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How to Grow a Flip Chip Bumping Service Business

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www.pactech.de
Content

- Comparison of Bumping Technologies
  - Advantages of electroless Ni/Au
- History of electroless Ni/Au Bumping
- Pac Tech formation and development of business strategy
- Overview of production implementation and worldwide volume production ramp up
- Outlook & Roadmaps for future of electroless Ni/Au on wafer Level
I

Comparison of Bumping Technologies
Under Bump Metal Process

Electroless Plating of Ni/Au Bumps

Backside Coating

Aluminum Cleaning

Zincate Pretreatment

Electroless Nickel

Immersion Gold

Coating Removal
Ultra Fine Pitch Bumping of Ni/Au

Pitch: 50 - 70 µm
Stencil Solder Printing Process Flow

Electroless Ni/Au Bumping

Solder Paste Printing

Reflow

Wafer Cleaning

Wafer Inspection

Pack & Ship
Wafer Level Solder Printing

Chip for GSM Phone

Wafer: Si-Ge Technology
Comparison of Bumping Technologies

- Evaporated Solder Bump
- Sputtered UBM + Plating
- Sputtered UBM + Print
- **PacTech**
  - Electroless UBM (+)
  - Print or Ball Attach

- C4 Solder
- Solder
- Solder
- Solder

- Au

- Ni/Au
Electroless Ni/Au, Printed Solder Bump or Solder Ball Attach

- Lowest Cost, Simplest Process
- Comparable Reliability to other Bumping Technologies
- 200µm Peripheral or 225µm Full Area Array Pitch (Production)
- High Alloy Flexibility Possible
- Production: 4, 6, 8 and 12 Inch
Advantages of electroless Ni/Au UBM

1) Low Process Cost compared to Electroplating
   Below 20 US$/Wafer in high volume

2) Average investment:
   ElectroPlating: 10-20 Mio US$
   Electroless UBM + Solder Print/Ball: 3-5 Mio US$

3) 300 mm compatibility
   no additional invest (PACLINE 300)

4) High Throughput
   300.000 wafers per year minimal guaranteed throughput with PACLINE 300
5) Proven Reliability

6) E.less Ni/Au UBM Roadmap at Leading IC-Manufactures, OEM

7) Compatibility with all FC-Assembly processes
   Soldering
   ACA
   Conductive Adhesive

8) Suitable for Al and Cu pad metallization

9) Compatibility with Wire Bonding
   Revolution: one pad metallization for wire bonding and Flip Chip
II

History of Electroless Ni/Au Bumping
Electroless Ni/Au for Semiconductor Devices

A Crazy Idea?

• Technically impossible
• Wrong concept
• Not reliable
• No infrastructure
• Economically not feasible
• hard to control → dangerous / critical
• Will be never accepted by customer

Sounds familiar? 1990
A Crazy Idea?

- Technically impossible
- Wrong concept
- Not reliable
- No infrastructure
- Economically not feasible
- hard to control → dangerous / critical
- Will be never accepted by customer

Remember:

1886
History of electroless Ni/Au

- Basic studies & publications in 1985
- First active electroless bumped wafer in 1989
- Formation of Pac Tech in 1995
- Further developments of the electroless Ni UBM
- Pilot production line in 1997
- Start of customer qualification & production in 1998

...establishing of subcontractor sites in Japan and US
1st Ni Bumps

ELECTROLESS DEPOSITION OF BUMPS FOR TAB-TECHNOLOGY

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Abstract

The technology of electroless nickel bump deposition is reviewed in this article. Some phenomena like nucleation and nucleation are explained. This technology allows to produce solderable bump structures on a variety of substrates (Cu, Al, Ti, etc.) within several minutes. In the beginning of the electroless deposition the layers form a barrier on the substrate. The barrier is important in the formation of the bump by electroplating. Electroplating Ag, Au or Ni on the barrier layer is possible. If the barrier layer is not compatible with the substrate the substrate has to be removed before the deposition. The advantages of the bump are demonstrated as a fiber optic connector. Additionally, the reliability of the bump is described. The process of bumping is defined as a technique to deposit Ni on metal substrates by bump bonding as a bump with a thickness of several tenths of a millimeter.
Development & Implementation of eless Ni & Solder Printing into Production Level
Products using electroless Ni/Au

• …First for products under very high price pressure (RFID)

• Meanwhile wide range of applications
  - ASIC (Sensors)
  - LCD Drivers
  - PowerMOS (Automotive)
  - MOSFET
  - Protection devices (Passives) CSP‘s, WLCSP‘s
  - Memories and memory modules
  - Consumer electronics
  - Battery control (Mobile Phone)
  - Medical (Ear phone)
III

Pac Tech formation and development of business strategy
Pac Tech Formation & Business Strategy

- **1995**
  - Researchers of Fraunhofer-IZM founded Pac Tech
- **1995-1997**
  - Close relationship & cooperation with IZM
  - Using of techn. Infrastructure IZM & TU Berlin
- **1996**
  - First building in Berlin
- **1997...**
  - Own building in Nauen
  - Setup of infrastructure and cleanroom for wafer bumping services
  - Start of first evaluations and qualifications for worldwide customers
  - Introduction of eless Ni & solder printing for FC into the worldwide market
  - Customer acceptance of eless UBM & solder printing for FC
- **1999**
  - Opening of Sales Center in Silicon Valley (Fremont, Menlo Park)
- **2000**
  - Formation of ABT in Japan
- **2002**
  - Opening of Manufacturing Site in Silicon Valley (Santa Clara)
Pac Tech Germany – Production Site
Berlin (Equipment Manufacturing)

1996
Now let’s go East and make some money!

1997

PacTech Nauen, former East Germany
Pac Tech Germany – Production Site Nauen
(HQ & Wafer Bumping Subcon. Service)
Pac Tech Germany Nauen - Cleanroom

Manual Equipment

Automatic Equipment

1998  2004

300 mm Capability!
Pac Tech Germany Nauen - Cleanroom

2004

Certified DIN EN ISO 9001
Pac Tech USA – New Production Site in CA

2002
Pac Tech USA - Cleanroom

2004
Pac Tech Exhibitions

Japan

Singapore

Europe
## Pac Tech Worldwide Production Capacity

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<tr>
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<td>Total</td>
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<td>Total Capacity per Year</td>
<td>320.000 Wafers</td>
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IV

Overview of production implementation and worldwide volume production ramp up
Business Development – Licenses of Pac Tech

- **Japan (SubCon)**
- **Korea LCD-Driver**
- **USA Memory**
- **USA SubCon**
- **Europe RFID**
- **China n.a.**

Year:
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005

Growth
Process Transfer to Japan (License)

Installation of Equipment

2000
Process Transfer to Japan (License)

Installation of Equipment

2000
Worlwide Implementation of electroless Ni/Au for Al pad metalization

- **Europe**
  - 1 subcontractor bumping facility
  - 3 wafer foundries

- **Asia**
  - 3 subcontractor facilities
  - 4 wafer foundries

- **USA**
  - 2 subcontractor facilities
  - 3 wafer foundries
Worldwide use of electroless Ni & solder printing 1/3

Overview on the implementation of electroless Ni

Main Customers

USA (10)
Europe (15)
Asia (11)
Worldwide use of electroless Ni & solder printing 2/3

Overview on Status of Implementation

- Production 22
- Qualification 4
- Prod. Ramp Up 7
Worldwide use of electroless Ni & solder printing 3/3

Overview on Applications

- Memory 3
- RFID 5
- Pass. Comp./CSP's 7
- MOSFET
- Power MOS 1
- LCD Driver 1
- ASIC 7
- IGBT 1
- Mobile Phone 1
- Medical 4
Outlook & Roadmaps for future of electroless Ni/Au on Wafer Level
Market Shares Overview
Future of electroless Ni/Au

• Eless Ni/Au NOT only for Al, also for Cu pads
• Eless Ni/Au UBM for FC and Wire Bonding
• Eless Ni/Pd/Au for Wire Bond of Power Devices
Electroless Ni/Au on Copper Pad

- Backside Coating
- Copper Cleaning
- Palladium Pretreatment
- Electroless Nickel
- Immersion Gold
- Coating Removal

300 mm Capability!
Thick Au Finish for Wire Bonds

Au: 0.8 µm

Capability for Au Wire Bonding

Shear modes (Au stud)
Backside Coating
Aluminum Cleaning
Zincate Pretreatment
Electroless Nickel
Electroless Palladium
Immersion Gold
Coating Removal

Electroless Ni/Pd/Au Bumping on Al
Outlook

- Due to more and more demand in low cost products using bumped Flip Chips & Wafer Level Packages there is an extremely big potential in less expensive bumping technologies...

ELECTROLESS Ni/Au
Questions ?