Microvia Electroplating
SYLLABUS

INSTRUCTOR INFORMATION

Instructor: Dr. Despina (DD) Davis

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Phone: 469-909-8878

Best time to call: Usually available between 5pm – 8pm Central Time USA.
Leave message anytime.

PROGRAM DESCRIPTION

This course addresses the influence of plating quality on the reliability of microvias. High density interconnects have led to the evolution of microvias, ranging from single-level to stacked/staggered and stair-cased microvias. This course will concentrate on four main challenges for fabricating reliable microvias: strong interface at the copper target pad, generating no voids in the electrodeposited copper, improving uniformity in the copper plating across the panel and reducing microvia rework cycles. Taught by an Electrochemical (International) Society recognized Boeing PWB Design Subject Matter Expert, Dr. Despina Davis with 20 years of experience in the field and multiple highly rated publications, will address:

- Plating Techniques → Pulse Plating Schemes Recipes → Uniformity
- Current calculation for microvias taking in consideration side-reactions currents
- Copper kinetics mechanisms
- Copper bath types & bath aging

LEARNING AND PERFORMANCE OBJECTIVES

This program is designed to provide PCB fabricators that work in the electroplating area with a balanced foundation of theoretical knowledge and practical skills to handle jobs that require Microvia Plating. Upon completion, participants will be able to:

- Calculate plating currents based on Faraday's Equation.
- Calculate Current Efficiency.
- Design pulse plating schemes for double sided simultaneous plating.
- Troubleshoot why recipes do not match theoretical values.
- Improve copper plating uniformity alternatives.
- Understand effects of mass transport/diffusion on Microvia Plating → non-steady state process.

COURSE STRUCTURE

- Instructor and participants meet online twice per week from the comfort of their own home.
- Participants can view recorded online sessions to review course content and class discussions.
- The course can be accessed on virtually any device with an Internet connection and major web browser, including Chrome, Firefox, Safari, Edge, and Internet Explorer.

SUPPLEMENTAL MATERIALS

- Fundamentals of Electrochemical Deposition, M. Paunovic, ISBN: 978-0-471-71221-3
- Electrochemical Deposition of Nanostructured Metals, E. J. Podlaha, Y. Li, J. Zhang, Q. Huang, A. Panda, A. Lozano-Morales, D. Davis, and Z. Guo, Handbook of Nanomaterials ISBN: 0849323088, P 475-496, 2006, CRC Taylor and Francis Publishing.
- GMR and Thermoelectrics Nanostructures Electrodeposition, Davis Despina, 2009, Lambert Academic Publishing, ISBN: 978-3-8383-0593-6.
- Electrodeposition of Magnetic Nanowires and Nanotubes, Davis Despina, 2010, Lambert Academic Publishing ISBN: 978-3-8383-3052-5
- IPC White Paper: Troubleshooting Microvia Failures, Hardeep Heer & Bill Birch
- IPC White Paper: Reliability of Stacked Microvias, Hardeep Heer & Ryan Wong
- IPC White Paper: Impact of Assembly Cycles on Copper Wrap Plating, Hardeep Heer, Ryan Wong, Bryan Clark, Bill Birch, Jason Furlong

IPC STANDARDS COVERED (PROVIDED WITH COURSE)

- IPC-2221 Generic Standards on Printed Board Design
- IPC-6012 - Qualification and Performance Specification for Rigid Printed Boards
- IPC-TM-650 Method – Test Methods Manual - 2.6.7.2 (Thermal Shock, Thermal Cycle and Continuity).

COURSE SCHEDULE

WEEK 1 – THEORETICAL BACKGROUND

- Potential (voltage) differences, Electromotive Force (EFM)
- Electrochemical cells
- Thermodynamics and Nernst Equation
- Electrical double layer @ electrode interface
- Faraday's Law
- Current efficiency
- Reference electrodes
- Coulometry, voltammetry and cyclic voltammetry
- Impedance, Nyquist plots & electrochemical impedance spectroscopy
- Instrumentation (voltmeters, potentiostats, galvanostats, function generators)

WEEK 2 – MICROVIA COPPER PLATING

- Why copper electro-plating? Why electrodeposition as the method of choice?
- Discuss copper conductivity & resistivity implications
- Copper plating kinetics and reaction mechanism
- Electroplating currents calculation vs. Side-reactions currents → Efficiency monitoring
- Plating Techniques → Pulse plating schemes recipes & uniformity vs. DC plating
- Japanese paddle cell design
- Copper bath types
- Copper bath aging & analysis

WEEK 3 – MICROVIA CASE STUDY 1 & 2

- Microvia Case Study 1 (Lessons Learned)
- Copper Analysis Techniques: crystal structure, SEM, resistivity, stress
- Plating Equipment: Anodes, Heaters, Level sensors, Pumps, E-ductors vs. Spargers, Power Supply (Rectifier Capabilities & Settings), Connectors (crimp vs. solder), Bath Maintenance (carbon filtering, analysis, adjustments, re-analysis). Bath dumping schedule/Decanting)
- Microvia Case Study 2 (Lessons Learned)

WEEK 4 – REVIEW & FINAL EXAM

Class session will focus on content review, questions and final exam.

Session 1 will be review. Session 2 will be final exam.

FINAL EXAM:

- Complete final exam during Session 2 or a defined exam time during the last week of the course.
- Completion of the program with a score of 70% or higher on the final exam and/or final project is required to earn a certificate of completion.
- Attempts allowed: 2. Grading method: Highest grade.