DESIGN-BUILD-OPERATE (DB01)

ELECTRONICS PACKAGING SUBSTRATE FABRICATION (3-0-3)
ECE/MSE 4755 – Offered Fall Semester

CLASS HOURS	Lecture: Mondays, 12:20 p.m. – 1:10 p.m.; Love 299 Lab: Thursdays, 3:00 p.m. – 5:45 p.m.; GTMI/MaRC #158 (Cleanroom)
CREDIT	3 Hours
PREREQUISITES	CHEM 1310, PHYS 2212
INSTRUCTORS	**Dr. Himani Sharma** himani.sharma@gatech.edu GTMI/MaRC 343; 404 385-0708 Teaching Assistants **Mr. Atom Watanabe** Office Hours: Monday 1:30 p.m. – 2:30 p.m. atom@gatech.edu GTMI/MaRC 152; 404 919 2148 **Mr. Muhammad Ali** Office Hours: Monday 1:30 p.m. – 2:30 p.m. ali_cmi@gatech.edu GTMI/MaRC 354; 404 644 6890
TEXT BOOKS AND SUGGESTED READING	• "Fundamentals of Microsystems Packaging," McGraw Hill, Tummala, 2001 • "Introduction to System-On-Package (SOP), McGraw-Hill," Tummala and Swaminathan, 2008 SELECTED RESEARCH PAPERS AND CLASS NOTES
COURSE FORMAT	• The course is spread over 12 weeks of intensive hands-on practice.
COURSE OBJECTIVES	The entire program is offered in two semesters one that begins in the Fall and the second in the Spring. The DBO 1 course offered in Fall for ECE, ME, MSE and ChBE students, covers electronics packaging substrate fabrication processes and will include lectures and hands-on labs in the following topics: • Introduction to 3D Systems Packaging • Introduction to Package Substrates • Substrate Design/Layout • Advanced Polymer Materials for Substrates • Dielectric / Polymer deposition and curing • Laser and photo processes for microvia formation • Fine line lithography process methods • Fine Line and Microvia Copper metallization • Multilayer wiring and build-up substrate technology • Glass and Silicon Interposers as Next Generation Substrates • Inspection, metrology and substrate testing • Laboratory Safety

GRADING	• Lecture
	  o Exam #1: 10%
	  o Exam #2: 10%
	  o HW#2: Research article 2-pg write up: 10%
	• Lab
	  o HW#1: Design project: 10%
	  o Lab Notebook: 20%
	  o Final Lab Report: 30%
	Attendance: 10%

HONOR CODE	Students are expected to act according to the highest ethical standards and to abide by the Georgia Tech Academic Honor Agreement. • Students are expected to act according to the highest ethical standards. Violations include, but are not limited to: possessing, using or exchanging improperly acquired written or verbal information in the preparation of any essay, laboratory report, examination, or other assignment included in an academic course; plagiarism; false claims of performance or work that has been submitted by the claimant. While these acts constitute assured instances of academic misconduct, other acts of academic misconduct may be defined by the professor.

4755 LECTURE SCHEDULE – 2019

Mondays, 12:20 p.m. – 1:10 p.m.; Love #299

Date	Class Topic	Instructor	Special Notes
August			
Mon –19	1. Course Introduction	Sharma	
Mon – 26	2. Chapter 1: Lectures, Labs, Grading Fundamental SOP substrates	Sharma	
September			
Mon –2	**Labor Day- School Holiday**		
Mon –9	3. Chapter 4: Substrate Electrical Design	Ali	
Mon – 16	4. Lithography	Sharma	
Mon – 23	5. Substrate Materials & Their Properties	Sharma	HW# 1 Due – ADS and Sonnet-based
Mon – 30	6. Substrate Processes: A. Ultra-Thin Polymers	Sharma	
October			
Mon – 7	**Exam #1 (Mid Term – Lectures 1-6)**		
Mon –14	**Fall Break – No Class**		
Mon –21	7. Substrate Processes: B. RDL Via Formation	Sharma	
Mon –28	8. Substrate Processes: C. Conductor Metallization – SAP	Sharma	
Mon – 28	9. Substrate Processes: D. Passivation and Surface Finish	Sharma	
November			
Mon – 4	10. Substrate Processes: D. Passivation and Surface Finish	Sharma	HW # 2 Research article 2 pg write-up
Mon – 11	11. Glass, Si & Organic Interposers	Sharma	
Mon – 18	12. Embedded Components Passive	Sharma	
Mon – 25	13. Interconnects, Electrical Test & Reliability	Vanessa Smet	
December			
Mon – 2	**No Class – Preparation Time for Report and Homework**		
Fri – 6	**Exam #2 (Not a Final Exam - Lectures 7-12)** 11:20 AM - 2:10 PM	Sharma	Lab Reports Due

4755 LAB SCHEDULE – 2019

Thursdays, 3:00 p.m. – 5:45 p.m.; GTMI/MaRC 158 (Clean Room)

Date	Class Topic	Instructor	Location Change
August			
Thurs – 22	General Safety Orientation & Lab Orientation	Chris White	GTMI Room 401
Thurs – 29	ADS Tutorial (2D)	Ali	(Klaus building 1st floor computer lab)
September			
Thurs – 5	Sonnet Tutorial (2.5 D) Advanced Modeling of transmission lines	Atom	(Klaus building 1st floor computer lab)
Thurs - 12	Metal 1 Layer (Lithography)	Atom & Ali	GTMI clean room (1st floor #158
Thurs – 19	Copper Surface Treatment and Polymer Dielectric Lamination	Atom & Ali	
Thurs – 26	Microvia drilling	Atom & Ali	
October			
Thurs – 3	Electroless Cu Seed Layer Plate	Atom & Ali	
Thurs –10	Semi-additive Process (Metal 2 Layer)	Atom & Ali	
Thurs – 17	Electroplate Cu	Atom & Ali	
Thurs – 24	SAP Process Complete (Metal 2 Layer)	Atom & Ali	
Thurs – 31	Electrical Test	Atom & Ali	
November			
Thurs – 7	**No Lab**		
Thurs – 14	Micro-sectioning & Inspection	Atom & Ali	GTMI Room 383
Thurs – 21	Lab Hours as Needed to Complete Fabrication	Atom & Ali	GTMI Room 383
Thurs – 28	**No Lab – Thanksgiving Break**		
December			
Thurs –5	**Reading Period**		
Thurs – 12	**Submit Final Lab Reports**	Sharma	**Due 5:00 p.m.**

INSTRUCTOR BIOGRAPHIES

Dr. Himani Sharma	Dr. Himani Sharma is a Lecturer in School of Materials Science and Engineering at GT, coordinating the undergraduate laboratories. Before joining as a full-time teaching faculty in MSE, she worked as a Research Scientist-II in the Packaging Research Center (PRC) at Georgia Tech for 10 years. She received her B.S. M.S. and Ph.D. degrees in Chemistry from University of Delhi, India. Dr. Sharma also worked as a research associate in Electrical Engineering department in Alabama A&M University on NSA-funded project, before joining GT as a Postdoctoral Fellow in 2008. Her research focuses on developing materials for next-generation electronics and packaging. She has authored more than 75 publications in international peer-reviewed journals and conferences. She has co-authored 1 book and 3 book-chapters and 1 pending patent. She has been awarded Best Poster Award for her work on high density capacitors in 2012 IEEE-Electronic Component and Technology conference. Dr. Sharma is contacted at himani.sharma@mse.gatech.edu.
Mr. Lila Dahal	Lila Dahal is a process equipment engineer at the PRC, and also provides Packaging Support for the Institute for Electronics and Nanotechnology (IEN). He has been with the PRC since 2017 focusing on Assembly support and Laboratory Infrastructure. He received his BS in Electrical Engineering from Georgia Tech. Mr. Dahal may be contacted at ldahal3@gatech.edu.
Mr. Atom Watanabe	Atom Watanabe is a Ph.D. student advised by Prof. Rao Tummala and Prof. Madhavan Swaminathan, being mentored by Prof. Raj at FIU. His research focus is on EMI shielding and 5G mm-wave module integration. Email contact: atom@gatech.edu.
Mr. Muhammad Ali	Muhammad Ali is a Ph.D. student advised by Prof. Rao Tummala and Prof. Madhavan Swaminathan, being mentored by Prof. Raj at FIU. His research focus is on design, fabrication, and characterization of 5G and mm-wave passive components. Ali can be reached at ali_cmi@gatech.edu.

LABORATORY NOTEBOOKS

All students must keep a neat hard-bound laboratory notebook. These will be checked periodically and will be collected at the end of the term.

What should I write in my Laboratory Notebook?

Before entering the laboratory, you should write out a detailed procedure for the experiment. Do Not just copy out the entire procedure in the hand-out; prepare a step-by-step list of instructions which you can work from. Note when you need to make a measurement or observation. DO NOT include any photocopies of materials and handouts. This will require that you think about how you will perform certain operations. Copies of experiment will be available in the laboratory or with the instructor, for use. During the laboratory you should record all measurements, observations and changes to the procedure you have written. Hand your notebook on for final grading.