

Excess oxygen to atomic layer deposition of Al_2O_3 provided by Cu_2O and indium-tin oxide substrates



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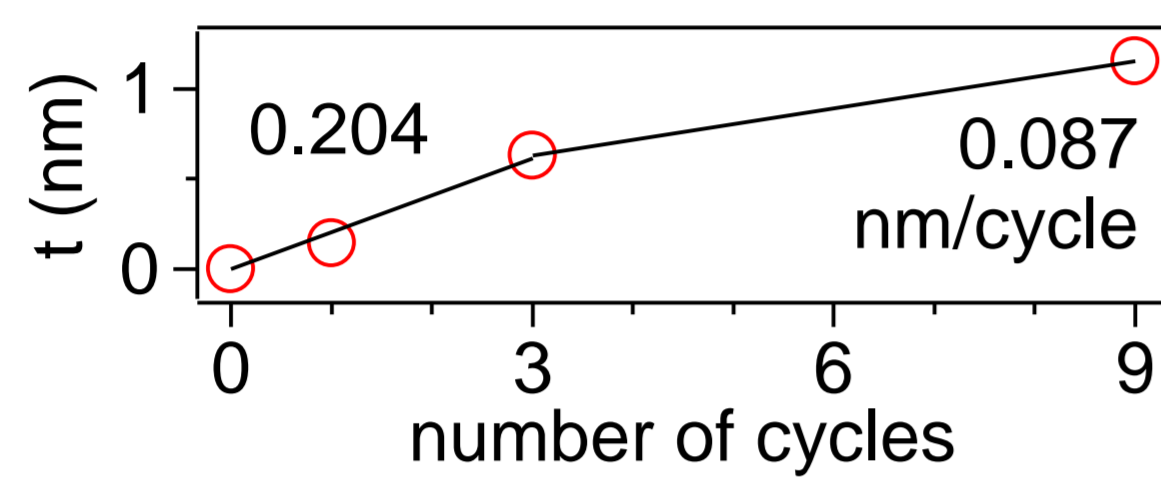
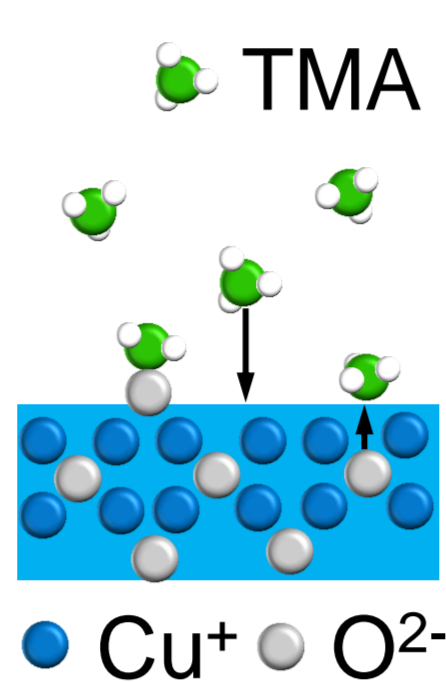
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MS- Cu_2O \ ALD- Al_2O_3

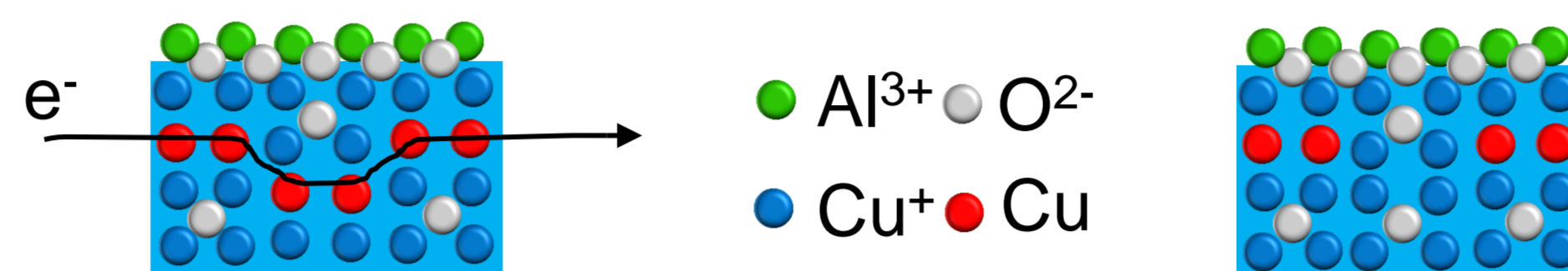
ALD precursor TMA reacts with Cu_2O lattice oxygen:
 → reduction to Cu
 → initially enhanced growth per cycle



Resume

1. Reduction of Cu_2O to Cu will inhibit field-effect in top-gated transistor devices:

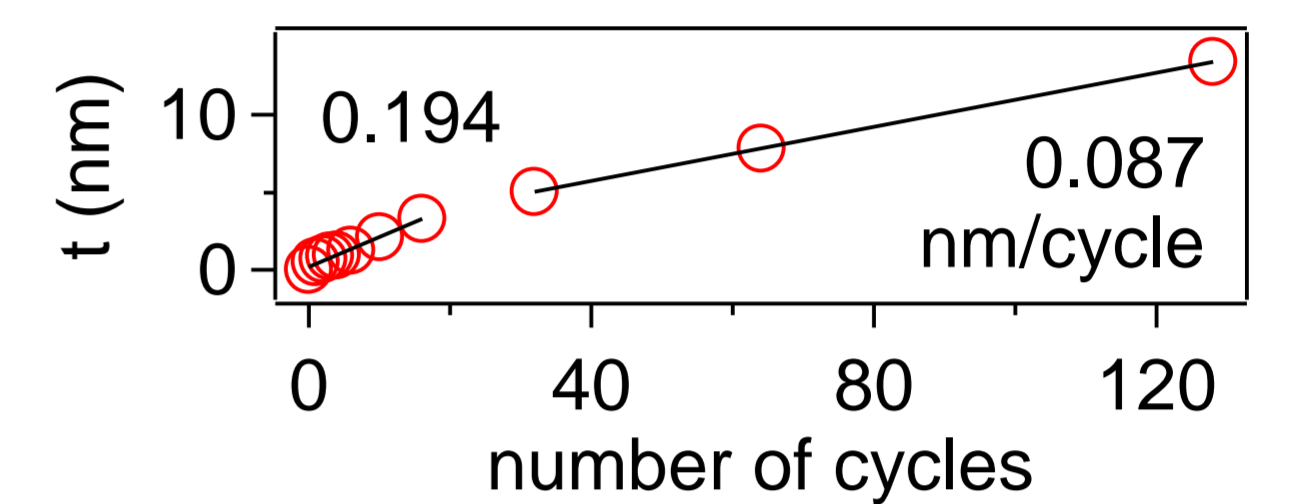
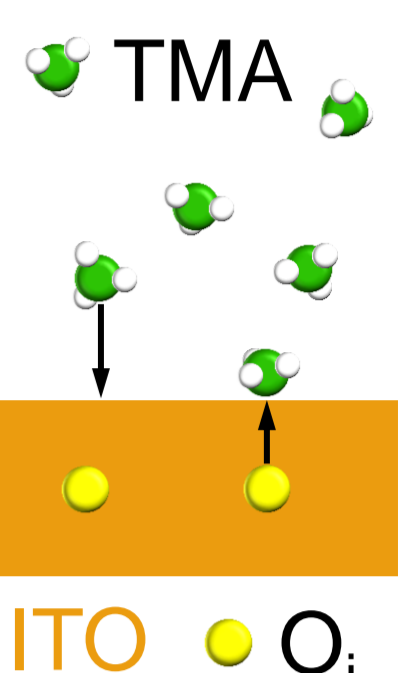
a) metallic conduction b) Fermi level pinned at Schottky junction



2. Fermi energy in ALD- Al_2O_3 is pinned to 4.5 eV due to hydrogen from atomic layer deposition¹.

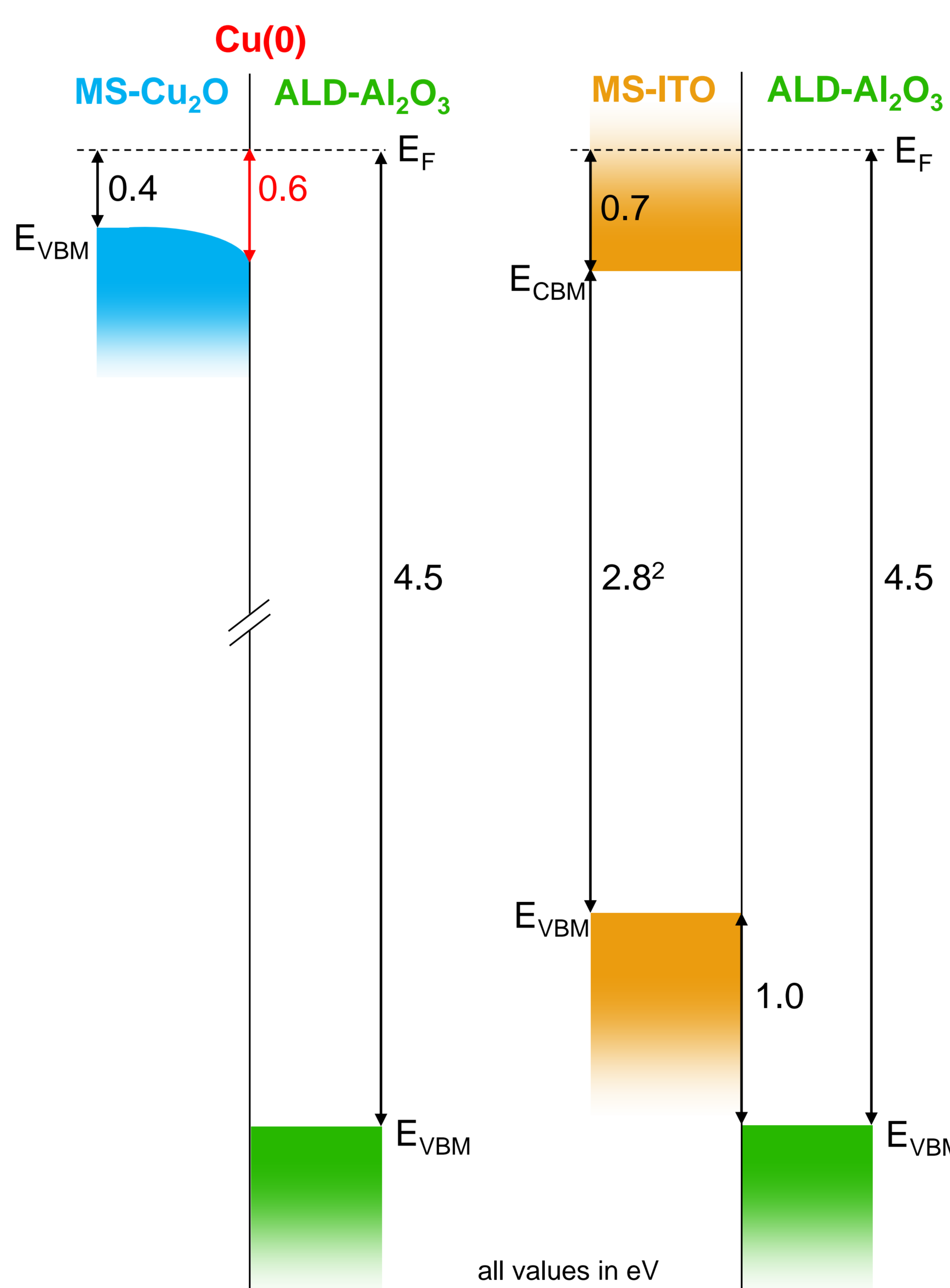
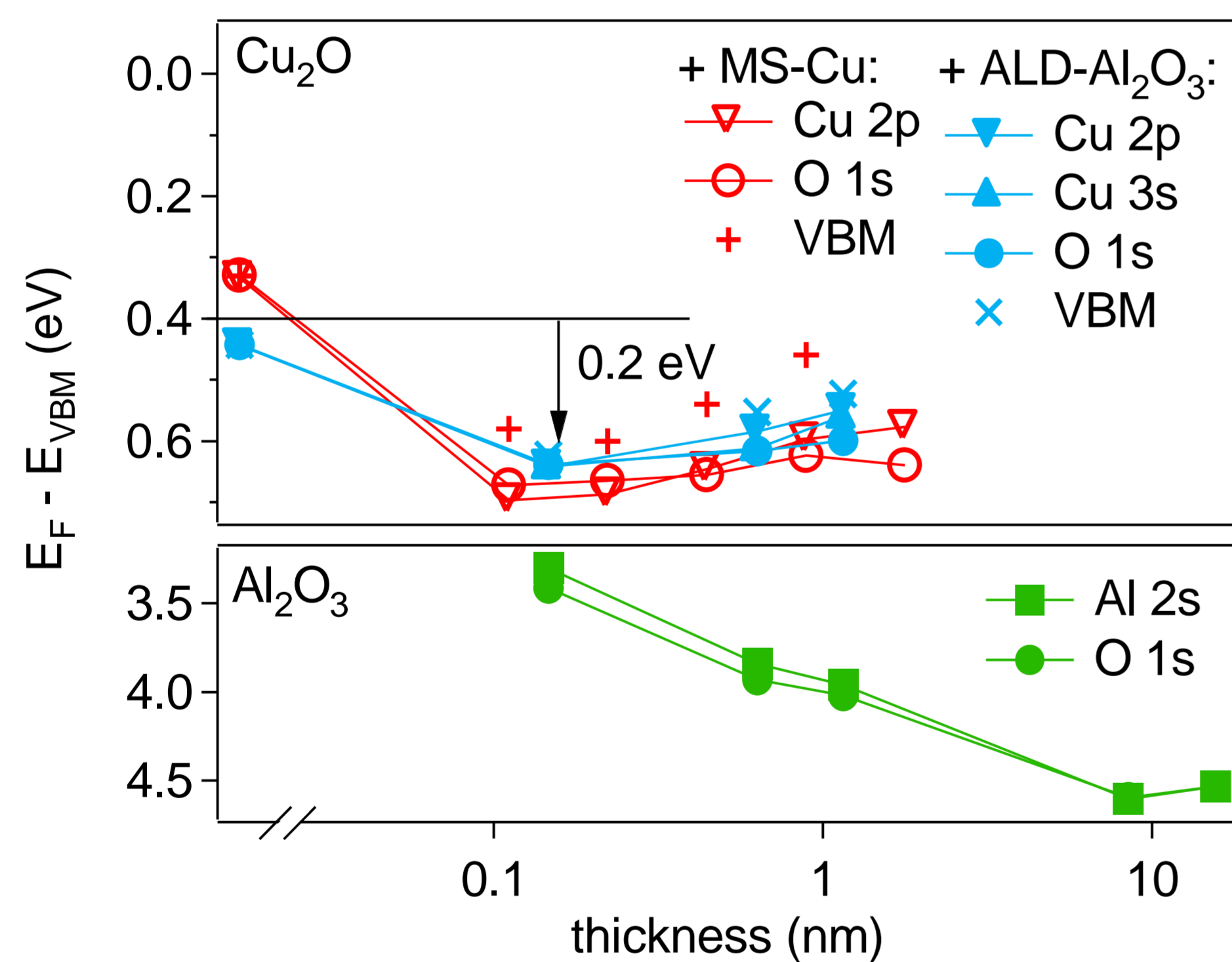
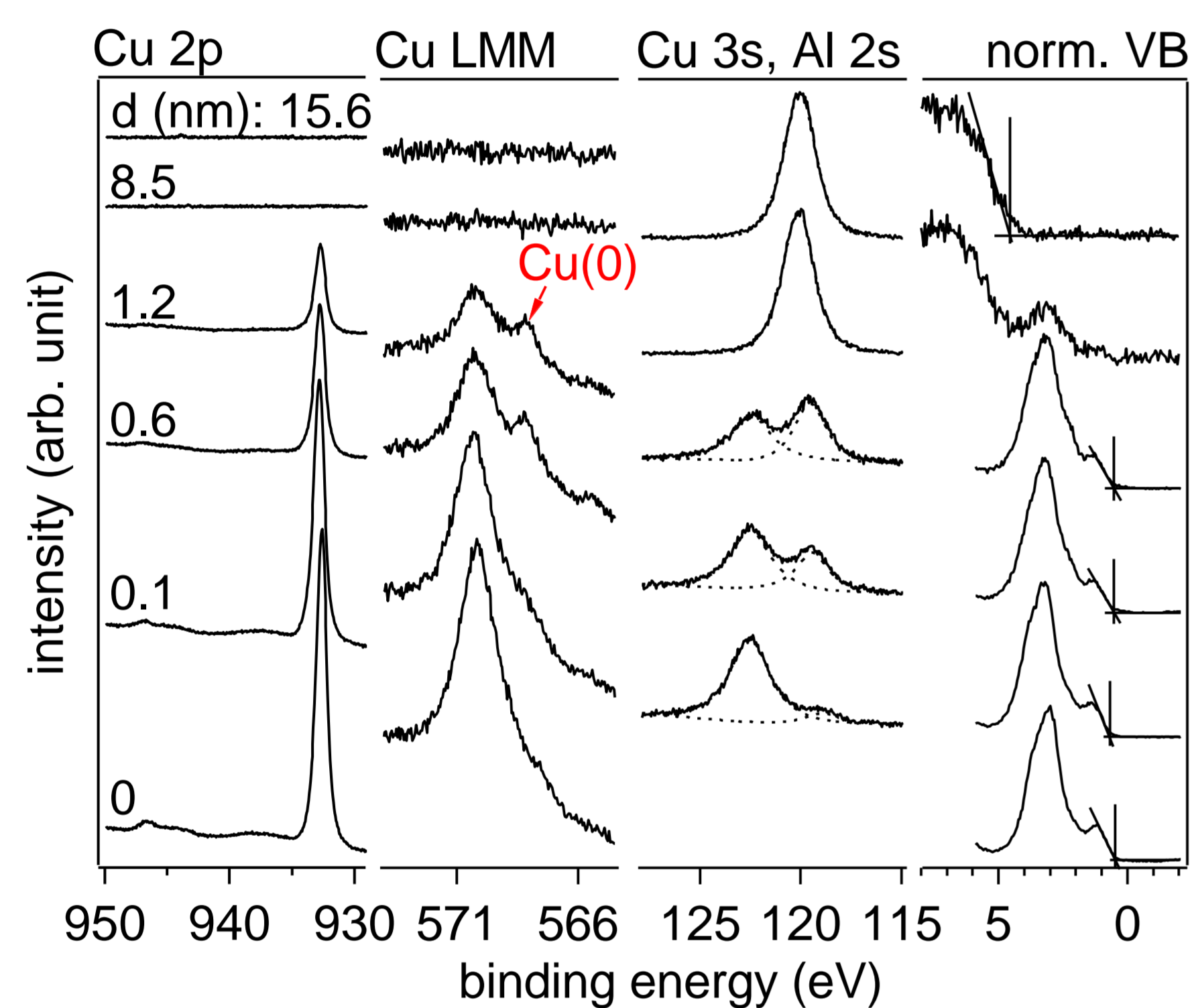
MS-ITO \ ALD- Al_2O_3 ¹

TMA reacts with interstitial oxygen O_i :
 → no reduction of In(III)
 → highest E_F in ITO so far reported
 → initially enhanced growth per cycle

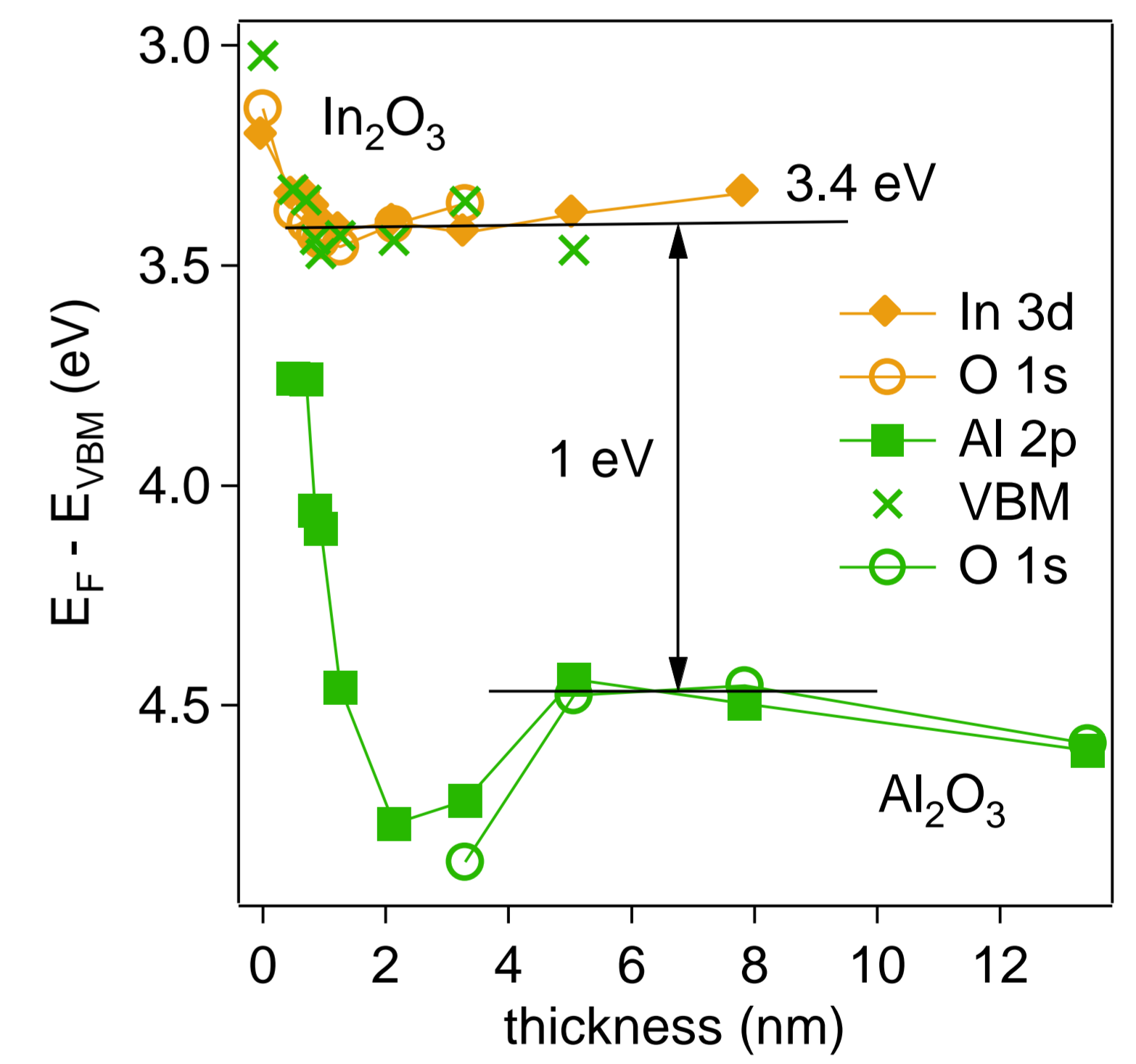
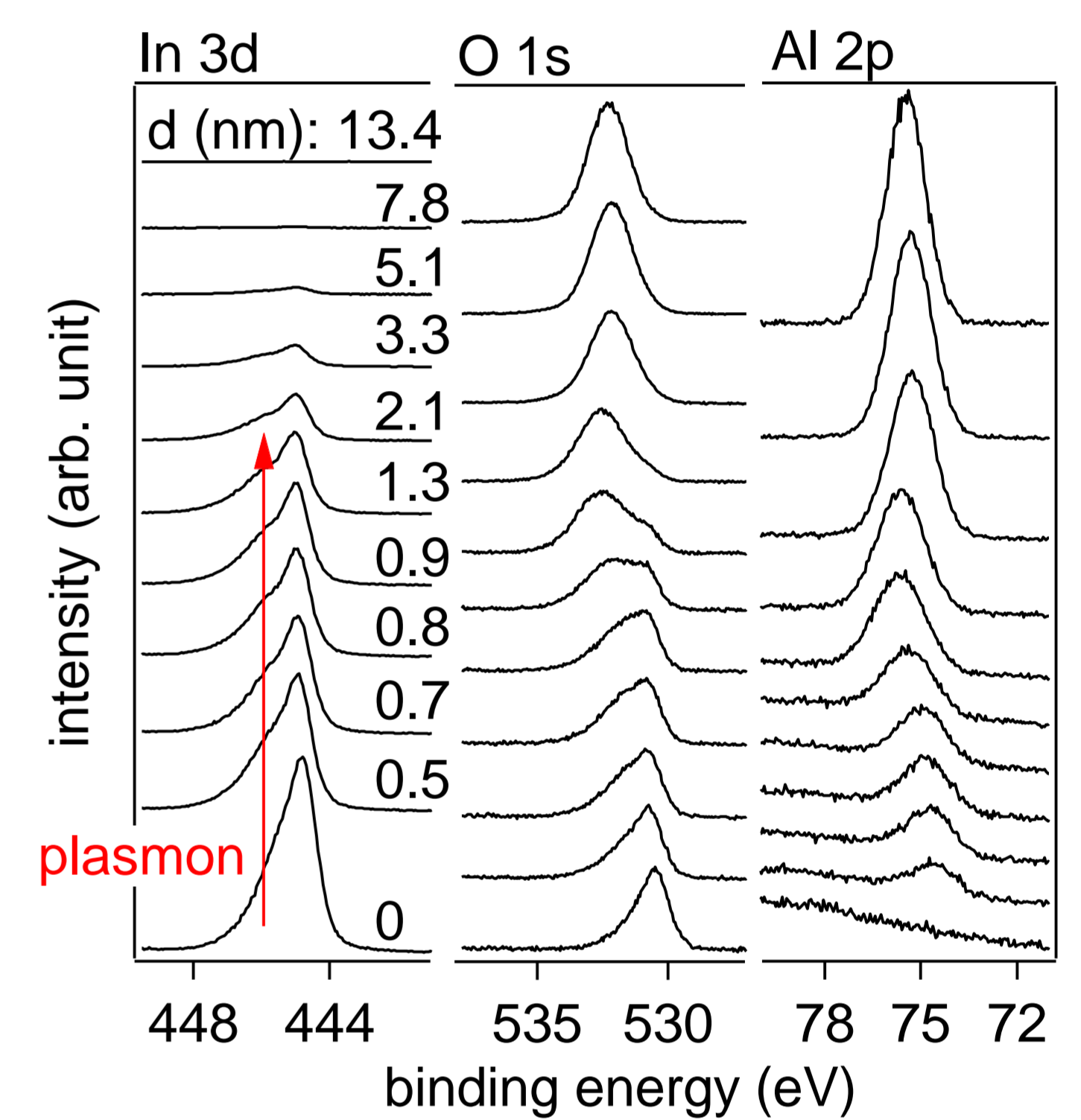


Results

Photoelectron spectroscopy

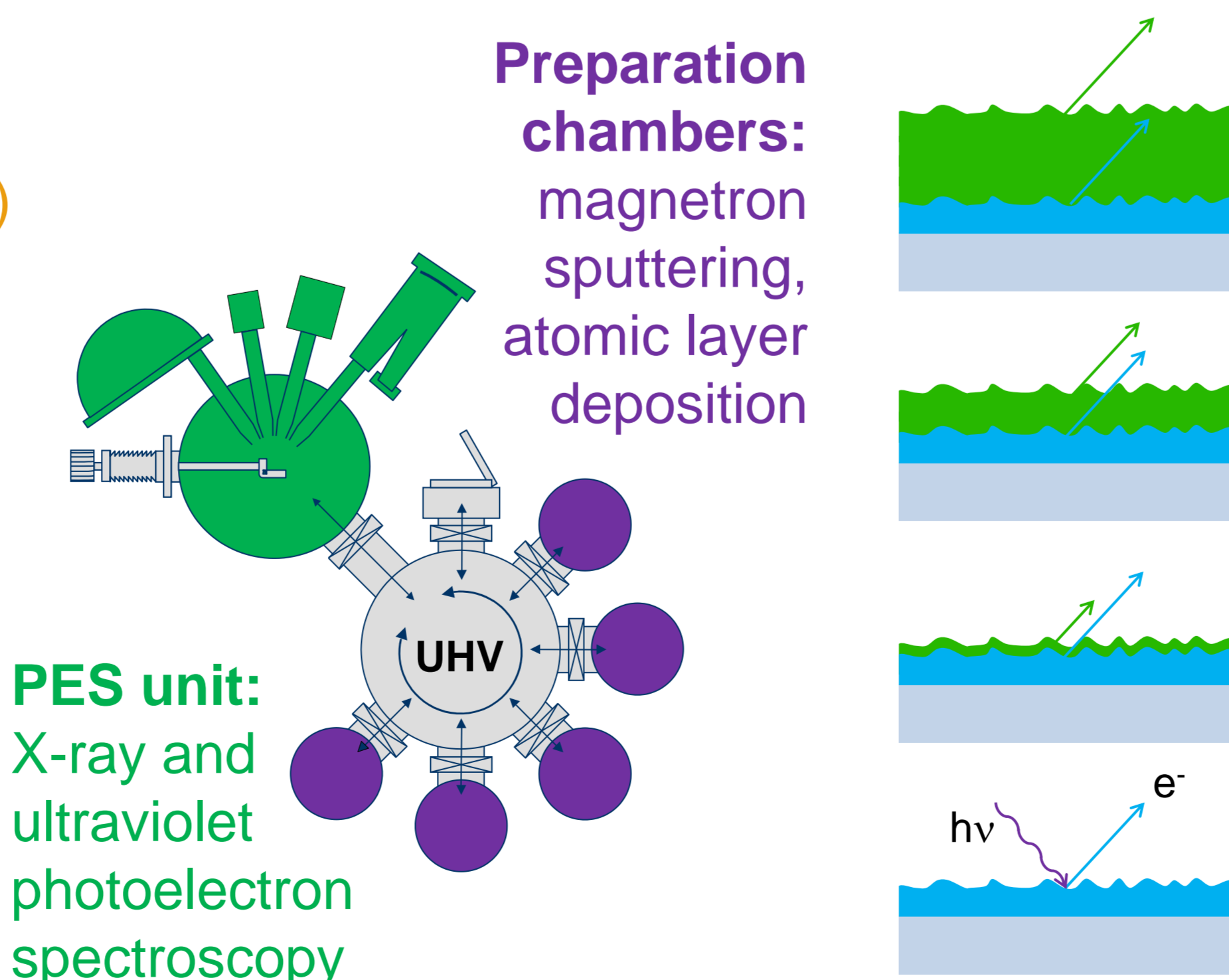


Photoelectron spectroscopy



Experimental

- Copper oxide / indium-tin oxide (ITO):**
 - reactive r.f. magnetron sputtering (MS) from 2" target of copper / ITO (10 wt% Sn)
 - 4.3% oxygen in the sputter gas
 - room temperature / 400°C
 - power density: 1.3 W/cm²
- Aluminum oxide:**
 - atomic layer deposition (ALD) with trimethylaluminum (TMA) and water at 200°C
 - growth rate: 0.09 nm/cycle³
 - 5 min evacuation between individual pulses



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- Portuguese Foundation for Science and Technology (SFRH/BD/77103/2011)
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- Bayer, T. J. M. et al., *Chem. Mater.* **24**, 4503–4510 (2012)
- Walsh, A. et al. *Phys. Rev. Lett.* **100**, 167402 (2008)
- Puurunen, R. L. et al., *J. Appl. Phys.* **97**, 121301 (2005)



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