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A Liquid-Phase Quartz Crystal Microbalance for Photovoltaics Research

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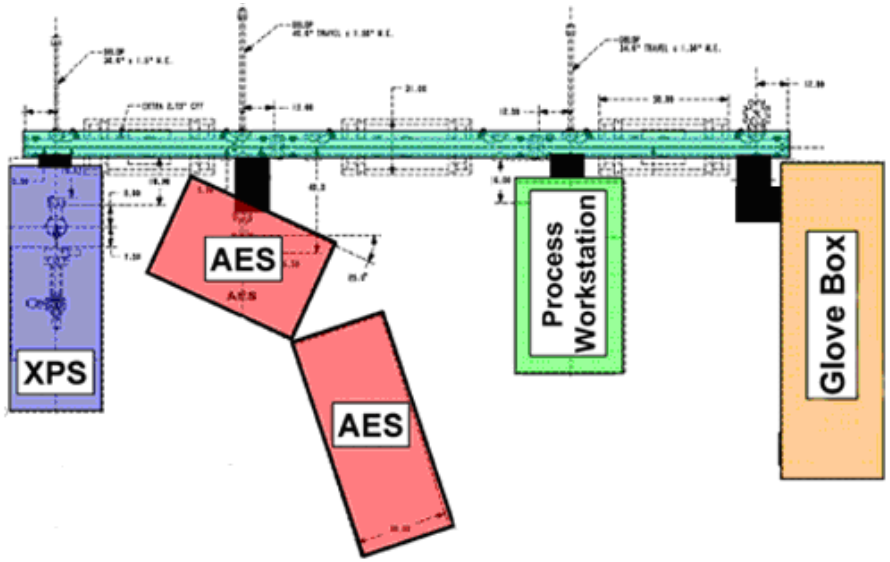
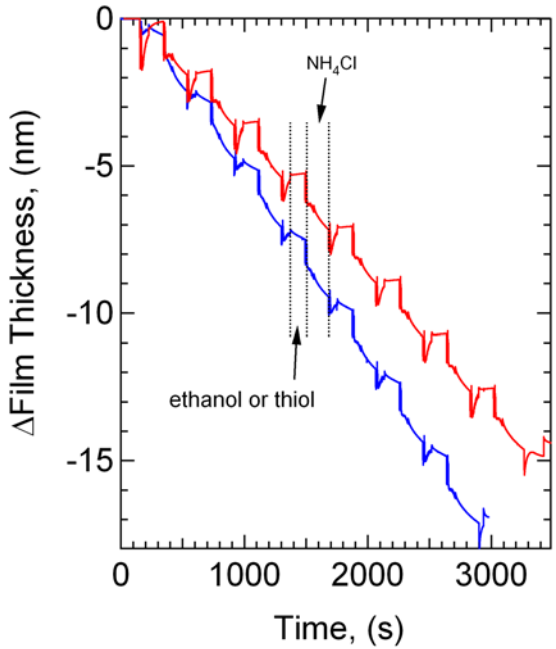
NREL/PR-520-43324
Presented at the 33rd IEEE Photovoltaic Specialist Conference held May 11-16, 2008 in San Diego, California

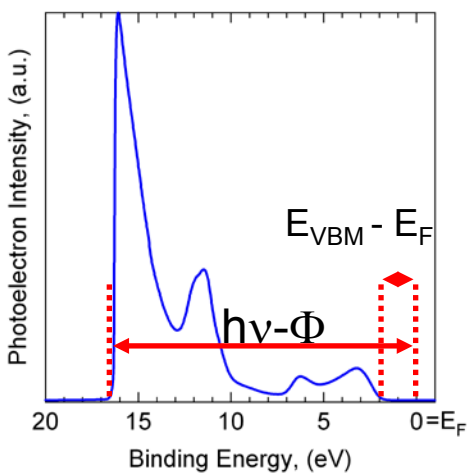
STF 140 cluster tool: PES/AES/MS/LQCM



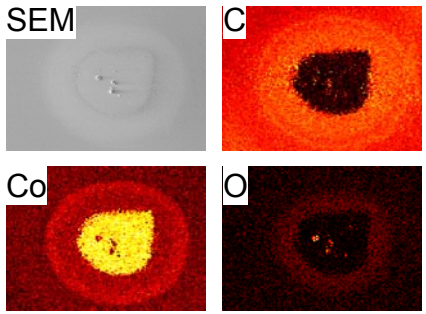


controlled ambient transfer, QCM, chemical growth, etching, & modification

Photoemission



AES mapping & spectroscopy



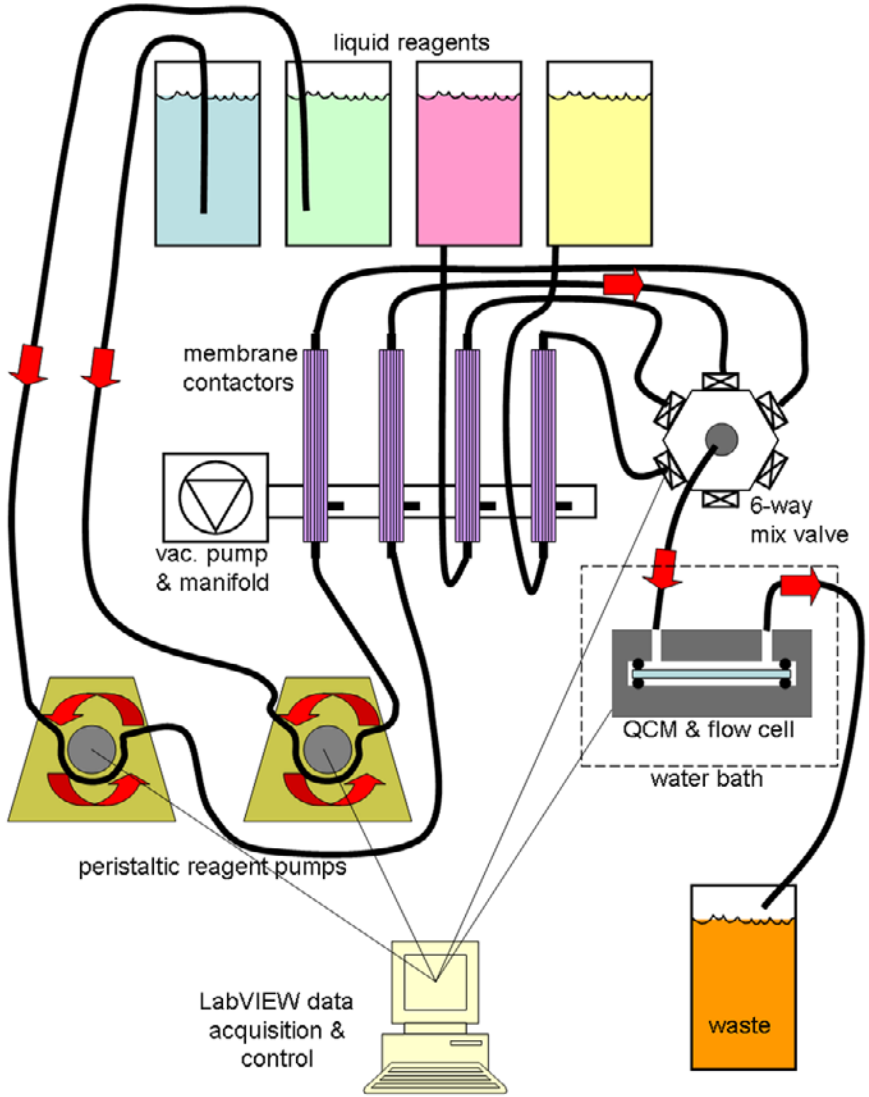
M. Law et al. "The Structural, Optical and Electrical Properties of PbSe Nanocrystal Solids Treated Thermally and with Simple Amines", *J. Am. Chem. Soc.*,(2008) ASAP article.

J.M. Luther et al.,"The Structural, Optical, and Electrical Properties of Self-Assembled Films of PbSe Nanocrystals Treated with 1,2-ethanedithiol", *ACS Nano,* **2** (2008) 271-280.

G. Teeter, "X-ray and ultraviolet photoelectron spectroscopy measurements of Cu-doped CdTe(111)-B: Observation of temperature-reversible CuxTe precipitation and effect on ionization potential", *J. Appl. Phys.*, **102** (2007) 034504.

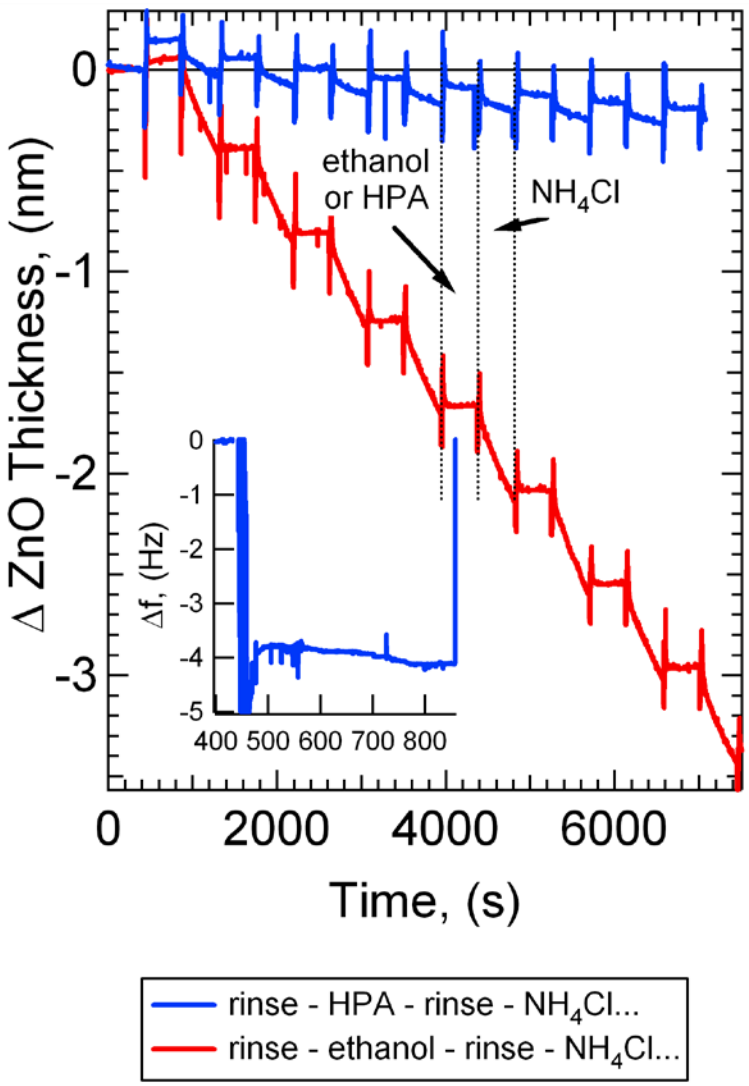
QCM-Based Flow Reactor Schematic

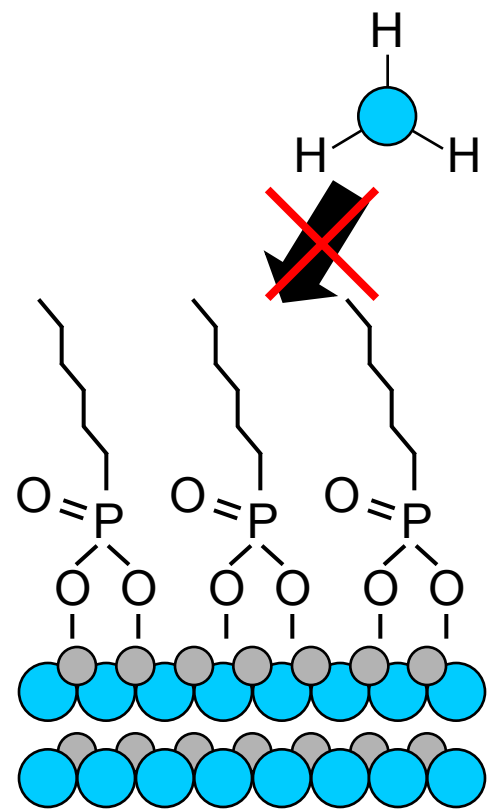
$$\Delta f = -f^{3/2}\sqrt{\frac{\eta_L \cdot \rho_L}{\pi \cdot \mu_q \cdot \rho_q}}$$



K. K. Kanazawa and J. G. Gordon, *Analytica Chimica Acta* **175**, 99 (1985).

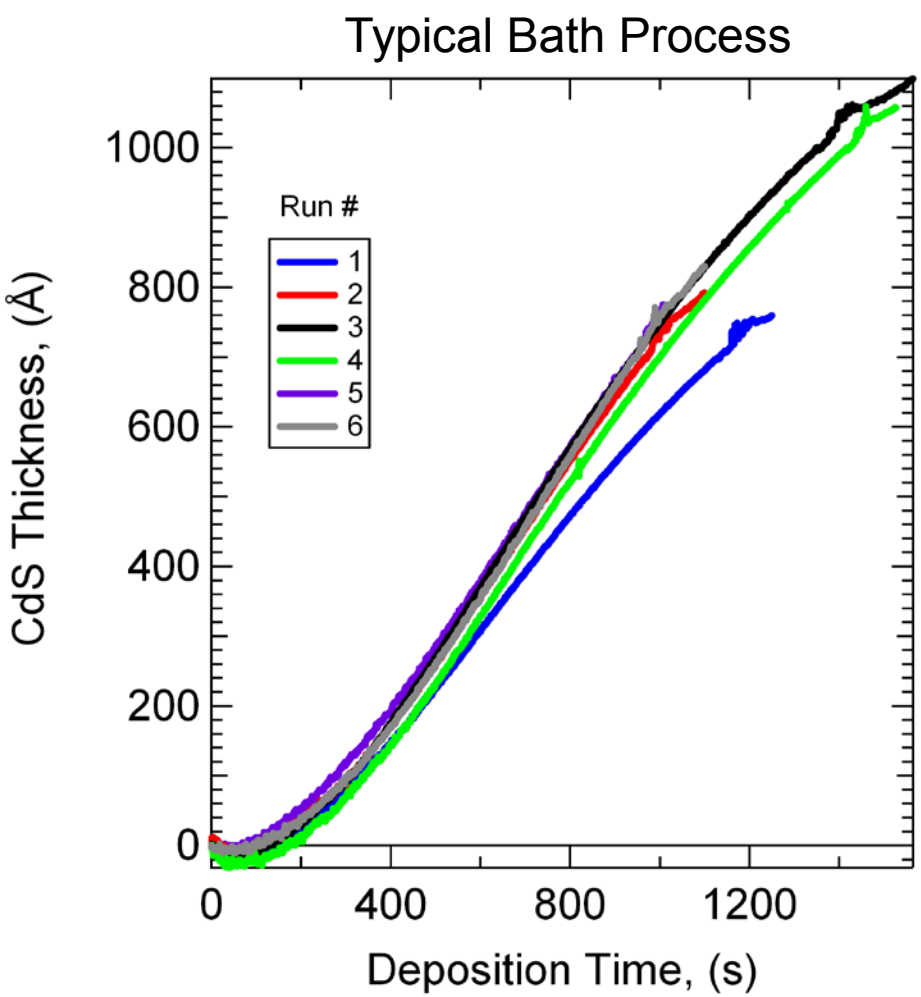
NH_4Cl: Using an Etchant as a Probe of ZnO-molecule Interactions

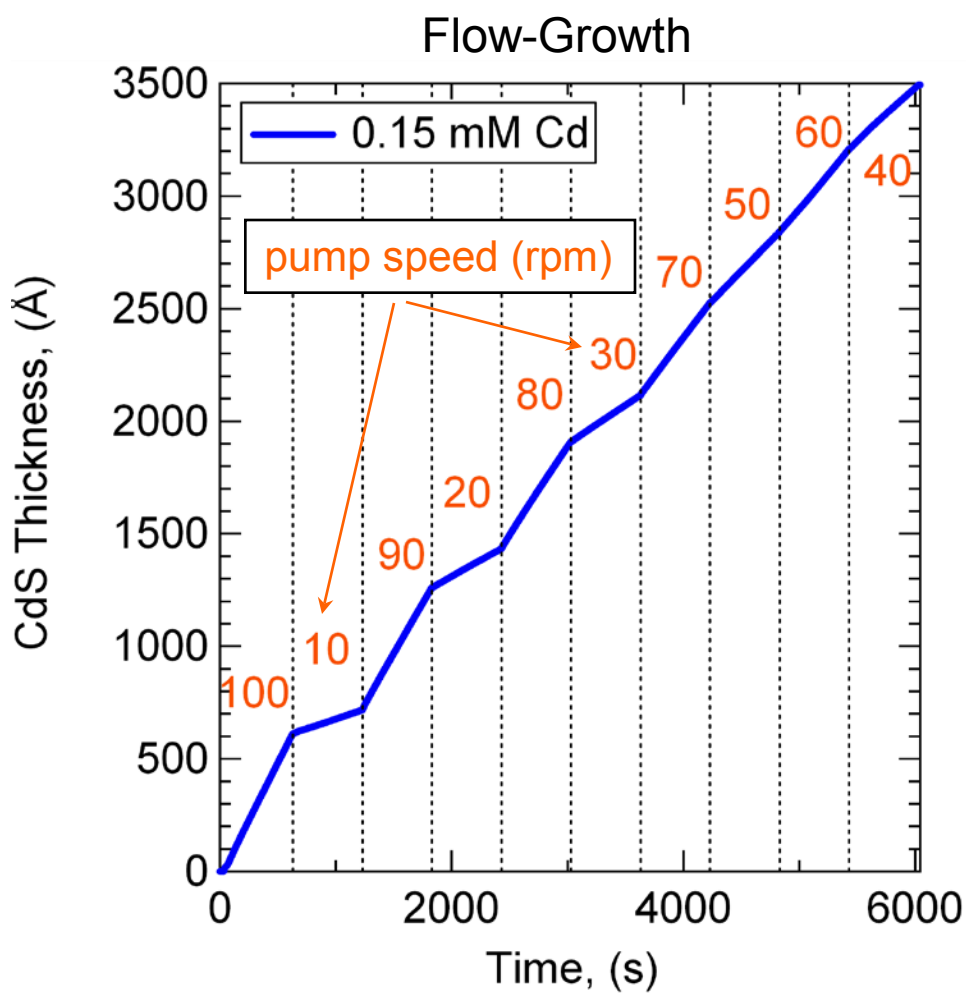




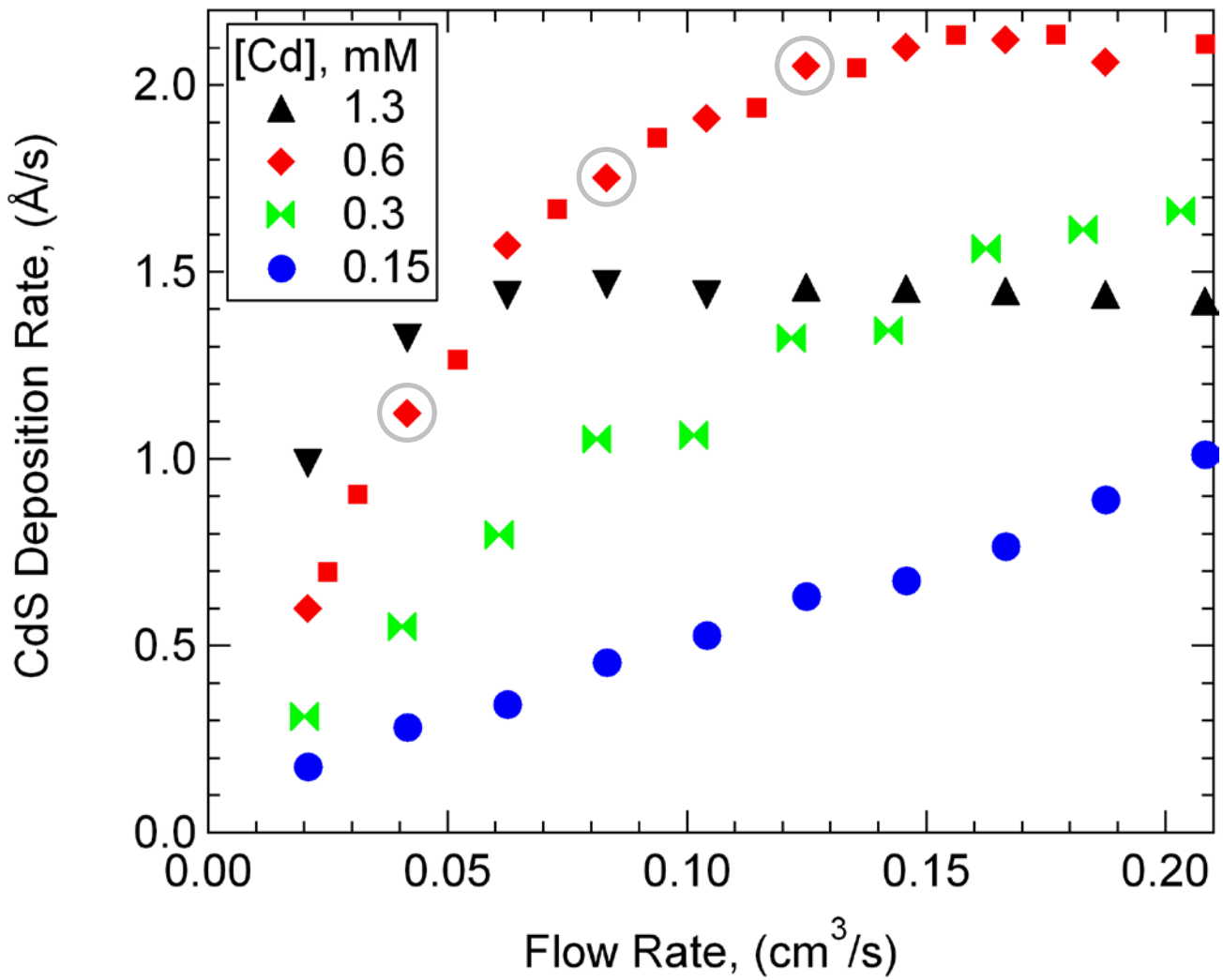
4 Hz → 2.6 x 10^{14} mol·cm^{-2}, or 0.24 monolayer.

QCM Thickness Data for CdS Chemical Depositions



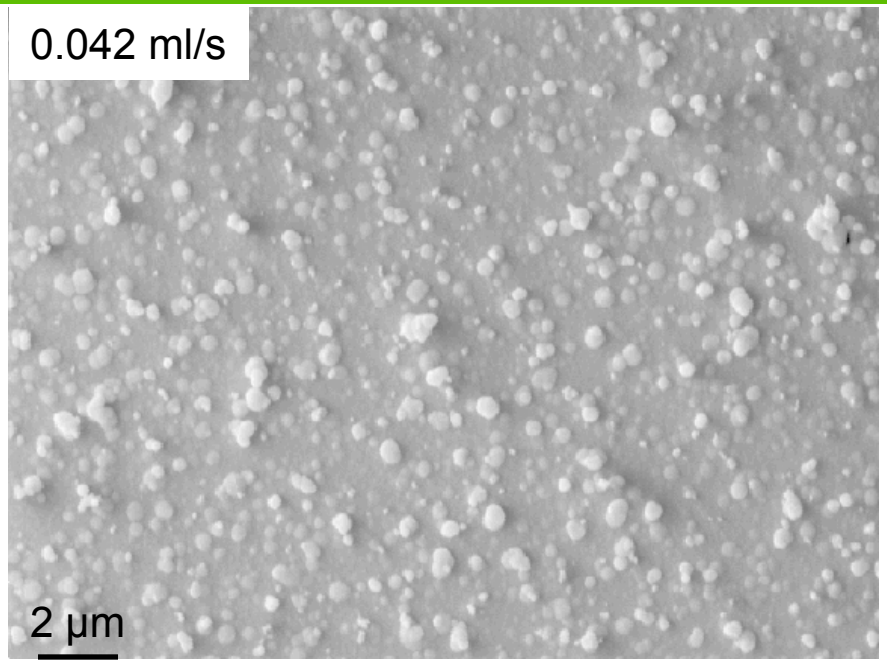


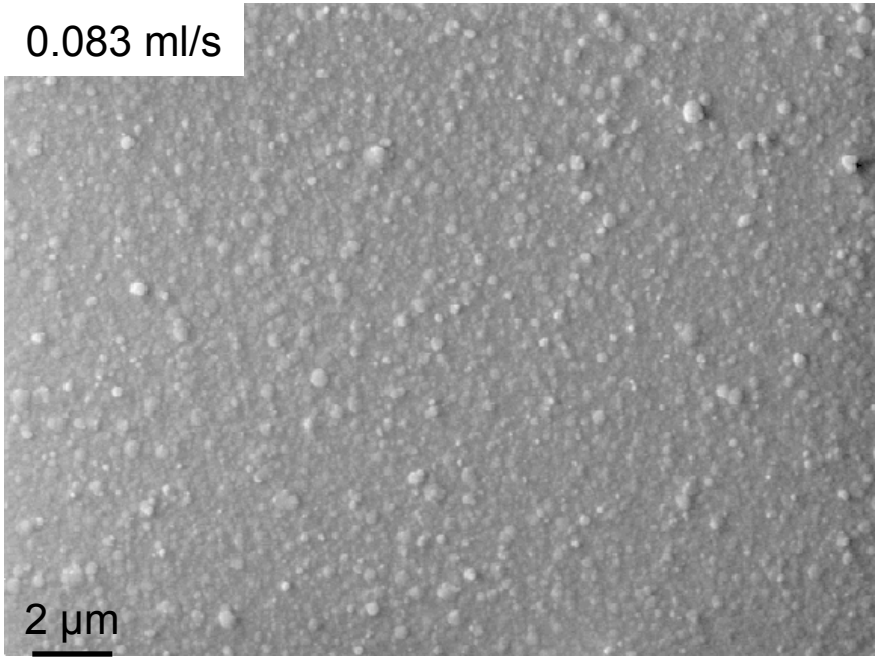
Deposition Rates as f(flow, [reactants])

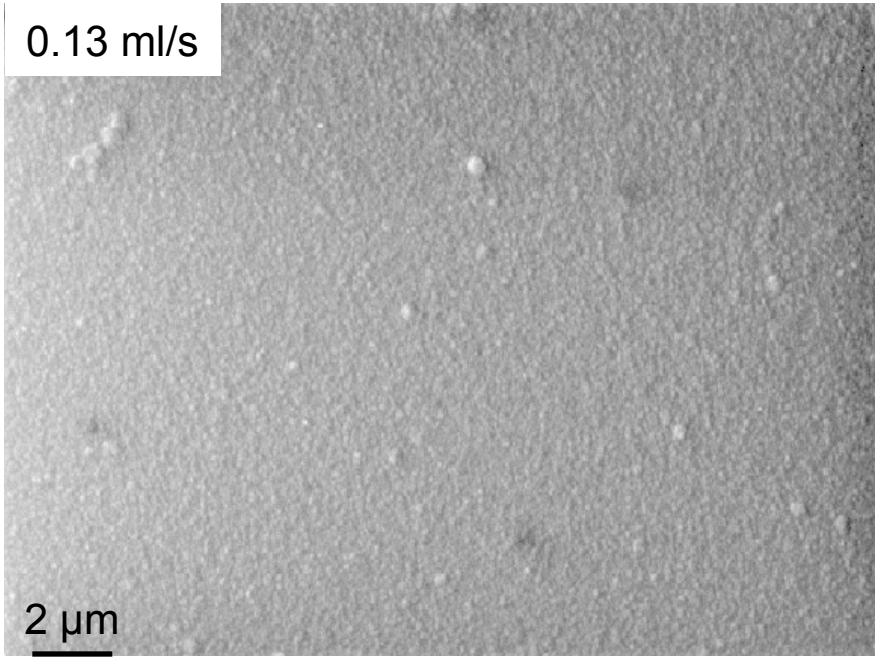


Flow-Rate Dependent Morphology of Chemically Grown CdS Films

Film thickness = 0.4 µm
T_{growth} = 63 ºC







Summary

- Construction of a new QCM-based flow reactor has been completed
- Initial results include:
  - Stable oscillation achieved with crystals sputter coated at 200 ºC with 500 nm ZnO
  - Sub-Hz noise level means << monolayer sensitivity
  - Operation at elevated temperature possible after installation of membrane contactors
  - Determination of ZnO etch rates using dilute ethanolic NH_4Cl
  - Demonstration of use of an etchant as a probe of oxide-molecule interactions.
  - Use in flow rate-dependent CdS chemical deposition

Acknowledgments:

Xiaonan Li, Sally Asher, Glenn Teeter, Pete Sheldon

This work was supported by the U.S. Department of Energy under Contract No. DE-AC36-99GO10337 with the National Renewable Energy Laboratory.

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