

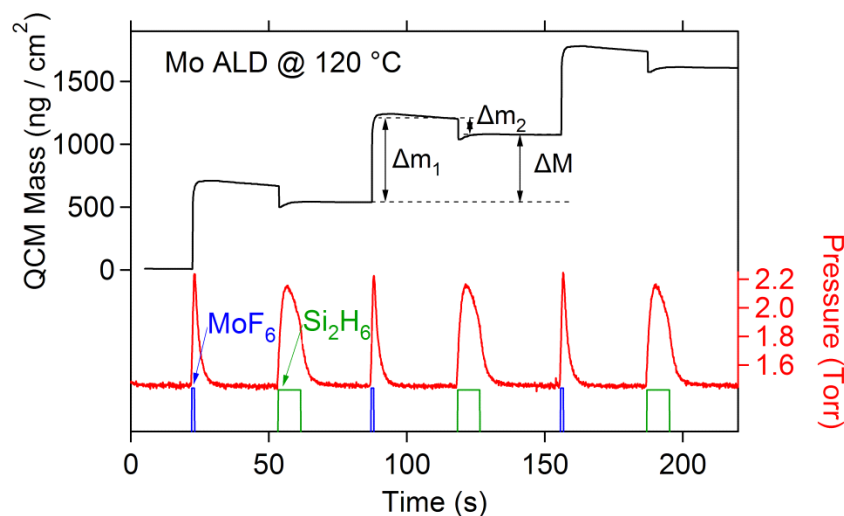
Exploratory ALD Surface Chemistry

Many binary materials can be deposited using ALD techniques. However, many other materials remain to be demonstrated and other existing ALD methods could be improved using different precursors or new chemical approaches. We have been active in developing new ALD methods for various binary materials and metals. These studies are performed using FTIR and QCM techniques.

Recent materials that have been explored include MnO and MgO ALD using metal cyclopentadienyl precursors and H₂O [1,2]. SiO₂ ALD has been demonstrated using HSi(N(CH₃)₃) and H₂O₂ [3]. The so-called "rapid" SiO₂ ALD process was also examined to understand the mechanism of this interesting reaction [4]. In addition, we have successfully grown high quality TaN ALD films using TBTDET and hydrazine [5]. Al₂O₃ ALD has also been grown using TMA and ozone [6].

We are currently exploring TiO₂ ALD using "waterless" surface chemistry based on TiCl₄ and Ti(OCH(CH₃)₂)₄ reactants. This "waterless" surface chemistry is needed to prevent oxidation of oxygen-sensitive surfaces such as cobalt-containing films used for magnetic disks.

We have determined that the isopropyl group is susceptible to β -hydride elimination at higher ALD growth temperatures.



We are also developing Mo ALD using MoF₆ and Si₂H₆ as the reactants. This chemical approach is analogous to W ALD using WF₆ and Si₂H₆ as the reactants. QCM results for Mo ALD are shown in the

accompanying figure. We also hope to grow W/Mo alloys to obtain more thermally stable metallic coatings that should be less likely to crystallize or restructure at higher temperatures.

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3. B. B. Burton, S. W. Kang, S.W. Rhee and S.M. George, "SiO₂ Atomic Layer Deposition Using Tris(dimethylamino)silane and Hydrogen Peroxide Studied by in situ Transmission FTIR Spectroscopy", *J. Phys. Chem. C* **113**, 8249 (2009).
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6. D.N. Goldstein, J.A. McCormick and S.M. George, "Al₂O₃ Atomic Layer Deposition using Trimethylaluminum and Ozone Studied by in situ Transmission FTIR Spectroscopy and Quadrupole Mass Spectrometry", *J. Phys. Chem. C* **112**, 19530 (2008).