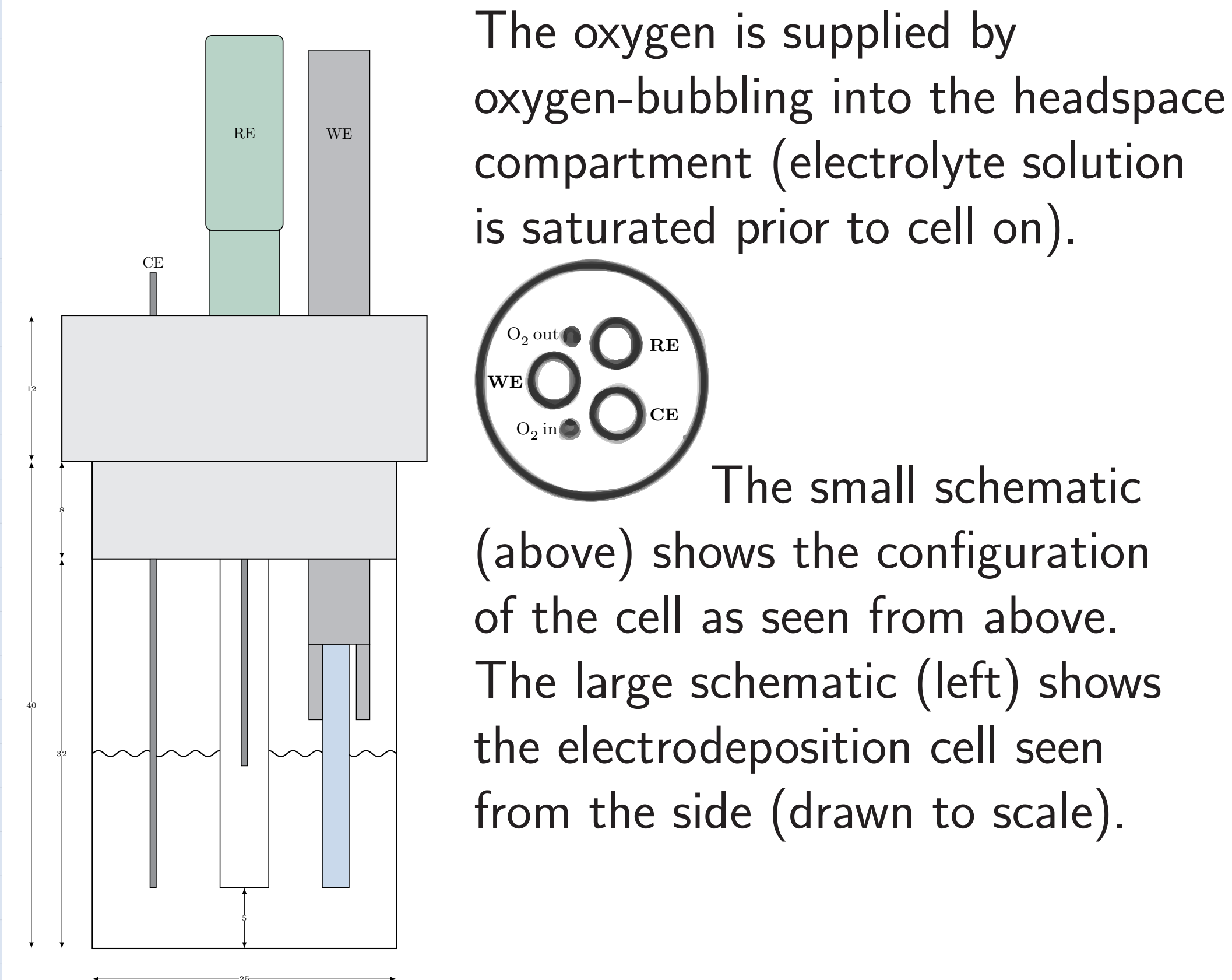
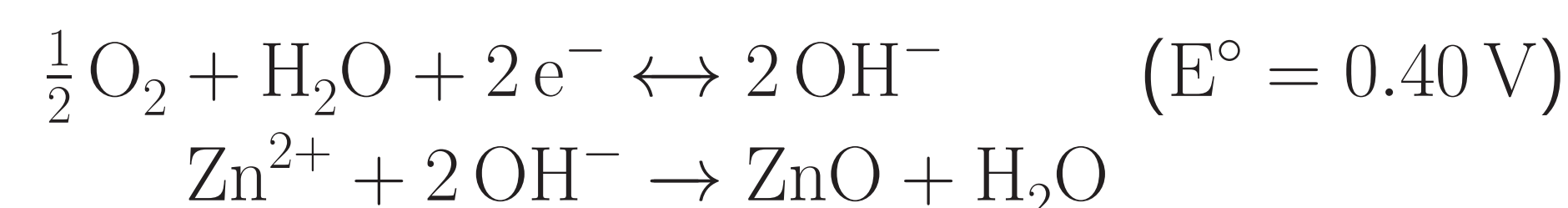


Electrochemical deposition of ZnO

The working electrode is kept at a potential negative to the reduction potential of O_2 , which causes oxygen gas near the electrode to be reduced to hydroxide ions. The hydroxide ions react with the zinc ions and forms zinc hydroxide, zinc oxyhydroxide or zinc oxide (depending on temperature).



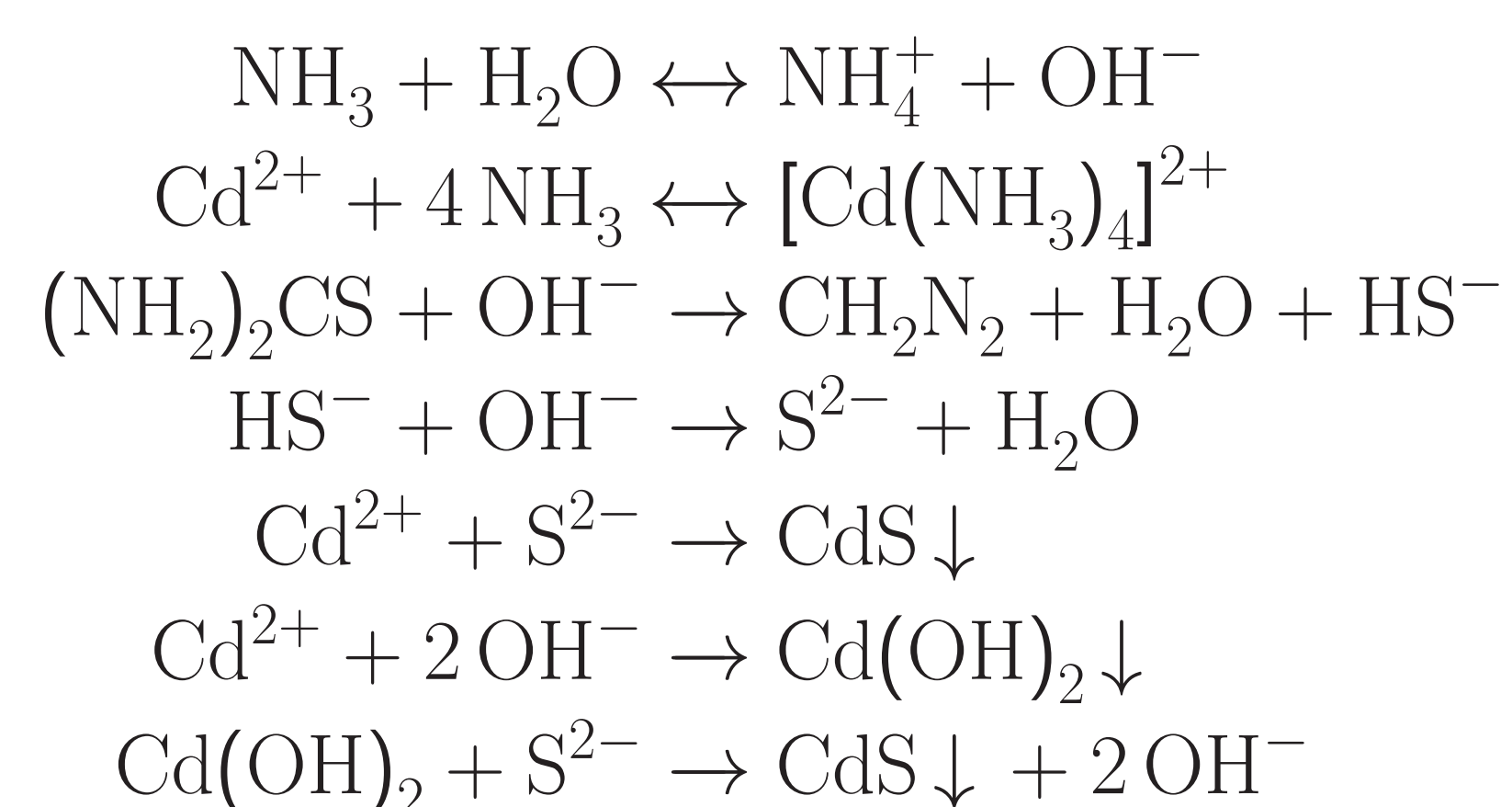
The oxygen is supplied by oxygen-bubbling into the headspace compartment (electrolyte solution is saturated prior to cell on).

The small schematic (above) shows the configuration of the cell as seen from above. The large schematic (left) shows the electrodeposition cell seen from the side (drawn to scale).

Cathodic deposition at -0.7 V vs. $Ag/AgCl$ for 90 min with an initial pulse at -1.3 V vs. $Ag/AgCl$ for 0.1 s, 0.5 s or 1.0 s. Electrolyte: $0.1 \text{ mmol dm}^{-3} ZnCl_2(aq)$ and $0.1 \text{ mol dm}^{-3} KCl(aq)$. A temperature of 80°C was maintained using a thermostat-controlled waterbath.

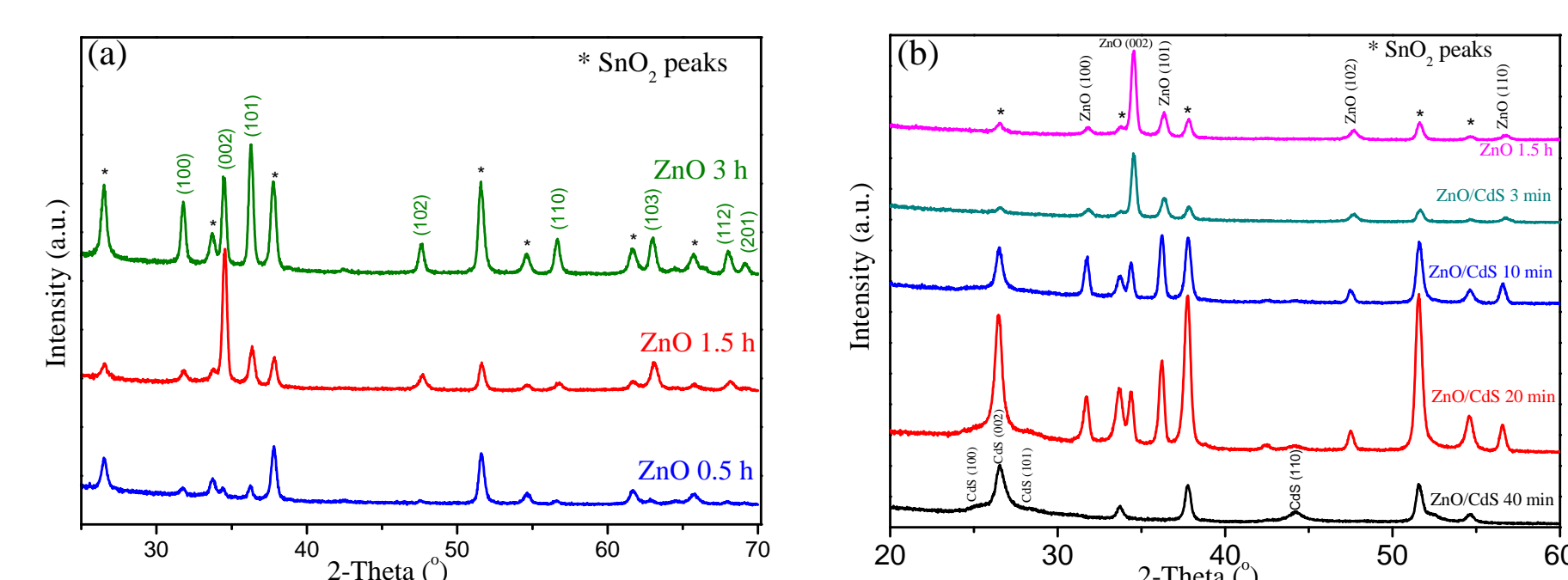
Chemical-bath deposition of CdS

An aqueous bath solution of $2 \text{ mmol dm}^{-3} CdSO_4$, $10 \text{ mmol dm}^{-3} CH_4N_2S$, and $1 \text{ mol dm}^{-3} NH_3$ was thermostatically maintained at 60°C before immersing the substrate for a set amount of time (up to 2 h).



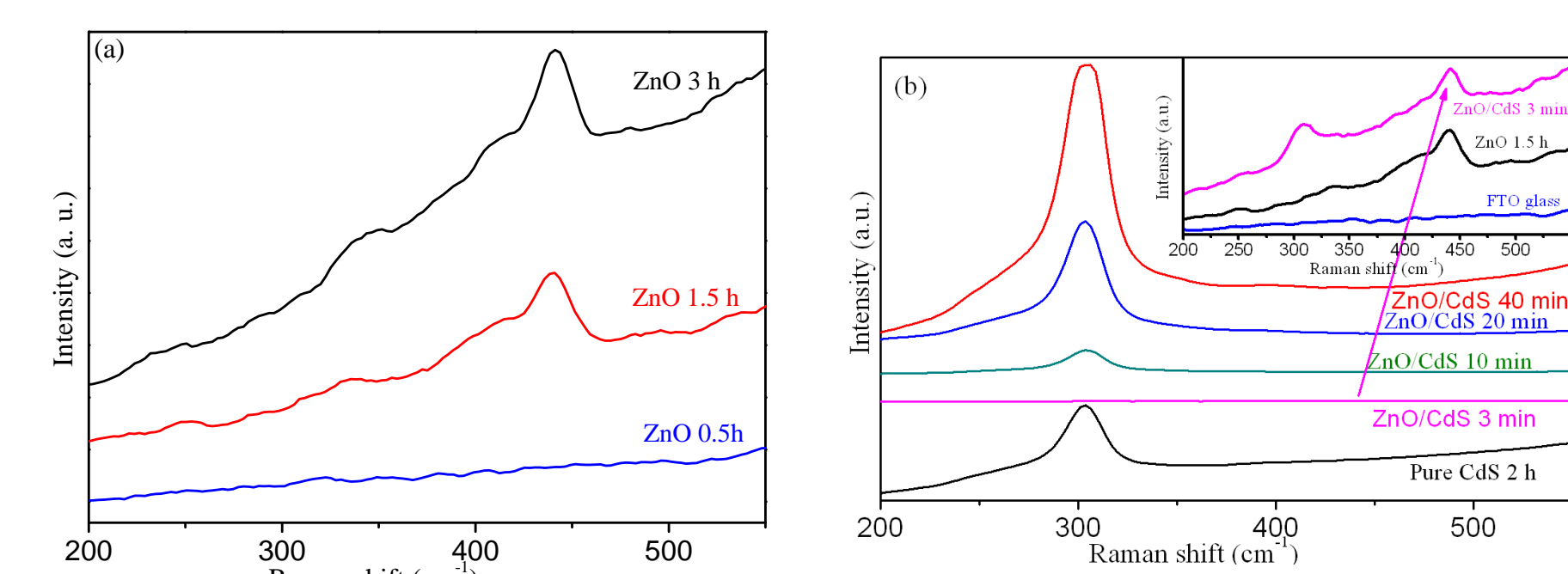
The substrate was suspended vertically and the solution was continuously stirred during deposition.

X-ray diffraction



All ZnO samples have a hexagonal wurtzite structure. Preferential growth along the [0001] direction (normal to the (002) plane). As more ZnO deposits, the pH of the solution acidifies, and eventually the deposited rods start etching away. Stopping the deposition after 90 min resulted in a maximum amount of deposited crystals.

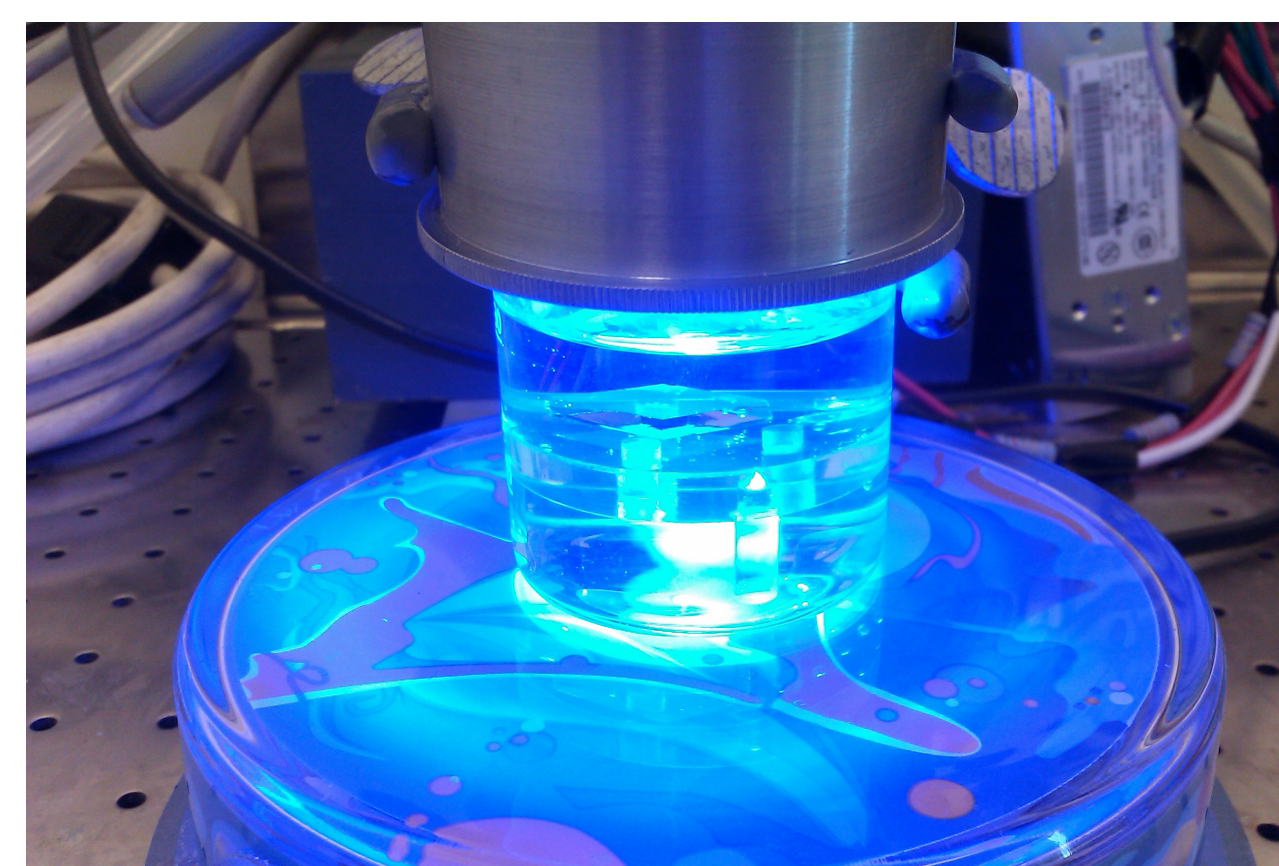
Raman spectroscopy



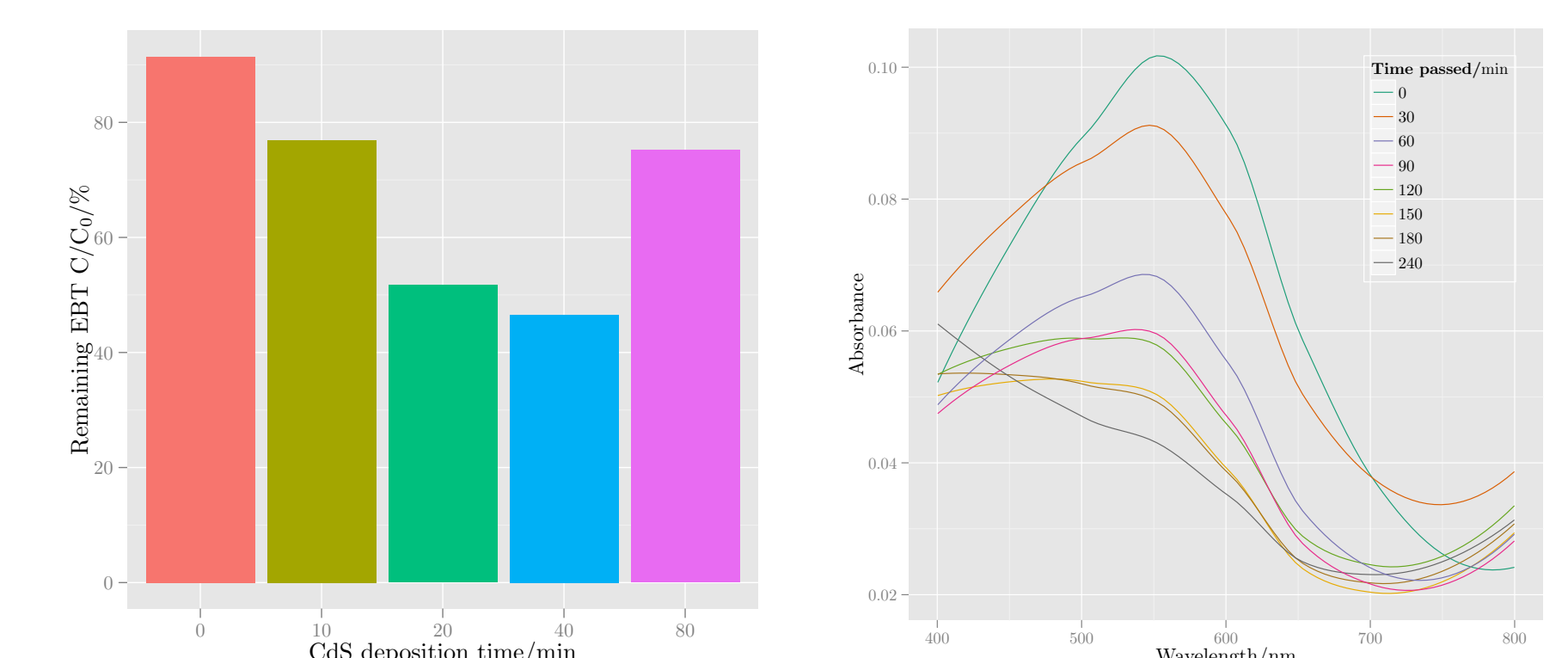
The 1LO peak of CdS at $\approx 309 \text{ cm}^{-1}$ indicates the presence of the hexagonal CdS phase. It is probably stabilized by the hexagonal ZnO substrate. Both the ZnO and CdS peaks grow with longer deposition times.

Photodegradation of Eriochrome Black T

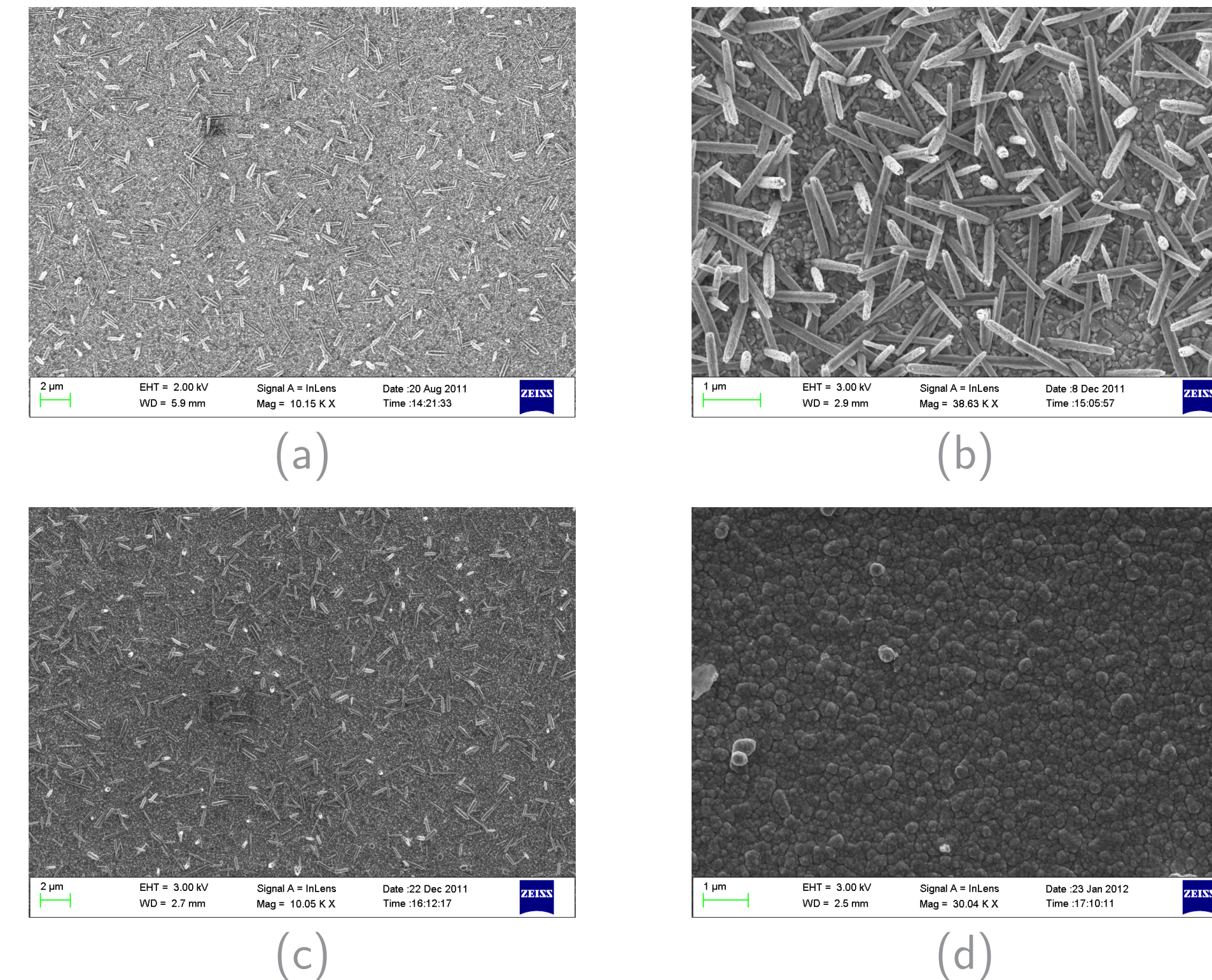
A blue LED (450 nm) with an intensity of 0.4 W cm^{-2} (at the sample level) was used for photodegradation tests.



Left: Remaining EBT concentration after irradiation for 90 min. Right: Absorption spectra at different times for the ZnO/CdS 40 min sample.

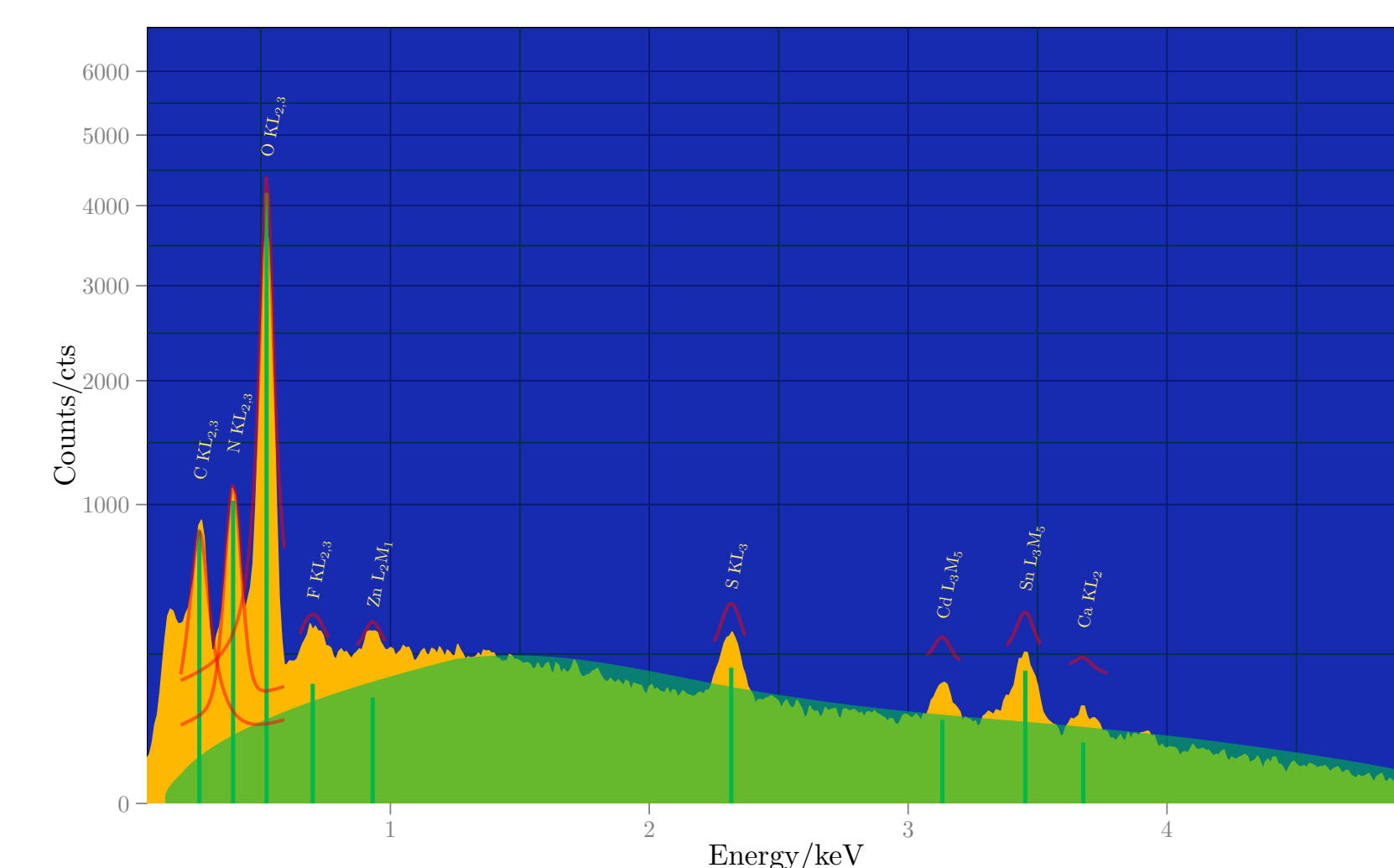


SEM



(a) short pulse (0.1 s), with a low charge density passed during deposition, (b) long pulse (1 s), with a high charge density passed during deposition. (c) and (d) show the same sample after (c) electrodeposition of ZnO, and (d) after 80 min CdS chemical-bath deposition.

Energy-dispersive spectroscopy



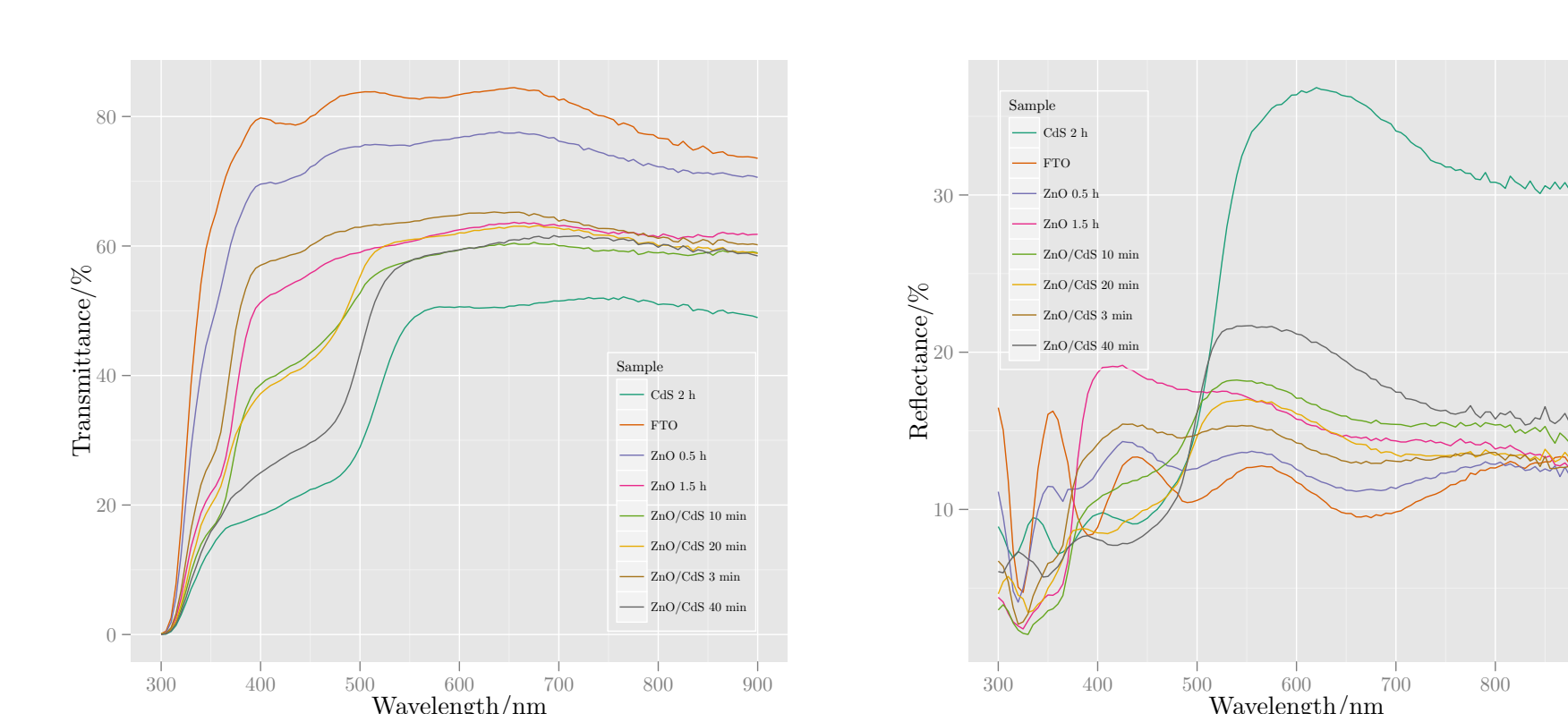
EDS spectrum of a ZnO/CdS 3 min sample after photocatalytic degradation.

- Carbon and nitrogen probably due to organic substances that did not wash off.
- Fluorine, tin, and calcium expected in the sodalime/FTO.
- Zinc, sulfur, and cadmium from the deposited layers.

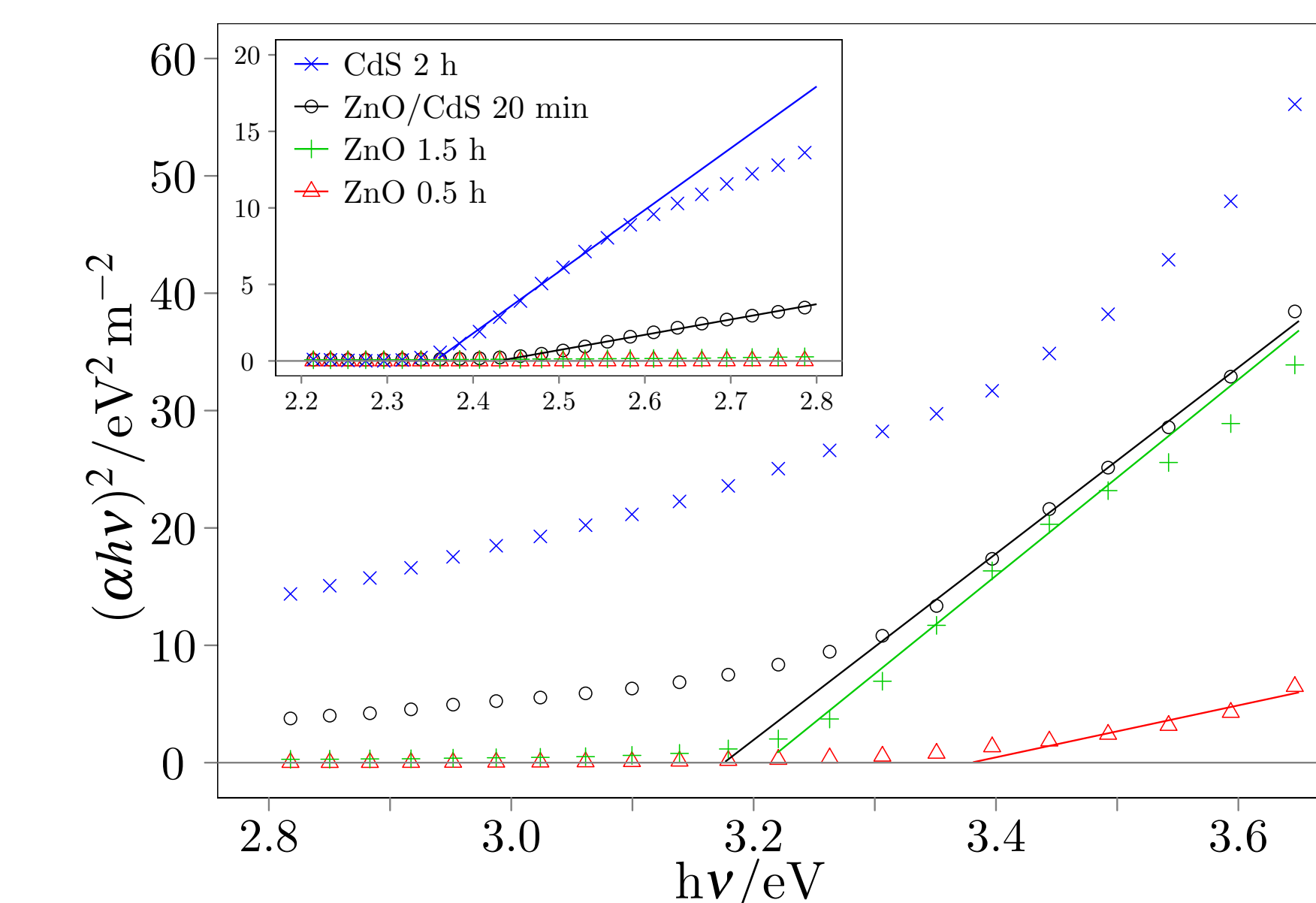
References

- Keis, Bauer, Boschloo, et al. *Journal of Photochemistry and Photobiology A: Chemistry* **148** (2002) 57–64.
 - Zhu, Chakarov, Zäch. In Zang (ed.), Springer (2011) 441–486.
- Honorable mentions:
L^AT_EX, R, beamerposter and the diffractometry package by Davies et al.

UV/Vis spectroscopy

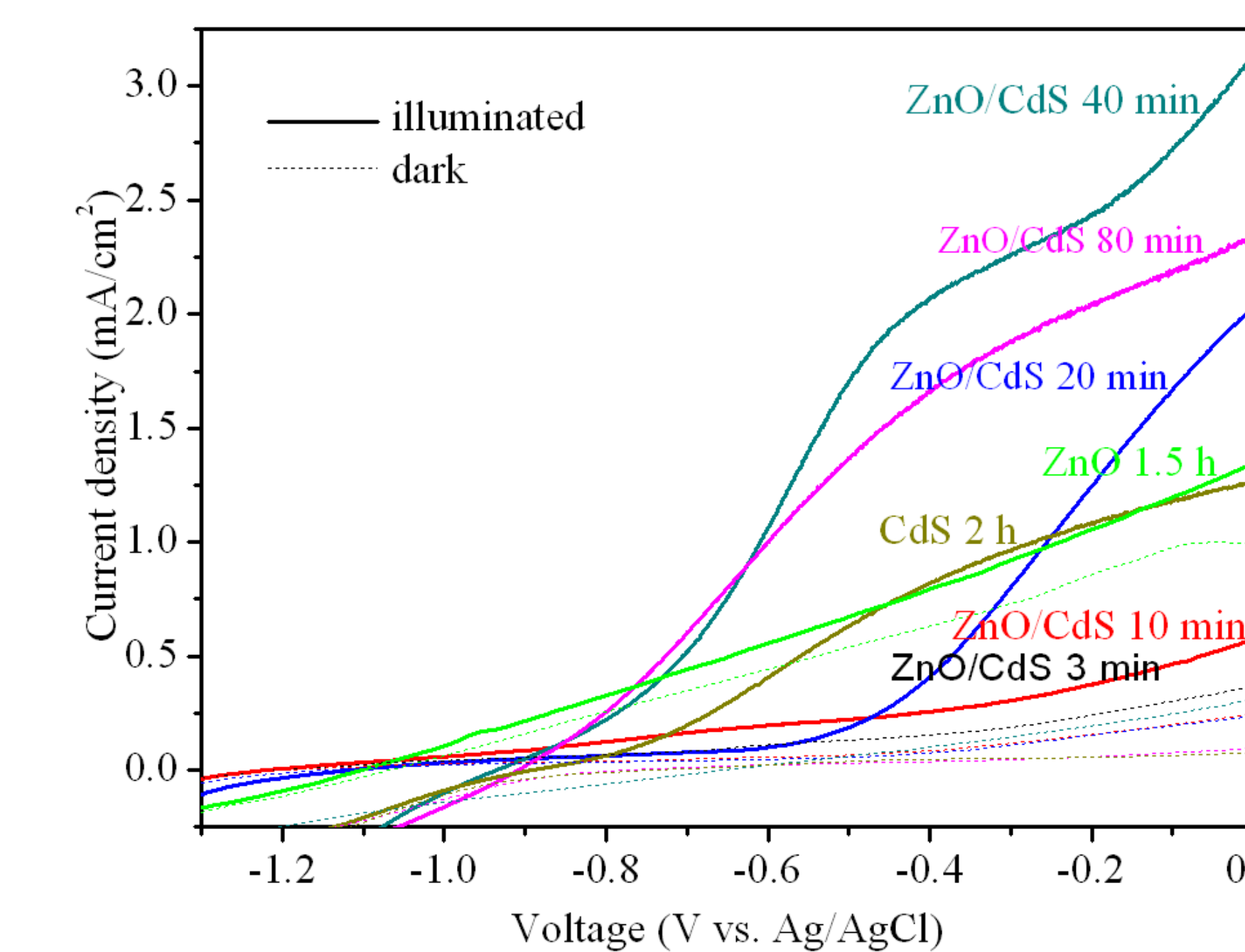


Transmittance and reflectance spectra at different CdS loadings. Recorded with spectrometer equipped with an integrating sphere.



Band gap determination from a so-called Tauc plot assuming an allowed direct transition. $E_g(\text{ZnO}) \approx 3.3 \text{ eV}$, and $E_g(\text{CdS}) \approx 2.4 \text{ eV}$. Furthermore, the band gap decreases with increasing deposition times, suggesting that the crystallite size increases.

Current-potential response



Acknowledgements

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