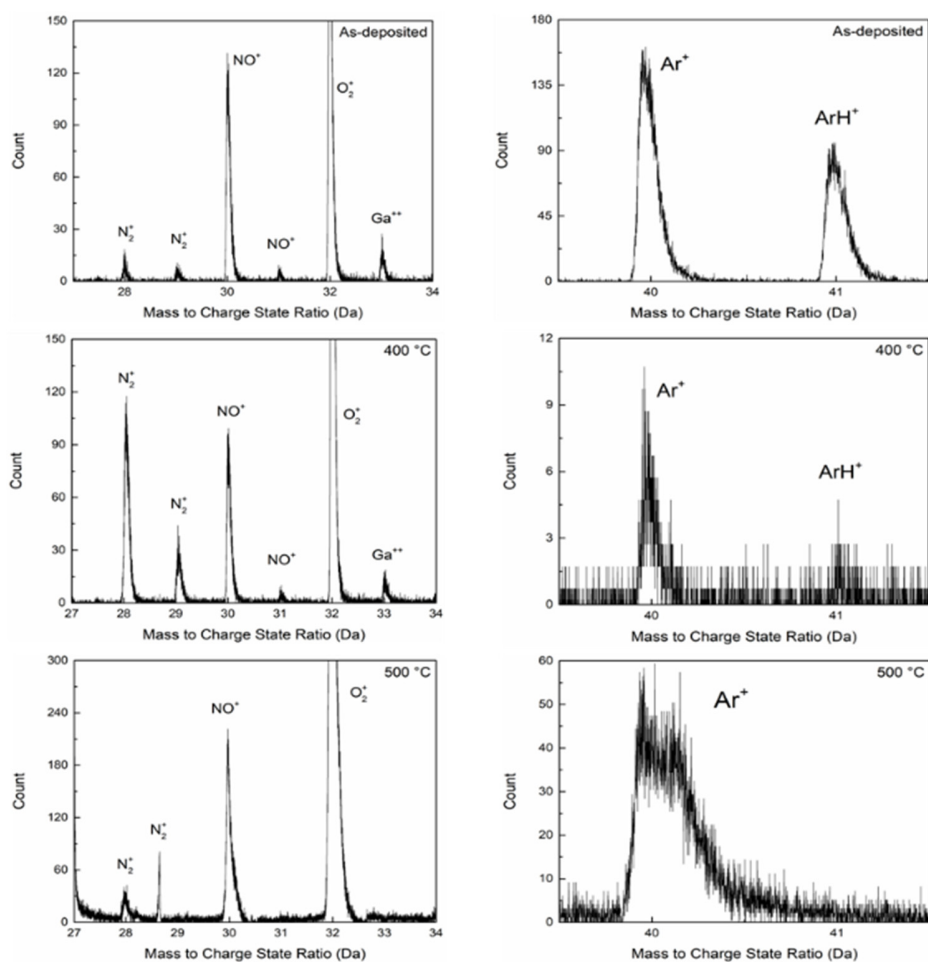


Figure S1. Mass spectra showing Ar and N-species content in as deposited, annealed at 400 °C and 500 °C WO₃ thin films.

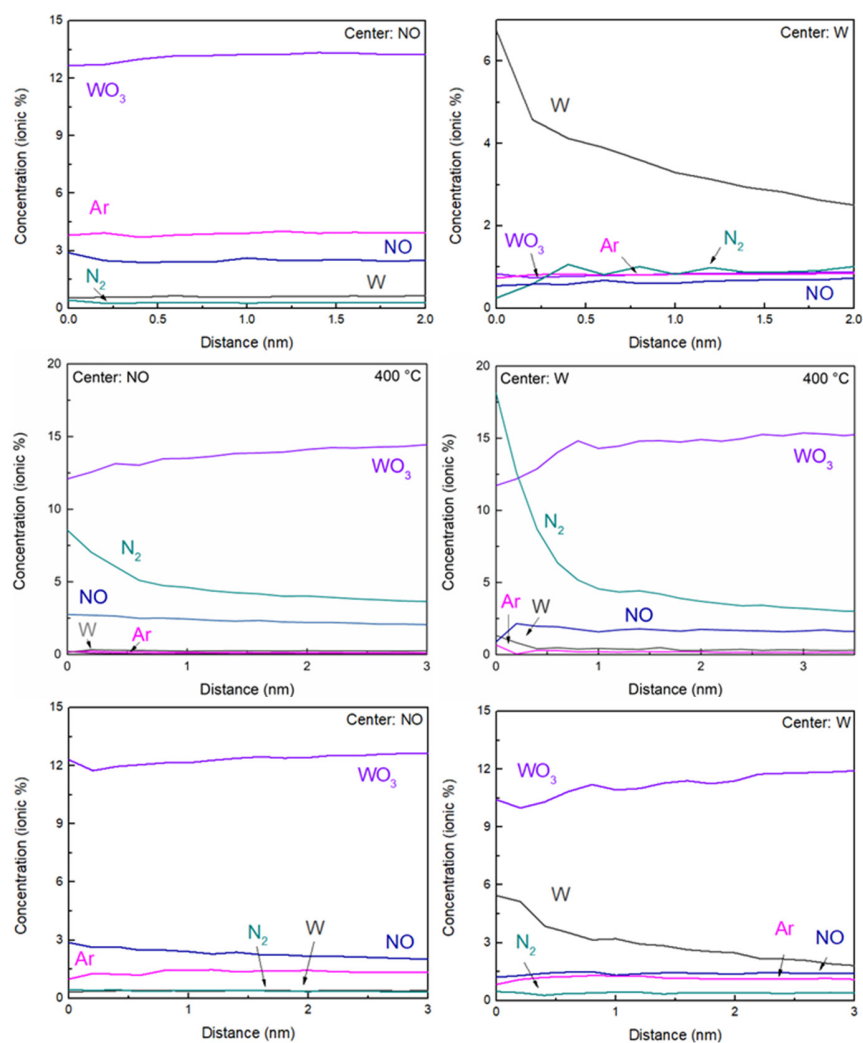


Figure S2. Radial distribution function with NO and W center ions.

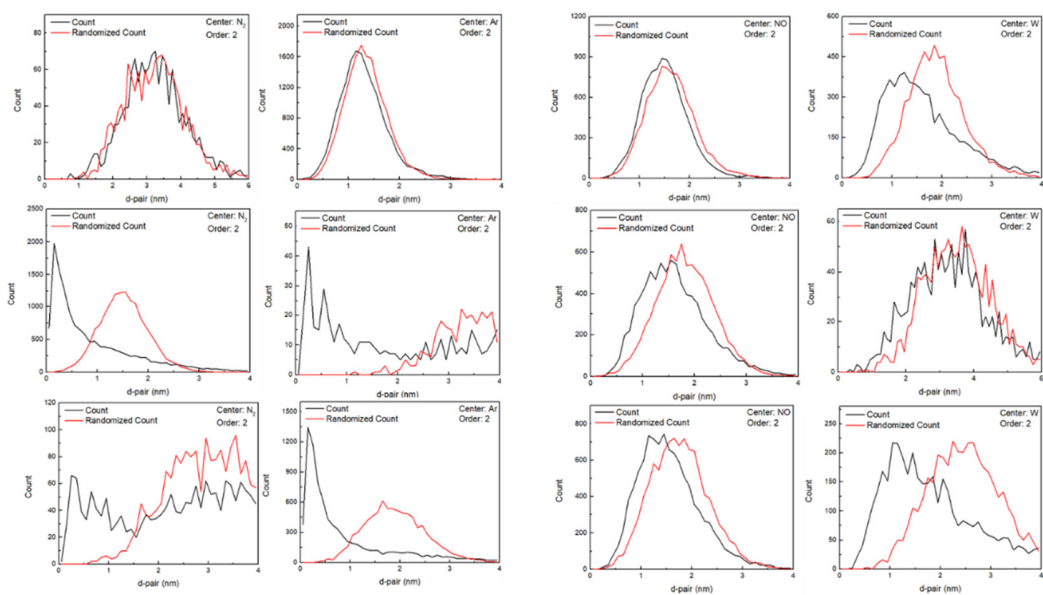


Figure S3. Nearest neighbor distribution for WO_3 thin films as deposited, annealed at 400 °C and 500 °C.

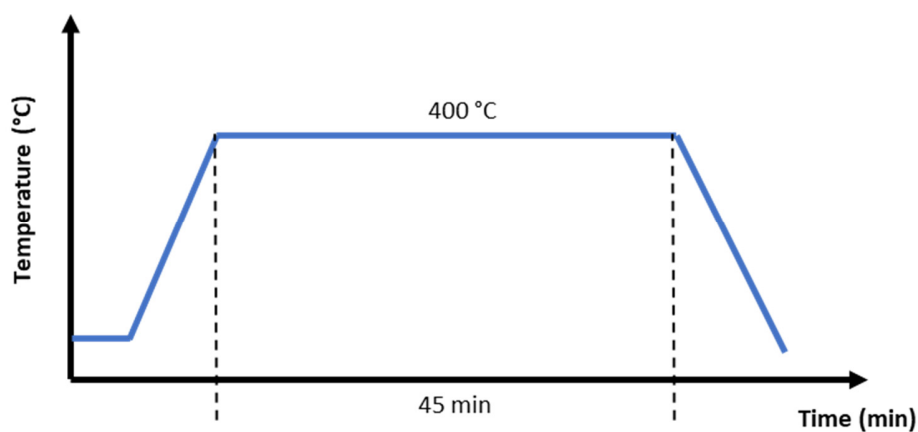


Figure S4. Annealing profile used for WO_3 thin film processing.

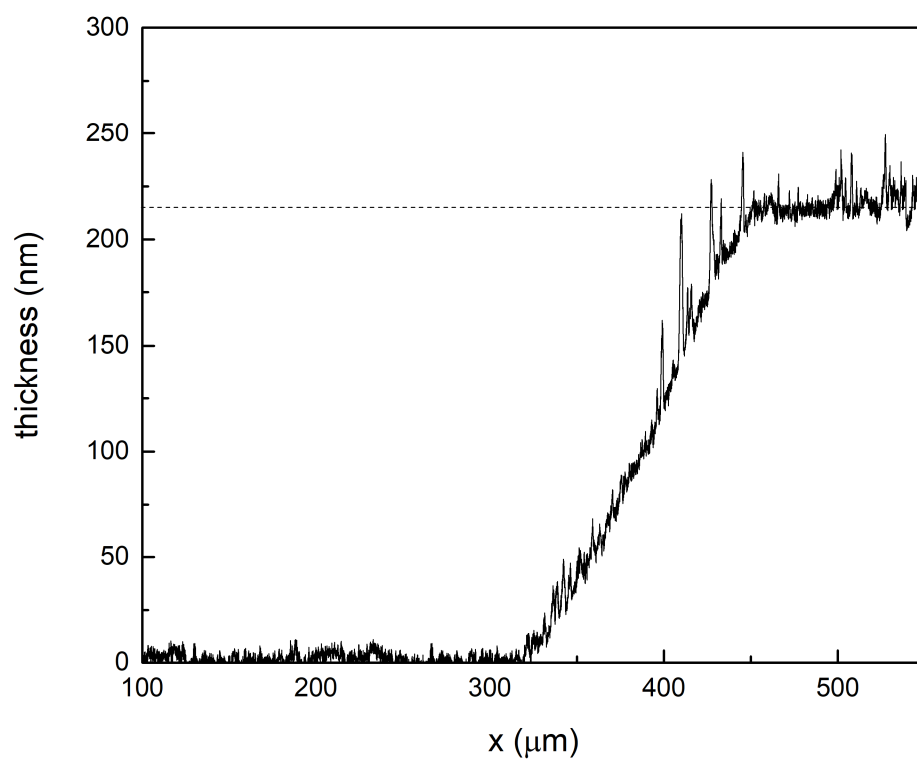


Figure S5. Profilometry to measure film thickness of WO₃.

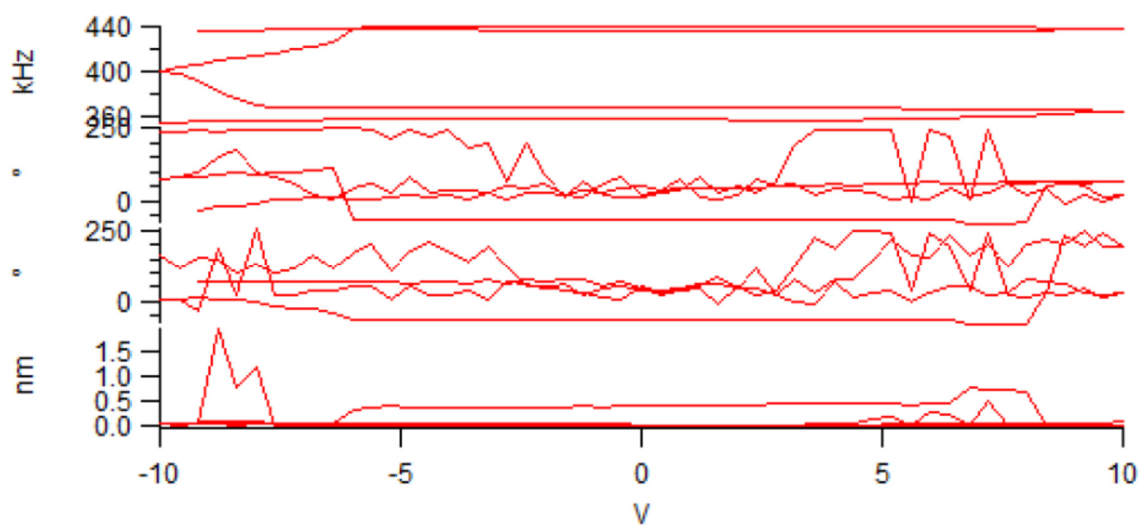
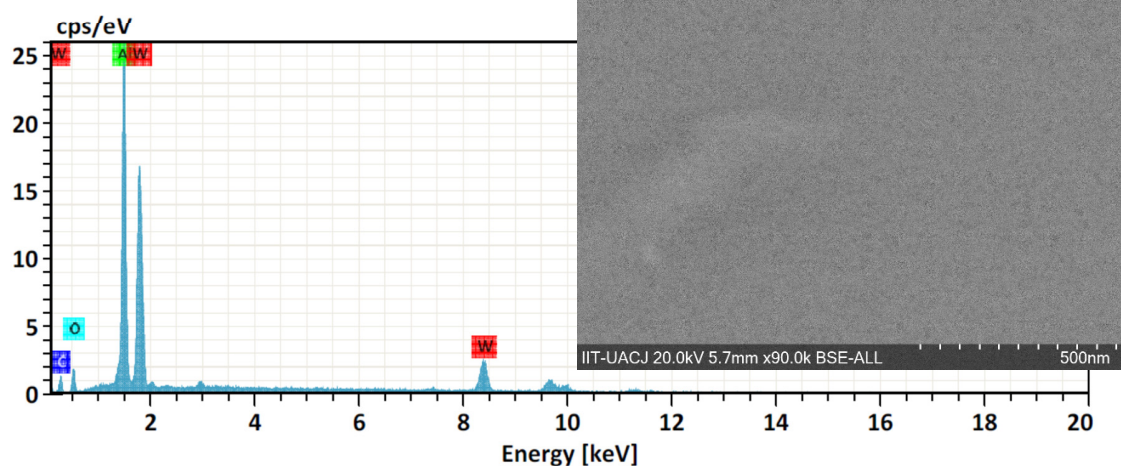
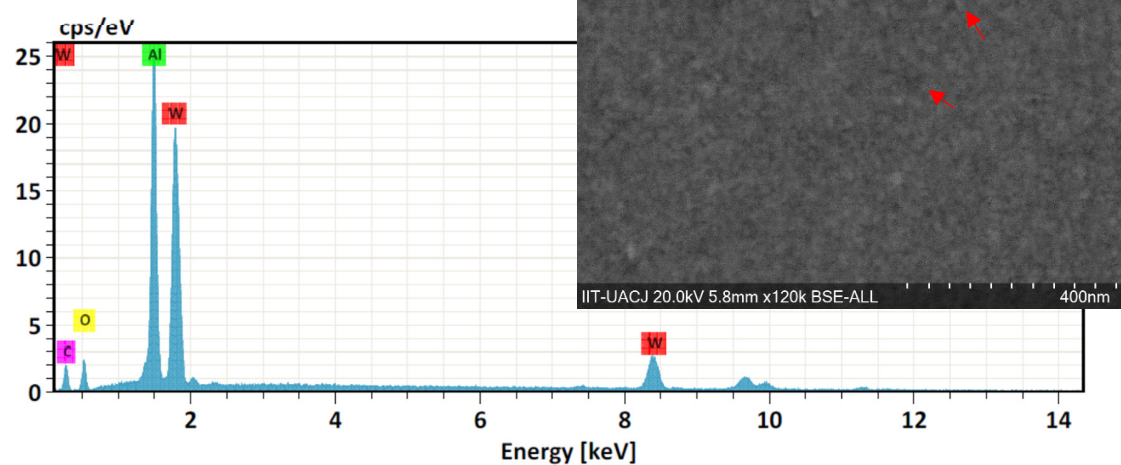


Figure S6. PFM off-field measurement of WO₃ – 500°C thin film indicating no piezoresponse.

a) As deposited WO_3



b) WO_3 - 400 °C



c) WO_3 - 500 °C

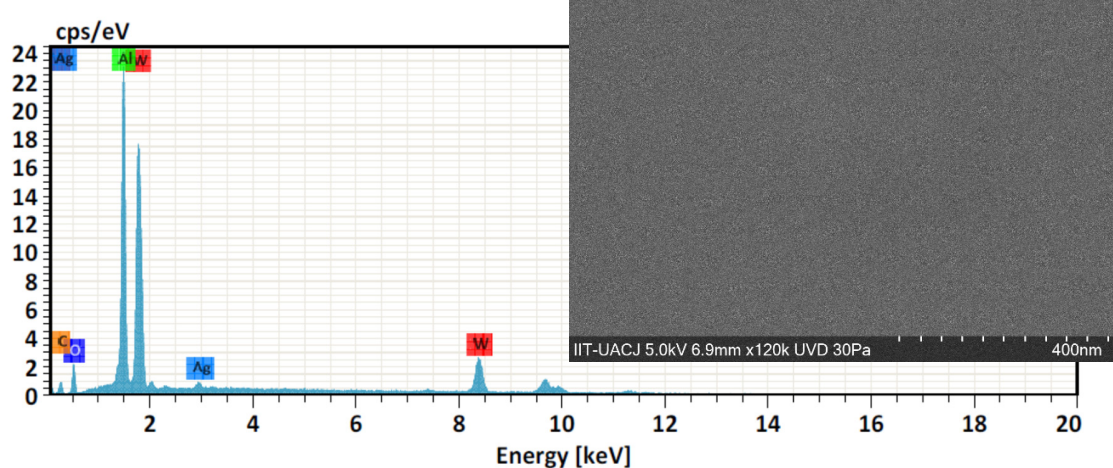


Figure S7. EDS and SEM for WO_3 thin films a) as deposited and annealed at b) 400 °C and c) 500 °C. Red arrows show porosity on the film surface.

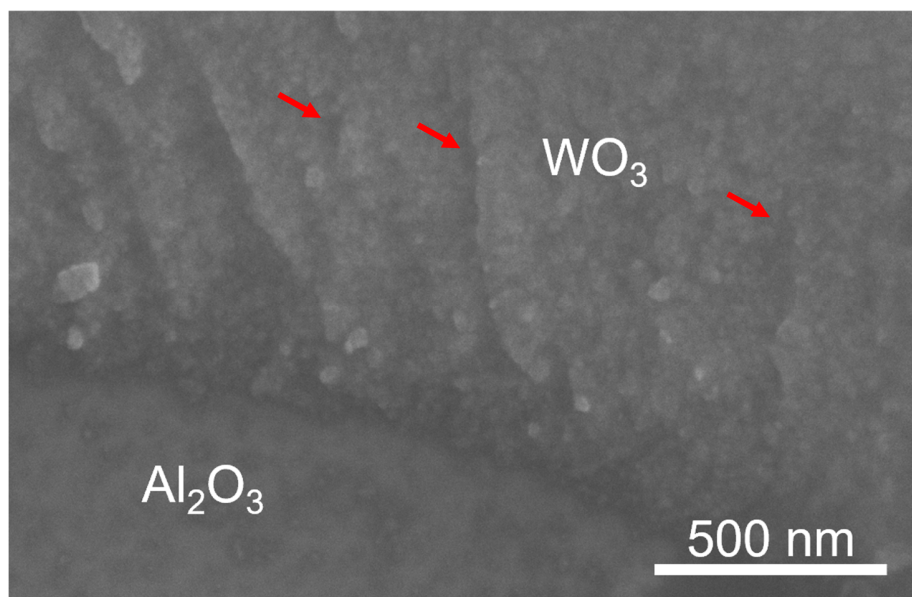


Figure S8. Cross-sectional SEM image of WO_3 thin film annealed at 500 °C where is possible to see porosity within film as indicated by red arrows.

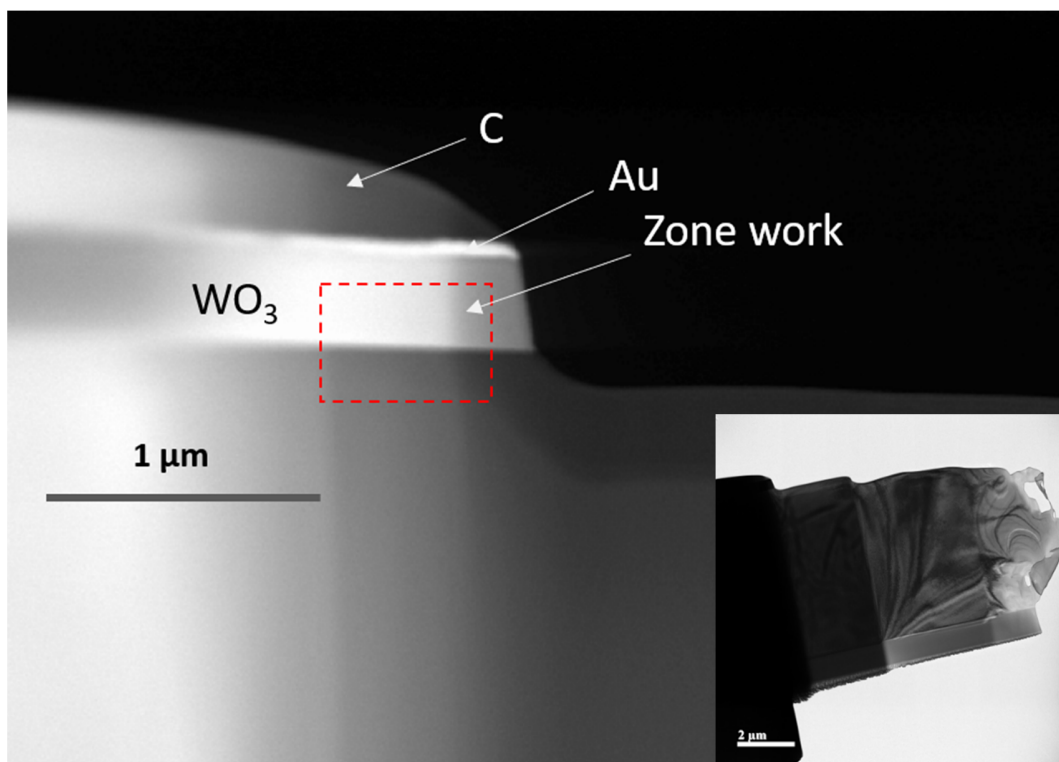


Figure S9. Lamella preparation sequence of images WO_3 – 400 °C thin film for TEM measurements.

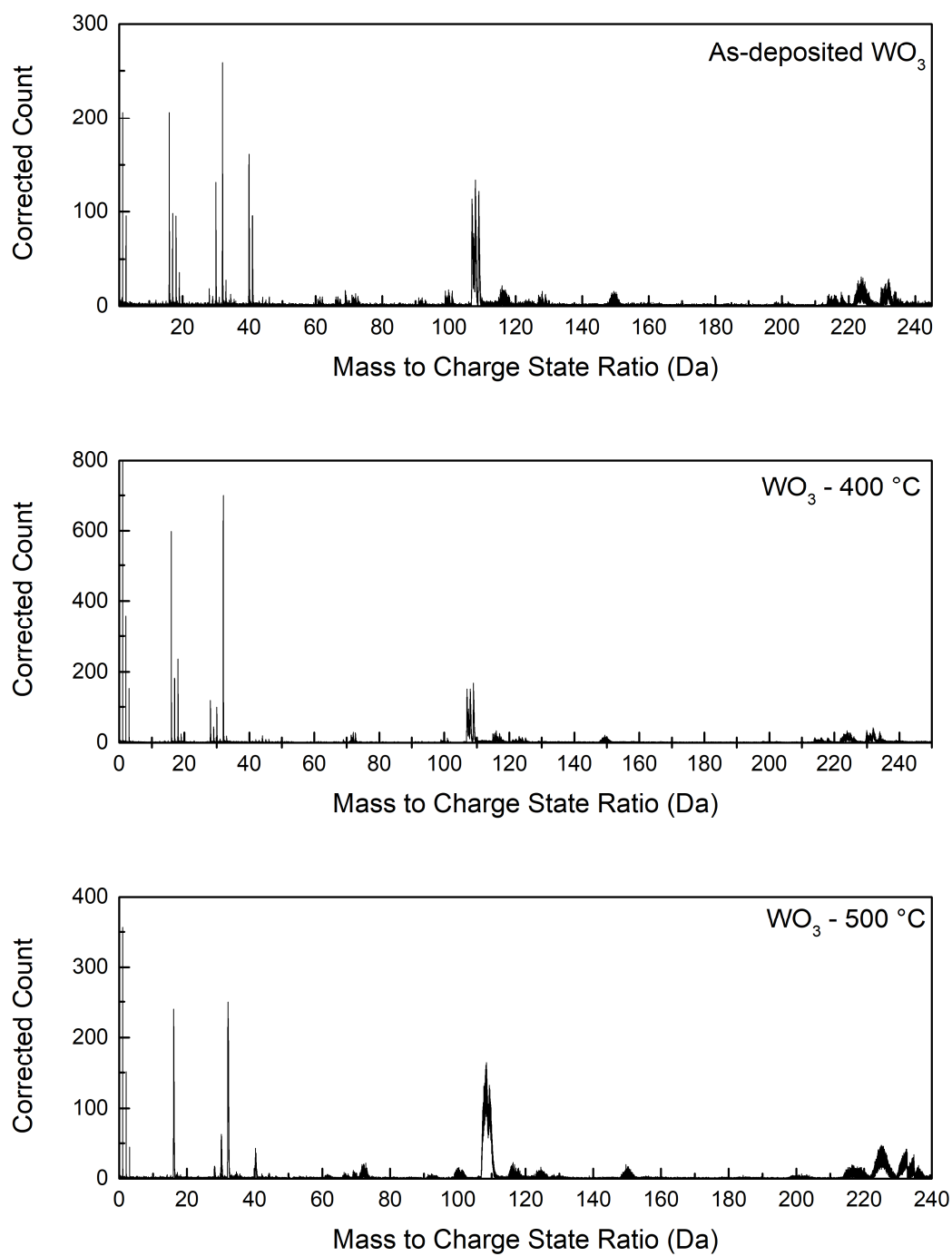


Figure S10. Mass spectra of WO_3 thin films measured by APT, as deposited and processed at 400 °C and 500 °C.