Global Interchange lecture on Engineering Technology
(Chemical Reaction Engineering for better understanding of CVD/ALD)

Intensive lecture, December 27-29, 2021

Overview:
CVD (Chemical Vapor Deposition) and ALD (Atomic Layer Deposition) are useful and important processes to fabricate thin films for various kinds of devices. It consists gas-phase and surface reactions to form thin films. In order to design the CVD/ALD processes to have uniform film thickness profile and better film qualities, kinetics on these gas-phase and surface reactions are mandatory. However, transport phenomena like as flow, convection, and diffusion, are also affecting to film growth. Extraction of these kinetic parameters are complicated and difficult. In this lecture, chemical reaction engineering approach to process design and development for CVD/ALD will be discussed. The applications of (area selective) ALD for devices will be also reviewed.

Prerequisites: It is desirable that participants have basic knowledge on chemical reactions and kinetics.

Textbook: N/A. Lecture materials will be distributed before the class.

Classroom: This course will be delivered online using zoom below.
Topic: SNU Global Interchange lecture on Engineering Technology
Time: This is a recurring meeting Meet anytime
Join Zoom Meeting
https://u-tokyo-ac-jp.zoom.us/j/82247152194?pwd=U0Z5cmJyTFlybmhPZGdjbE8xWG02UT09
Meeting ID: 822 4715 2194
Passcode: SNU-UT

Time: 10:00-11:30, 13:00-14:30, 15:00-16:30; December 27th 28th and 29th.

Evaluation: Participation (10%), Attendance (20%), Quiz (10%), Reports (60%).

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Class schedule

# (date)	Contents	Goal
Day 1 (12/27) #1 10:00-11:30 #2 13:00-14:30	#1 Introduction to Thin Film technology. 1.1 Thin films for coatings and devices. 1.2 History of ULSI device developments.	On the first day, we aim to learn the basics and applications of thin film processes. In particular, we will learn

#3 15:00-16:30	1.3 Thin films for Solar Cell and LED. 1.4 Si Wafer process #2 Fundamentals of Thin Film Processes 2.1 Wet and Dry Processes 2.2 PVD and CVD/ALD 2.3 Advantages of CVD/ALD processes #3 CVD/ALD kinetics – part1 3.1 CVD process – Gas Phase and Surface reactions 3.2 Elementary reaction and Overall reaction model 3.3 Quantum Chemical Calculation for CVD/ALD	about the structure and operating principles of MOS transistors, which are the basic structure of ULSI, and their fabrication process. In addition, students will learn about the principles, characteristics, and advantages of PVD, CVD, and ALD, and learn about their appropriate applications. In the 3rd class, We also aim to learn the basics of kinetics of CVD and ALD processes.
Day 2 (12/28) #4 10:00-11:30 #5 15:00-16:30	#4 CVD/ALD kinetics – part2 4.1 Experimental analysis on CVD kinetics 4.2 Analysis and applications of selective growth #5 Fundamentals and Applications of ALD 5.1 Ideal ALD process and ALD Window 5.2 ALD process through put 5.3 ALE (Atomic Layer Etching)	On the second day, we will learn the experimental analysis method of CVD process by reaction engineering approach. We will learn how to make optimum process design by using the reaction rate constants obtained from the analysis. In addition, students will learn the basics and applications of ALD process. In particular, assuming an ideal ALD process, students will learn why “ALD window” is formed and what measures can be taken to extend the temperature range of “ALD window”.
Day 3 (12/29) #6 10:00-11:30 #7 13:00-14:30	#6 ULSI-Cu interconnect 6.1 Basics of Interconnect Technology 6.2 RC-Delay and Reliability Issues 6.3 Al/W and Cu Technology 6.4 ALD for Cu Barrier Layer and Capping #7 Novel Thin Film Technologies 7.1 Supercritical Fluid Deposition (SCFD) for ULSI 7.2 SCFD for Terahertz wave guide device	On the last day, students will learn about ULSI-Cu interconnect technology. We will learn about the RC delay and reliability issues associated with the miniaturization of devices and countermeasures. In addition, students will learn about the material process technology necessary to form highly reliable interconnects. Finally, we will study a novel thin film fabrication technology using supercritical fluid and its application to Beyond 5G era.