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Develop a Thin Film Deposition Technique: Atomic Layer Deposition

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Develop a Thin Film Deposition Technique: Atomic Layer Deposition

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Project Summary

Atomic layer deposition (ALD) is a rising thin film deposition technique widely used in microelectronic industry, including IBM, Intel, Samsung, etc. In the past 10 years, the global ALD market has increased 5 folds from ~\$ 200 million in 2005 to ~ \$ 1 billion in 2014. Over the period of 2014-2018, the global ALD market is expecting another 36.1% increase. The great advantage of ALD is that it enables atomically precise coatings of thin film materials on complex objects. It employs self-limiting, sequential surface reactions, and therefore, it can achieve uniform coatings on the substrates as shown in Figure 1. It is the only technique that allows conformal thin film coating over a nano-sized 3D objects at the atomic level, which is critical to modern microelectronic design. The utilization of ALD permits the production of even more powerful portable microelectronic devices, such as smartphone, ipad, laptop, hard disc, etc. With the development of this technique, the utilization of ALD has found path to five other sections besides electronics, including mechanical/chemical, energy, optics, medical/dental, and nanotechnology.

At UAH, we are interested in developing this state-of-the-art technique to prepare nanomaterials for green energy conversion and production. These materials include heterogeneous catalysts, lithium batteries, fuel cells and solar cells.

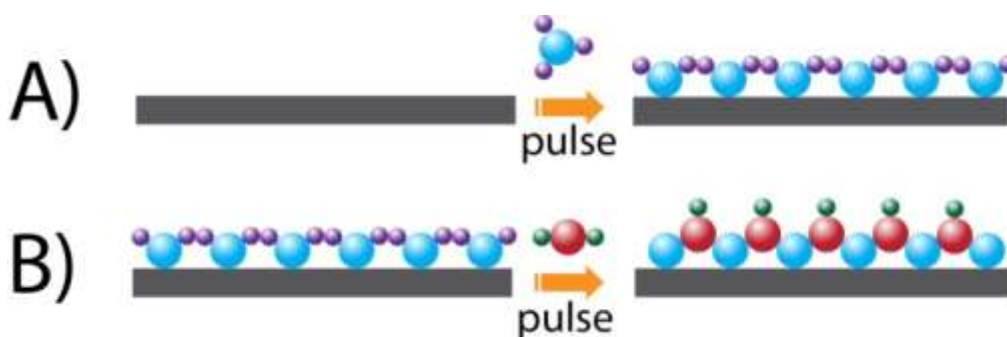


Figure 1. Schematic illustration of the Al₂O₃ ALD process. Alternating pulses of precursors required for atomic layer deposition of one monolayer.

Student Duties

Soak up as much knowledge as you can – provide enthusiasm in return.

The perspective undergraduate researcher will work closely with a graduate student Mr. Blake Nuwayhid on developing ALD recipe here at UAH (see Figure 2, located at Shelby Center 309). To do so, the student will use data acquisition interface for the ALD system and quartz crystal microbalance (QCM) to obtain understanding on the thin film growth behavior. The data acquisition interface will allow us to record operation parameters in real time, including pressure, temperature, precursor exposure time, and the film thickness. The summer undergraduate researcher is expected to carry out experiments to establish new ALD recipe for the research group. Critical information includes precursor exposure time – growth rate relationship, temperature dependence, and the effects of chemical inhibitors.

The perspective student is also expected to become familiar with the literature that is relevant to this project and with the wider literature in general.

The undergraduate researcher is desired to conduct the required work in a timely manner as directed by the mentors.

In summary, this project will be a great multidisciplinary learning experience for developing scientific skills in the area of nanotechnology, vapor deposition and thin film characterizations.

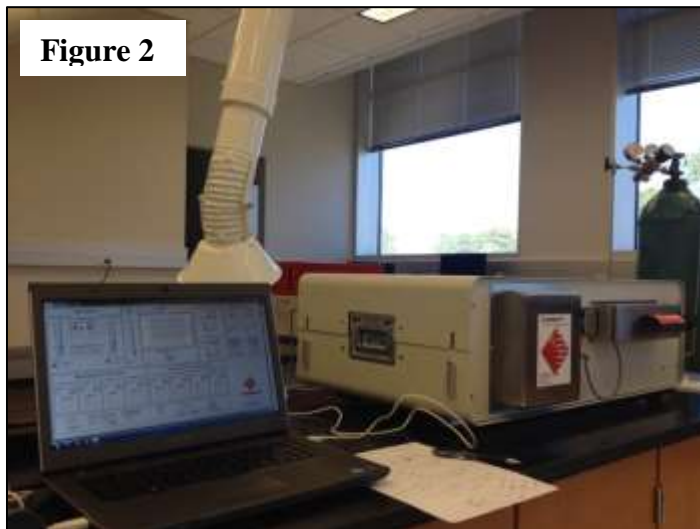


Figure 2

Required Experience and Education

- Basic knowledge of chemistry, and materials sciences
- Undergraduate student in Chemical Engineering, Chemistry, Physics, Materials Science, Electrical Engineering, Mechanical Engineering and related disciplines
- Good operational knowledge of LabView, electronics, gas delivery systems, data acquisition systems and vapor delivery is a plus.

Mentor Supervision and Interaction

The perspective student is encouraged to see the mentor if there is anything he/she wants to discuss, science or otherwise.

Lab Visit. The mentor will work in the lab with students when it is necessary. This will allow students to have access to qualified, expert advice when it is needed.

Individual Meeting. A definite schedule of individual meetings and team meetings is adopted weekly in our group. The group member will meet with the mentor in an informal fashion to discuss recent progress.

Group Meeting. Our group has biweekly group meetings together with Professors George Nelson and Eunseok Lee of Mechanical and Aerospace Engineering Department. Each group meeting can be divided into two parts: literature survey and research progress. The perspective student will participate in our weekly group meeting and be able to interact with graduate students and faculty members. He/She will also present a literature survey in the area of ALD and nanotechnology during the summer. At the end of the summer, the student will present research progress that she has made during the period of this project at UAH.