

CONTENTS

Chapter	Page
FOREWORD by <i>T. L. Houghton B.Sc., F.R.I.C., A.I.M., F.I.M.F.</i>	vii
EDITORIAL PREFACE	ix
1 GENERAL NOTES on base materials and finishes used in the electronics industry and on methods of producing those finishes by <i>W. MacLeod Ross</i>	1
1. Base Materials for Laminates – paper reinforcements – cloth reinforcements – resin binders – glass fibre laminates – other materials – ceramic substrates.	
2. Other Base Materials – resistor bases – capacitor bases.	
3. Finishes and Protective Coatings – metal coatings – conversion coatings – organic surface coatings – encapsulation.	
4. Methods of Producing Finishes – electrodeposition – vacuum metallising – anodising – other finishing processes.	
PART 1. PRINTED CIRCUITS	
2 DESIGN FROM THE PRODUCTION POINT OF VIEW by <i>R. Carrington C.Eng., M.I.E.E., M.I.Prod.E.</i>	24
Design Objectives	
Design Stages	
1. Board size, shape, material, etc.	
2. Component and conductor lay-out.	
3. Art work – materials – cut 'n' strip and scribing techniques – photographic techniques – production of photo masters by light beam.	
3 ETCHING AND CHEMICAL MILLING by <i>J. J. Butler A.R.P.S., A.M.I.O.P.</i>	40
1. Photo-sensitive Resists – types – advantages – application.	
2. Chemical Milling (Photofabrication) – etch factor – step-and-repeat methods – etching and printing – advantages and limitations.	
3. Etchants and Etching Systems – ferric chloride – ammonium persulphate – chromic/sulphuric acid – alkaline etchants – powderless etching – other etching systems.	
4. Etching Resists – lithographic resists – metal resists – silk screen etching resist inks.	
4 FABRICATION OF PRINTED WIRING BOARDS AND CIRCUITS by <i>P. Millett F.I.M.F., M.B.I.M., Assoc.I.R.T.</i>	61
1. One-shot Pierce and Blank Procedures – marking out – piercing – blanking – disposal of blanked boards – multi-impression tooling –	

close piercing – tool operating – sawing and guillotining – tool location holes – final piercing and blanking – cold-working laminates.

2. One-shot Blank and Jig Drill Procedures.
3. Routing.
4. Sight Drilling and Board Shaping.

5 FLUSH BONDED PRINTED CIRCUITS *by W. MacLeod Ross*

1. Production of Flush Bonded Printed Circuits – etching a metal-clad laminate – etching a metal foil – foil and transfer methods – machining a metal surface – machining individual segments – etching or machining cavities.
2. Materials Used for Flush Bonded Printed Circuits – insulating base – conductor materials.
3. Lubrication.

6 THROUGH HOLE CONNECTIONS BY ELECTRODEPOSITION

by G. C. Wilson and R. H. C. Lee

1. Drilling Standards.
2. Plated-up Through Hole Interconnections.
3. Through Hole Plating: Copper Reduction Process – tests to determine laminate compatibility – chemistry of copper-reduction process – problems arising in through hole plating.
4. Panel and Pattern Plating.
5. Copper Electroplating – general plating problems – porosity testing electrodeposits on contact areas – preparation of panel prior to image application.
6. Photography – methods of applying an image – screen printing – photo-mechanical techniques – application of photo-resist – types of photo-resists – new developments in photo-resists.
7. Tests for plated through holes.

MULTILAYER PRINTED CIRCUIT WIRING *by G. C. Wilson*

1. Interconnection Techniques – method 1: plated-up post interconnections – method 2: clearance hole interconnections – method 3: plated through hole interconnections.
2. Design Considerations for Multilayer Printed Circuits – questions for the mechanical designer – questions for the drawing office or layout department – questions for the production shop – questions for the electrical engineer.
3. Press Design – platen heating – temperature and pressure control – platen closing speed – press plates.
4. Types of Press Cycles – low pressure resin system – high pressure resin system – low pressure low temperature cycle – general notes for all types of pressing cycles – a few hints for increased production.
5. Pre-pregs – types of prepregs – pre-preg testing – handling prepreg material – storage conditions for prepreg – general notes on

- pregreg – glass cloth selection for prepeg.
6. Copper-clad Materials – stability of copper-clad materials – choice of copper foil inside the assembly – general problems of bow and twist.
 7. The Etch Back Process.
 8. Drilling.
 9. Plating of Through Hole Interconnections.
 10. Testing.
 11. Flexible Printed Circuits – advantages – disadvantages.

PART 2. OTHER APPLICATIONS OF METAL FINISHING PROCESSES

ELECTROLESS PLATING by *P. G. L. Vivian F.I.M.F.* 190

1. Chemical Replacement (Immersion Deposits) – immersion plating procedure – tinning – silvering – gilding – platinum, palladium, rhodium and ruthenium.
2. Autocatalysis (Electroless Plating).
 - Electroless Nickel Plating.
 - Electroless Copper Plating.
 - Other Metals.
 - Conclusion.

ELECTROPLATING by *P. G. L. Vivian F.I.M.F.* 202

- On Specifying a Finish.
- Applications of Electroplating.
- Methods of Electroplating.
- Common Electroplated Finishes and their Properties.
- Gold – gold plating procedure – applications of gold plating – testing gold electrodeposits.
- Silver – silver migration – process and applications – tarnish.
- Palladium.
- Rhodium.
- Platinum.
- Ruthenium.
- Rhenium.
- Tin/Lead.
- Tin/Nickel.
- Zinc, Cadmium, Copper, Tin, Nickel.
- Plating on Plastics – plating process – etching – electroless copper and nickel plating.

10 OTHER SURFACE TREATMENTS 225

by *G. D. R. Jarrett A.I.M.F., M.B.I.M., A.I.Corr.T.*

1. Brightening, Matting and Etching.
 - Aluminium – chemical brightening – electropolishing – frosting – matting – design etching.
 - Copper and Copper-based Alloys – chemical brightening – electropolishing – matting – etching.

- Nickel, Iron and their Alloys – chemical and electro-brightening – matting and etching.
2. Anodic Filming Treatments on Aluminium – sulphuric acid electrolytes – chromic acid electrolyte – boric acid electrolytes – typical anodizing sequence – coloured coatings.
 3. Colouring, Conversion Coatings and Passivation.
 - Aluminium – low resistance chromate films – black finishes.
 - Cadmium and Zinc – chromate conversion coatings – phosphating – chemical colouring.
 - Copper and Copper-base Alloys.
 - Iron and Steel.
 - Magnesium.
 - Nickel and Stainless Steels.
 - Silver.
 - Tin and Solder.
 - Titanium.
 4. Vacuum Deposition and Sputtering.
- 11 **MAGNETIC COATINGS**
by G. D. R. Jarrett A.I.M.F., M.B.I.M., A.I.Corr.T.
 Hard Magnetic Coating Materials—electroplated coatings electroless deposits.
 Soft Magnetic Coating Materials.
 Conclusion.
- 12 **CONNECTIONS (INTERNAL AND EXTERNAL)** *by V. W. Locke*
 Edge Socket Connectors.
 Connector Specifications.
 Contact Rows.
 Contact Terminations.
 Board Thicknesses.
 Contact Spacings.
 Contacts.
 Contact Platings.
 Contact Design.
 Terminals and Eyelets.
 Wrapped Joints.
 Terminal Posts.
 Component Welding – resistance welding – percussion welding
 parallel gap welding.
- 13 **SOLDERING AND SOLDERABLE COATINGS** *by C. J. Thwaites, M.Sc., A.R.S.M., F.I.M., F.I.M.F.*
 1. Surface Preparation – effect of abrasive cleaning – temporary protection.
 2. Solderable Coatings.
 3. Solder Resists.
 4. Fluxes and Fluxing – corrosive fluxes – intermediate fluxes – non-corrosive fluxes – application of the flux.

4. Solder Alloys.
5. Design of Joints.
6. Soldering Processes – dip soldering – mass soldering – bit soldering – soldering with pre-forms – reflow soldering – solder creams and pastes.
7. Post-soldering treatments – repairs.
8. Inspection.
9. Testing Solderability.

PART 3

- 14 **COMPONENT ASSEMBLY** by *R. D. Jones C. Eng., F.I.E.E.* 303
 Some Component Requirements.
 Standardisation of Printed Wiring Boards.
 General Considerations in Component Assembly.
 Preparation of Components for Assembly.
 Hand Assembly.
 Machine Assembly.
 Printed Board Assemblies.
- 15 **BIMETALLIC CORROSION** with special reference to printed wiring board assemblies by *R. D. Jones C.Eng., F.I.E.E.*
 Mechanism of Bimetallic Corrosion.
 External Environment.
 Internal Environment.
 Electrode Area Effects.
 Estimating Electro-motive Force and Acceptable Couples.
 General Design Considerations.
 Printed Board Assemblies.
- 16 **FINAL PROTECTION OF ELECTRONICS ASSEMBLIES AND PIECE PARTS** by *W. MacLeod Ross* 326
 Sealed Enclosures.
 1. Final Protection of Printed Wiring Boards and Related Modules – requirements of protective materials.
 Single-side Coatings.
 Encapsulation – silicone encapsulants – conformal coatings – total embedment – foamed plastics.
 2. Contacts and Connectors; Materials and Final Protection – effect of sealed enclosures – tarnishing – metals and platings employed.
 3. Final Protection of Structural Parts – conversion coating – metal coatings – organic coating systems – magnesium.
- 17 **QUALITY CONTROL: Activities of the Quality Control Laboratory** by *A. A. Ward M.S.E.E., A.I.M.F.*
 Equipping the Laboratory – services of consultants – activities described.

1. Plating Assessments – micro-sectioning – B.N.F. coulometric plating thickness gauge – beta back-scatter thickness gauge – average thickness – porosity – adhesion – protective capabilities under condensation – hardness.
2. Tests on Painted Surfaces – scratch resistance – bend test – impact resistance – cross cut adhesion test – cemented pad test – hardness test – humidity under condensation conditions.
3. Printed Wiring Assessments – plated through holes.
4. Radiographic investigations.
5. Environmental Tests – equipment – temperature measurement and recording – damp heat conditioning – corrosive atmosphere testing – thermal cycling – vibration and shock tests – mechanical shock tests – mechanical life test equipment.
6. Q.C. Sampling Procedures – acceptable quality level – extraction of samples – sampling plans – inspection level.

18 REPAIR AND REFURBISHING (*anonymous*)

Cleaning.
 Repairing Damaged External Finishes.
 Internal Finishes.
 Contact Surfaces.
 Sealant Coatings.
 Encapsulants.

19 SPECIFICATIONS

PART 1. SPECIFICATIONS RELEVANT TO PRINTED WIRING AND CIRCUITS *by H. G. Manfield*

Purpose of Specifications.
 Guidance in the Use of Specifications.
 Specifications for Base Materials.
 Materials Specifications – U.K. national documents and specifications – other future national documents – international materials documents.
 Printed Wiring Board Specifications – multi-layer boards – other specifications and recommendations – summary of documents for the printed boards.
 The Basic Grid.

PART 2. METAL FINISHING SPECIFICATIONS *by W. MacLeod Ross*

Pretreatments.
 U.K. Plating Specifications.
 U.S. Plating Specifications.
 Paint and Paint Finishing Specifications.

PART 3. B.S. 9000 *by A. A. Ward*

- 20 FUTURE TRENDS IN PRINTED CIRCUITS AND INTERCONNECTIONS
by H. G. Manfield
1. Printed Circuits on Organic Base Materials – multi-layer printed boards – flexible printed circuits and wiring – printed microwave circuits.
 2. Printed Circuits on Inorganic Bases.
 3. Mixtures of Printed Circuits and Thick or Thin Films.

READING LIST OF BOOKS ON METAL FINISHING 443

INDEX 446