

Figure 1. (a) In-situ ellipsometry data recorded during a TMP – O₂ plasma ALD process. Self-inhibited film growth was observed, with initially high growth which rapidly saturated. (b) Growth per supercycle (GPSC) for a [1·(ZnO) – 1·(PO)] supercycle (left axis) and the P content in the film measured using XPS (right axis) against the TMP dose time. Saturated ALD growth incorporated ca. 10–12 at.% P in the film, indicating the formation of a P-doped ZnO film.

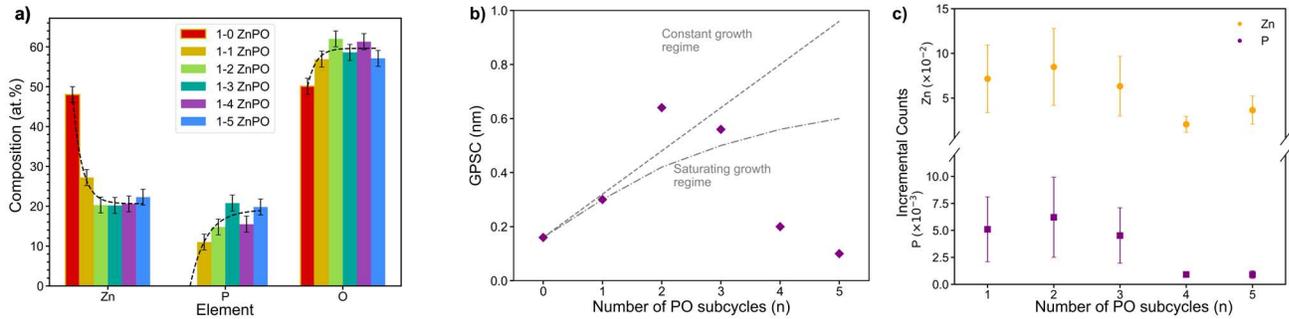


Figure 2. (a) Composition variation, (b) GPSC values, and (c) incremental Zn and P counts (elemental counts per elemental subcycle, measured by XRF) for the as-deposited ZnPO films, as n was increased from 1 to 5. The film composition saturated for $n \geq 3$. However, both the GPSC and the elemental Zn and P increments showed a concurrent decrease with increasing n . These trends do not conform to values expected for constant or saturating PO growth in the supercycles, indicating a non-ideal growth mode for the [1·(ZnO) – n ·(PO)] supercycles.

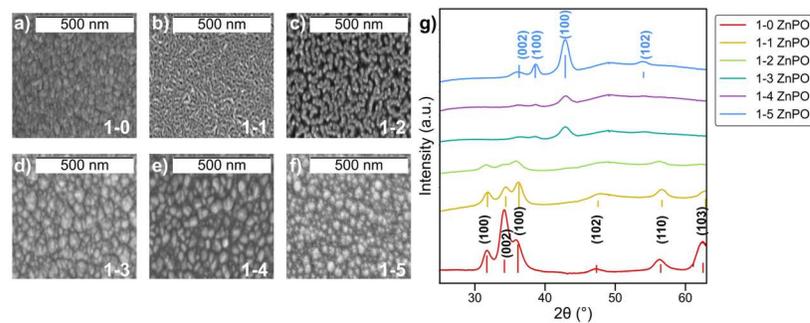


Figure 3. (a–f) SEM images measured at an acceleration voltage of 20 kV, showing the variation in surface morphology for films grown using [1·(ZnO) – n ·(PO)] supercycles (n : 0–5). (g) XRD patterns for different supercycles extracted from GIWAXS data measured at an angle of incidence of 0.4°.