

# Two major features of this text

試用

< This is a text to pass the Japanese national certification examination. >

- Since explanatory materials are systematically made based on subject examination questions, preparation studies are possible about all items of subject examinations without prior knowledge. Therefore, even if you begin studying from text parts, or solving problems, you can understand. It contains examination questions for the past four years.
- Studies other than processes of which you take charge are also easy.
- As for "difficult industry English notation", commentaries are attached.

< This is an educational text of semiconductor packages and backend processes for new employees. >

- All the semiconductor assemblies can be understood visually from beginning to end.
- Since the semiconductor packages are introduced in order of developments depending on familiar usage, you can understand why many kinds of packages are required.
- You will understand something with the assembly (the bonding) of the semiconductor.

## Chapter1 : Kinds of Packages

### Kinds and Use Examples of Semiconductor Packages

- 1 Vacuum Tube
- 2 Vacuum Tube Radio
- 3 Transistor
- 4 Transistor Television
- 5 DIP
- 6 Terminal Insertion Type
- 7 Home TV Game Machine
- 8 Refrigerators and Air Conditioners
- 9 QFP (Quad Flat Package)
- 10 SOP (Small Outline Package)
- 11 J Lead Surface Mounting Type
- 12 Second Generation TV Game Machine
- 13 BGA (Ball Grid Array)
- 14 BGA and QFN (QF Non-leaded Package)
- 15 Television and PC
- 16 BGA with a Heat Sink
- 17 Third Generation TV Game Machine
- 18 FCBGA (Flip Chip BGA)
- 19 Fourth Generation TV Game Machine
- 20 High Performance Computer
- 21 MCP (Multi Chip Package) in QFP
- 22 Control of In-vehicle Apparatus
- 23 MCP (Multi Chip Package) in BGA
- 24 Cellular Phone and Digital Camera
- 25 How to Call Package Externals

## Chapter2 : Roles of Packages

### Roles of Semiconductor Packages

- 1 Roles of Semiconductor Packages
- 2 Roles of QFP
- 3 Performance Necessary for Packages

## Chapter3 : What is Assembly?

### What is Assembly of a Semiconductor?

- 1 General Assembly Image
- 2 Classifications of Bonding and Adhesion
  - 3-1 Kind of Bonding Assembly of a Semiconductor(1/3)
  - 3-2 Kind of Bonding Assembly of a Semiconductor(2/3)
  - 3-3 Kind of Bonding Assembly of a Semiconductor(2/3)
- 4-1 Bonding Theory(1/5)
- 4-2 Bonding Theory(2/5)
- 4-3 Bonding Theory(3/5)
- 4-4 Bonding Theory(4/5)
- 4-5 Bonding Theory(5/5)
- 5-1 Exfoliation (Destruction) Theory(1/7)
- 5-2 Exfoliation (Destruction) Theory(2/7)
- 5-3 Exfoliation (Destruction) Theory(3/7)
- 5-4 Exfoliation (Destruction) Theory(4/7)
- 5-5 Exfoliation (Destruction) Theory(5/7)
- 5-6 Exfoliation (Destruction) Theory(6/7)
- 5-7 Exfoliation (Destruction) Theory(7/7)

## Chapter4 : Assembly Process

### Assembly Process of QFP

- 4-1 Outline of QFP Assembly
- 4-2 Outline of BGA Assembly

### Back Grinding Process

- 4-3 Back Grinding
- 4-4 Micro Crack by Stress
- 4-5 Stress Removal Method

## Dicing Process

- 4-6 What Is the Dicing?
- 4-7 Carrier Ring Structure
- 4-8 Adhesive Sheet Attachment
- 4-9 Adhesive Sheet Attachment Process
- 4-10 Dicer Structure
- 4-11 Dicing Blade
- 4-12 Step Cut Method
- 4-13 Cutting Method of Dicing
- 4-14 Order of Dicing
- 4-15 Defective Items of Dicing
- 4-16 Chip Crack
- 4-17 UV Irradiation Method

## Die Bonding Process

- 4-19-1 Kind of Die Bonding
- 4-19-2 Kind of Die Bonding
- 4-20 Resin Paste Die Bonder Structure
- 4-21 Various Metallic Characteristics
- 4-22 Structure of the Resin Paste Bonding Method
- 4-23 Role of Die Bond
- 4-24 Lead Frame
- 4-25 Lead Frame Manufacturing Method (Etching)
- 4-26 Lead Frame Manufacturing Method (Press)
- 4-27 How to Pickup Die
- 4-28 Die Quality Recognition Method
- 4-29 Structure of a Dispenser
- 4-30 Kinds of Dispense Method
- 4-31 Discharge of Resin Paste
- 4-32 Die Bonding of Resin Paste

- 4-33 Cure of Resin Paste
- 4-34 Lead Frame Supply Method
- 4-35 Kinds of defective die bonding
- 4-36 Die Shear Test

## Wire Bonding Process (Connection Process)

- 4-38 Capillary for Wire bonding
- 4-39 Outline of Wire Bonding
- 4-40 Bonding Structure of Wire Bonding
- 4-41 Wire Bonder Structure
- 4-42-1 Methods of Wire Bonding(1/4)
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- 4-42-3 Methods of Wire Bonding(3/4)
- 4-42-4 Methods of Wire Bonding(4/4)
- 4-43-1 Methods of Reverse Bonding(1/3)
- 4-43-2 Methods of Reverse Bonding(2/3)
- 4-43-3 Methods of Reverse Bonding(3/3)
- 4-44 Wire Pull Test
- 4-45 Ball Shear Test
- 4-46 Peel Test

## Molding Process

- 4-48 Transfer Mold Resin Molding Equipment Structure
- 4-49 Kinds of Molding Metal Mold Method
- 4-50 Composition of Molding Resin Materials
- 4-51 Manufacturing Method of Molding Resin
- 4-52 Management and Disposal Process of Resin
- 4-53-1 Molding Process (Transfer Mold Method)
- 4-53-2 Molding Process (Transfer Mold Method)
- 4-54 Section Structure of Molding Die and Defects
- 4-55 Popcorn Phenomenon

## Tie Bar Cutting Process

- 4-57 Roles of Tie Bar
- 4-58 Tie Bar Cutting and Lead Bending Mold Structure
- 4-59 Tie Bar Cutting Process

## Plating Process of the Lead

- 4-60 Theory of Electroplating
- 4-61 Electrolytic Degreasing
- 4-62 Deburring (High Water Pressure Washing)
- 4-63 Acid Washing
- 4-64 Etching
- 4-65 Electric Solder Plating
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- 4-67 Water Washing
- 4-68 Drying
- 4-69 Plating Evaluation Method

## Marking Process

- 4-70 Ink Marking
- 4-71 Laser Marking
- 4-72 Features of Laser Beam

## Terminal Formation and Singulation Process

- 4-73 Lead Tip Cutting Process
- 4-74 Lead Forming (Slide-bend formation)
- 4-75 Lead Forming (Roller Bending)
- 4-76 Lead Forming (Cam Bending)
- 4-77 Coplanarity (The Degree of Lead Flat)
- 4-78 Defective Mounting (Defective Solder Wettability)
- 4-79 Equipment, Use Material, and Tool Summary

## Chapter5 : Assembly Process of BGA

- 5-1 Substrate of BGA
- 5-2 Method of manufacturing substrate of BGA
- 5-3-1 Assembly Process of Wire BGA(1/2)
- 5-3-2 Assembly Process of Wire BGA(2/2)
- 5-4 Self Alignment Nature of Solder Balls
- 5-5 Substrate Dicing Cutting
- 5-6 Batch Molding BGA
- 5-7 Assembly Process of FCBGA (Bump Attachment)
- 5-8 Chip Singulation of FCBGA
- 5-9-1 Assembly Process of FCBGA(1/2)
- 5-9-2 Assembly Process of FCBGA(1/2)

## Chapter6 : Assembly Process of Ceramic Packages

- 6-1 Wedge of Ceramic System Packages (Tool)
- 6-2-1 Assembly Process of Ceramic System Packages
- 6-2-2 Assembly Process of Ceramic System Packages
- 6-3 Sealing Process of Ceramic System Packages
- 6-4 Airtight Tests on Ceramic System Packages

## Chapter7 : Assembly Process of TCP

- 7-1 Assembly Process of TCP
- 7-2 Cross Sectional Structure of TCP and COF

## Chapter8 : Assembly Process of WSP

- 8-1 Rewiring Process of WSP
- 8-2 Singulation of WSP

## Chapter9 : Test Process

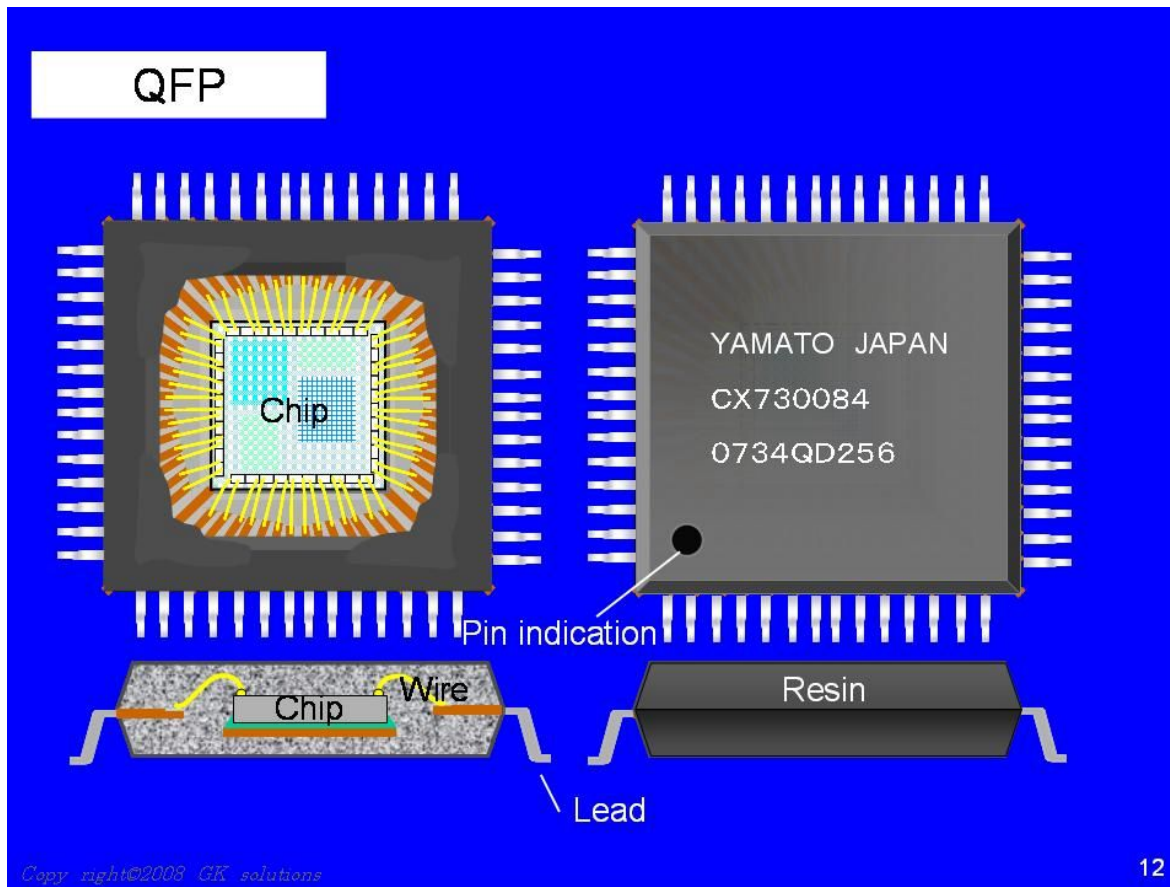
- 9-1 Test Process Flow
- 9-2 Defective Assembly Known by Tests
- 9-3 Electric Functional Tests

# Chapter 1-9 QFP (Quad Flat Package)

試用

When IC becomes large-scale, it becomes LSI. LSI increased in the number of outside terminals, so DIP couldn't cope with any more. Moreover, the number of installing of semiconductors increased also on the electric equipment, and to install in both sides of the wiring substrate, QFP of the surface mount type was developed. The package thickness also became thinning about 1mm from 3 to 4mm.

The surface mount type is called SMD (Surface Mount Device).



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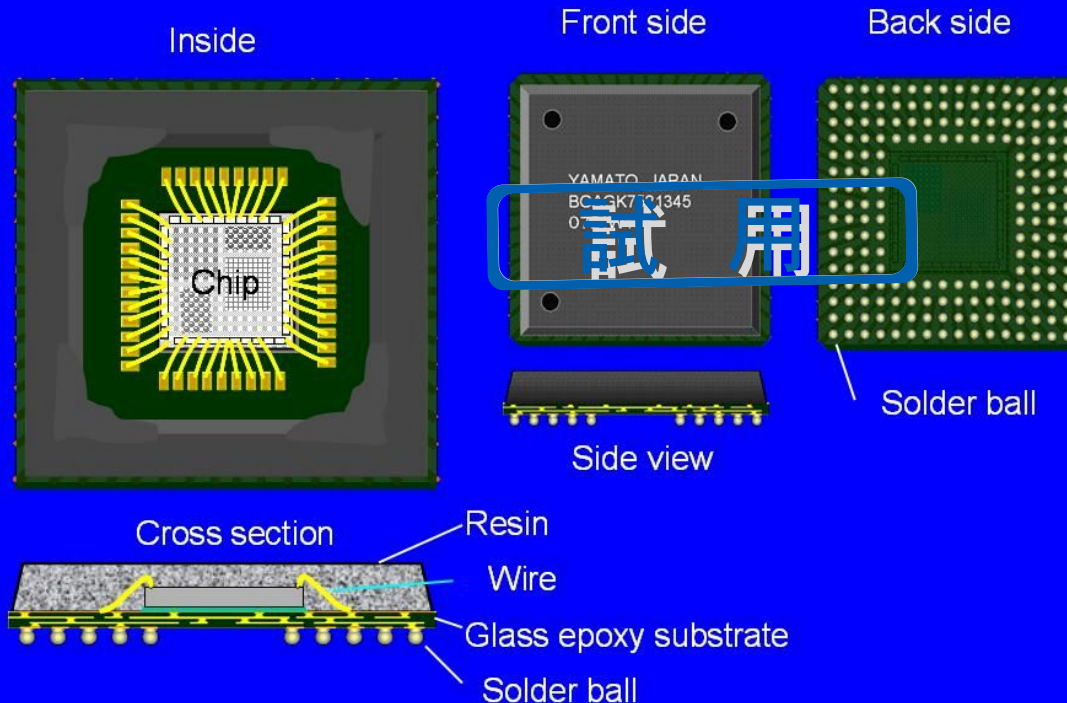
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# Chapter 1-13 BGA (Ball Grid Array)

試用

Since functions of the chip had become complex and compound more and more, it was not possible to catch up with an increase in the number of pins even if QFP was made enlarged, and made toward the fine pin pitch. As this measures, BGA (Ball Grid Array = solder balls are arranged like the lattice) whose terminals are formed with solder balls and whose underside becomes usable everywhere was developed.

## BGA



The substrate uses the same glass epoxy substrate as the wiring substrate. BGA has rapidly extended the production amount.

Strong and weak points of BGA (comparison with QFP )

### <strong points>

- ①The number of terminals is large.
- ②Connecting the chip and terminals can be changed freely in the substrate.

### <Weak points>

- ①The joint state of solder balls can't be confirmed from the outside.
- ②The cost of the substrate is high.

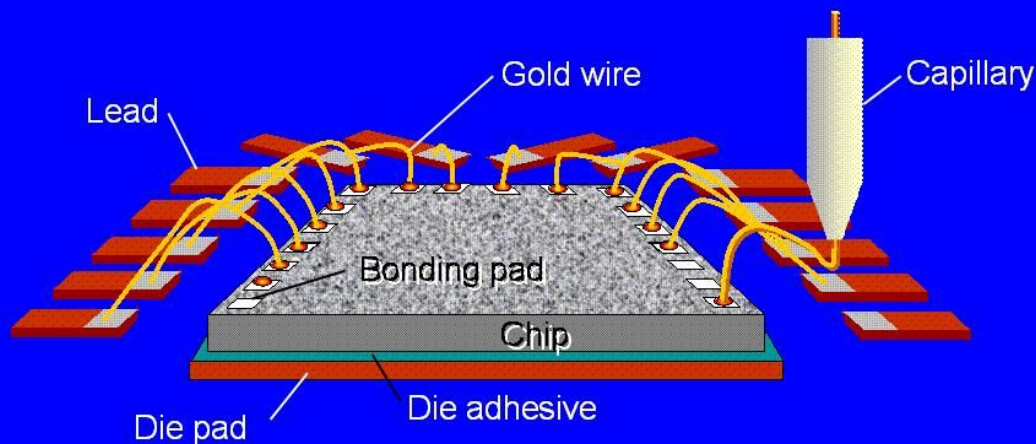


# Chapter 4-39 Outline of Wire Bonding

試用

Wire bonding is to connect bonding pads and leads of the chip bonded to the die pad by fine (diameter from  $20\mu\text{m}$  to  $50\mu\text{m}$  level) gold wires etc. of the purity of 99.99% or more. One gold wire is sequentially connected by using the capillary. Gold wires are formed so as not to contact an unnecessary part, and so as not to flow at the time of the resin molding. The wire bonding using gold wires is inefficient because it does one by one.

## Outline of wire bonding



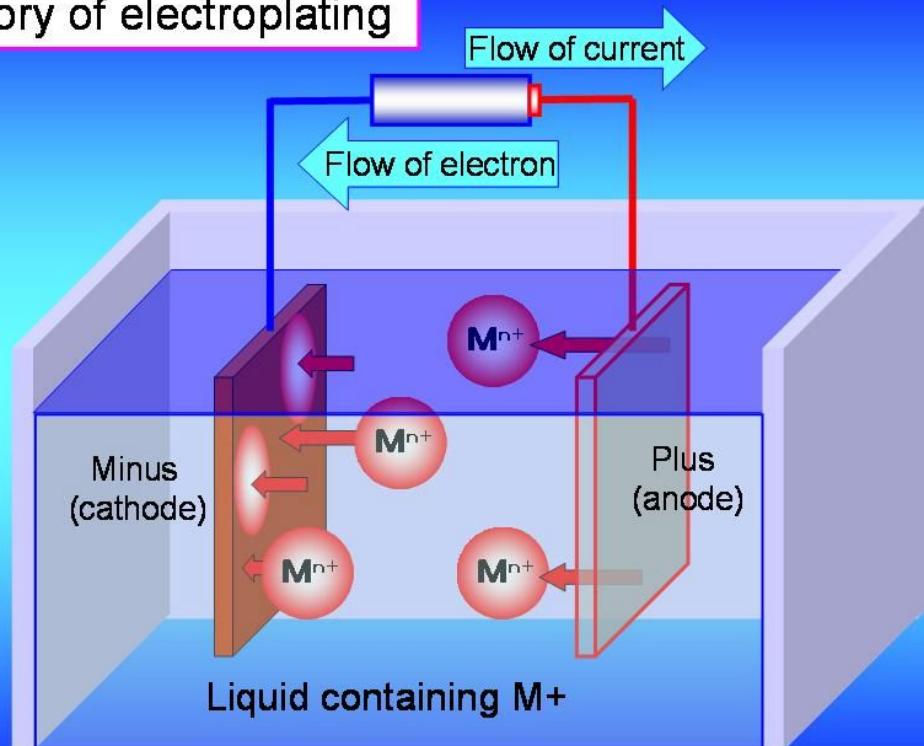
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Then, although the method of bonding a large number at once was devised variously, ① it can wire freely, ② the certainty of connecting wires (reliability) is high etc., and it is still main forces of the semiconductor assembly. To contribute most was that the level of making an automatic machine about wire bonder became high, and a high-speed bonding became realized. Although, the wire bonding method using materials other than gold, for example, copper wire, is beginning to be developed since the price of gold is high, it is the point whether the overall cost which includes productivity and reliability becomes cheap.

Plating of the external terminal (lead) of a lead frame is done by electroplating. The purpose is to improve ① securing the corrosion resistance of the lead, and ② soldering nature with a wiring board. In electroplating, the metal ion (plus) in a liquid adheres to negative pole metal by putting two metal plates into the liquid containing the metal ion used for plating, and turning on an electric current. If metal ions in a liquid run short, it will be supplied one after another from the metal on the plus side.

### Theory of electroplating



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**Characteristics required for plating are as follows:**

- ① Wettability to solder
- ② Close adhesion nature with the lead material
- ③ Bonding nature with solder
- ④ Heat resistance
- ⑤ Corrosion resistance
- ⑥ Corrosive protection nature
- ⑦ To be hard to generate a whisker
- ⑧ To be able to mass-produce at low-cost.

A whisker is the needle-like metal crystal which is also called 'mustache of a cat', the stress accumulated in plating causes its generation and growth, and it grows up from the surface of plating. Its thickness is from  $1\ \mu\text{m}$  to several  $\mu\text{m}$ , its length sometimes might reach several mm, and it might be short-circuited between terminals from the prolonged storage and the market environment.