Au-Au Flip Chip Mounting Technology by NEC

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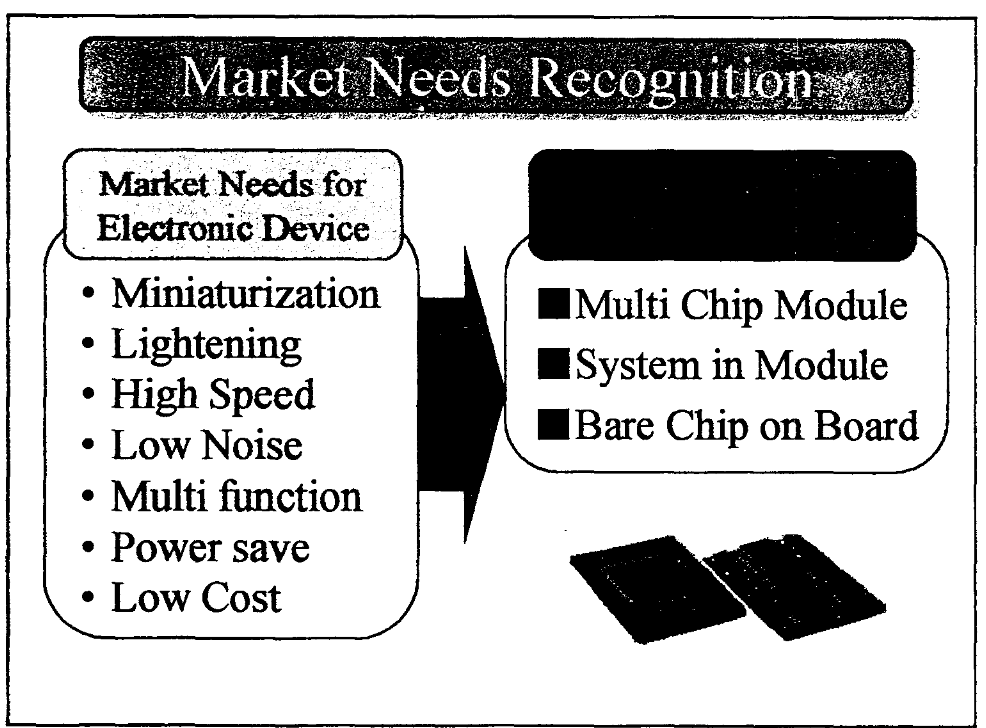
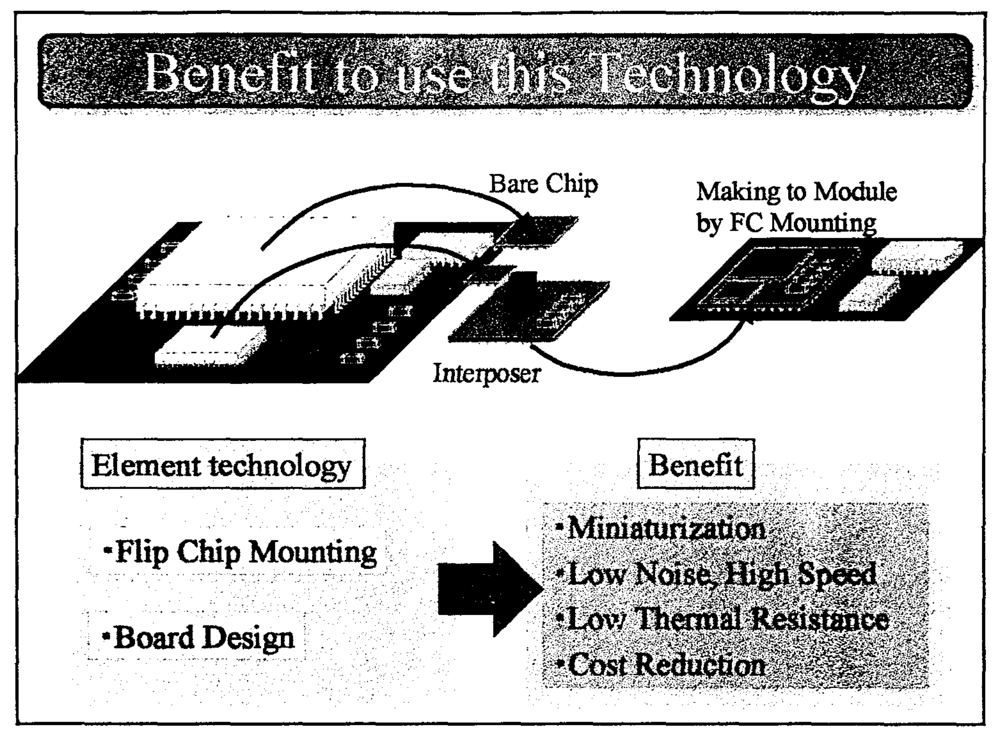
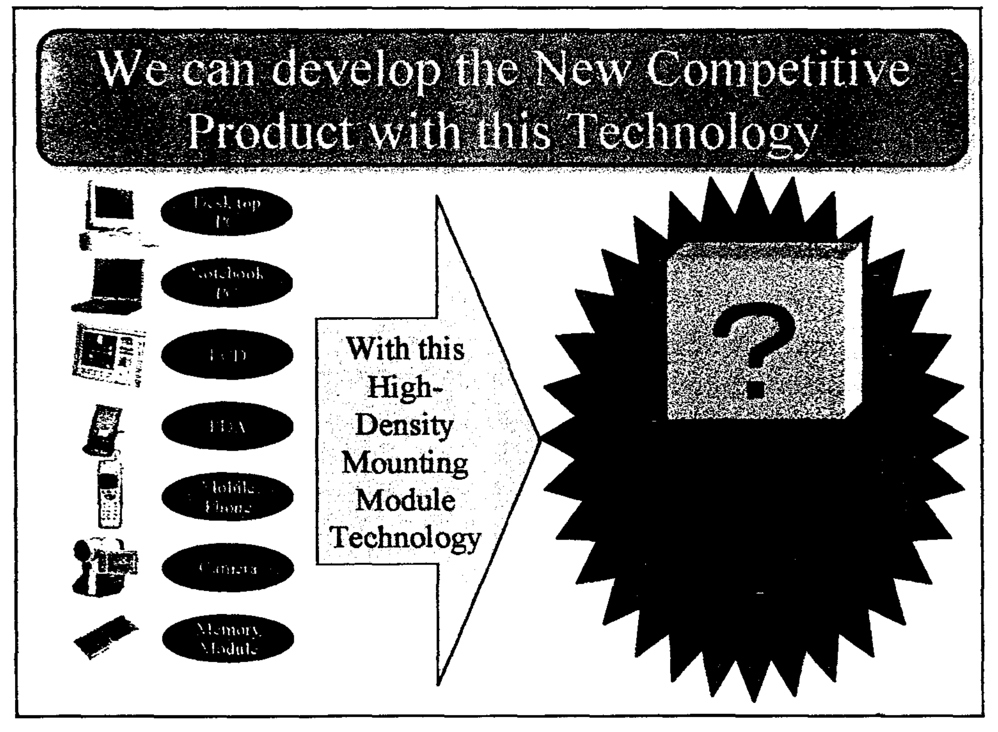
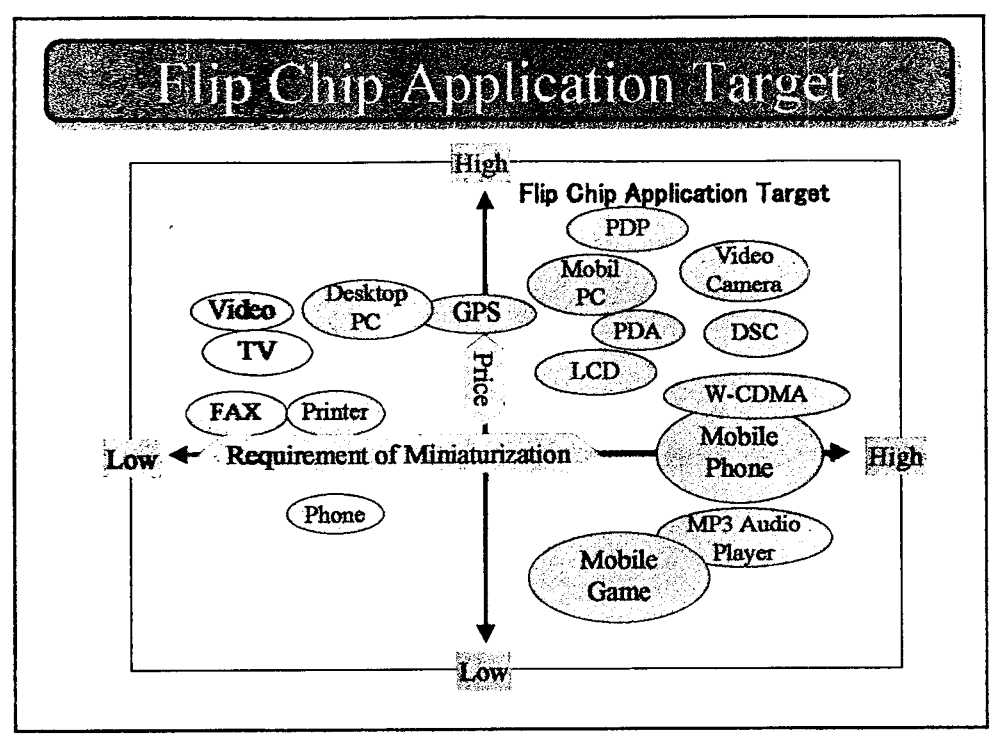
1. Introduction

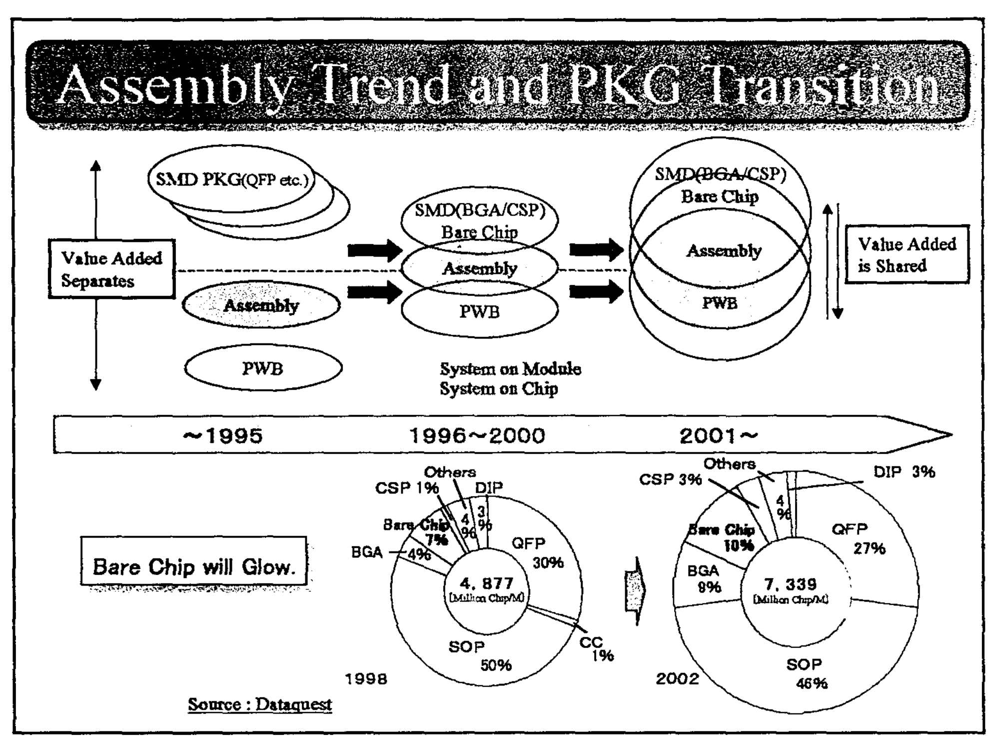


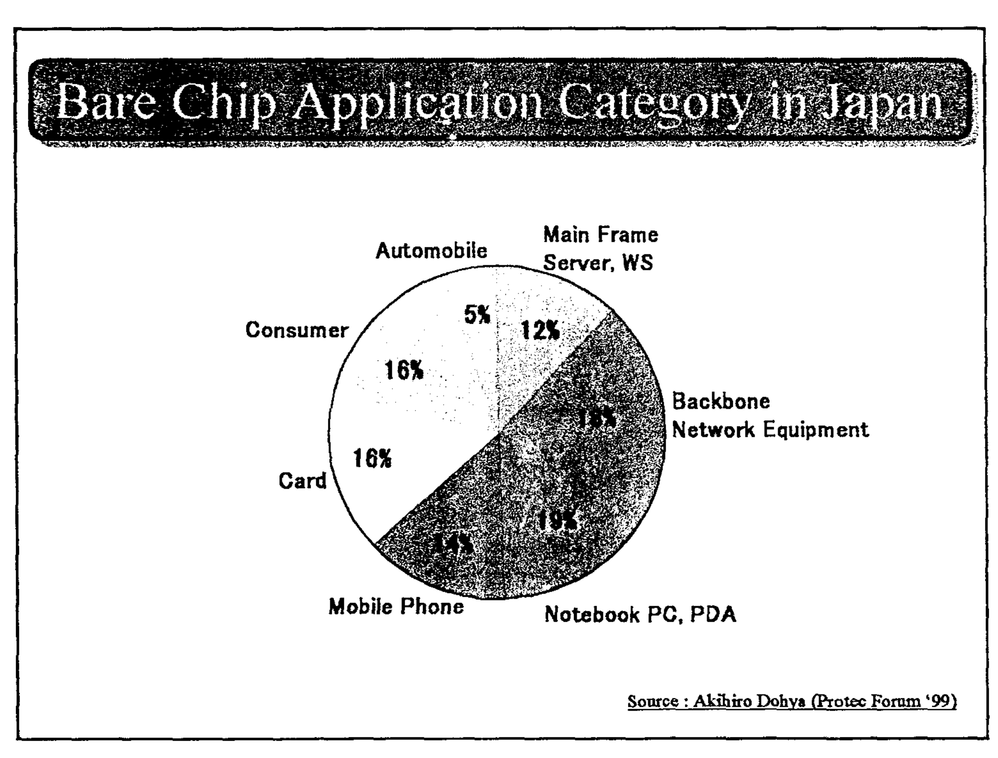

Benefit to use this Technology
Bare Chip
Making to Module
by FC Mounting
Interposer
Element technology
•Flip Chip Mounting
•Board Design
Benefit
•Miniaturization
•Low Noise, High Speed
•Low Thermal Resistance
•Cost Reduction

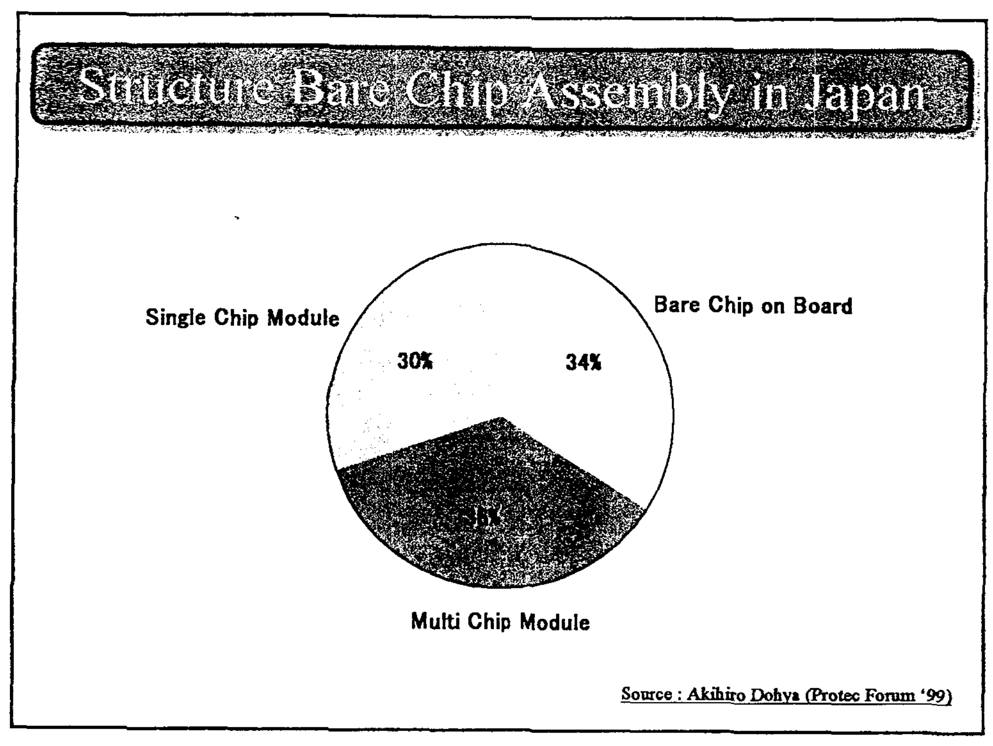

We can develop the New Competitive
Product with this Technology
Camera
Memory Module
With this
High-
Density
Mounting
Module
Technology
?

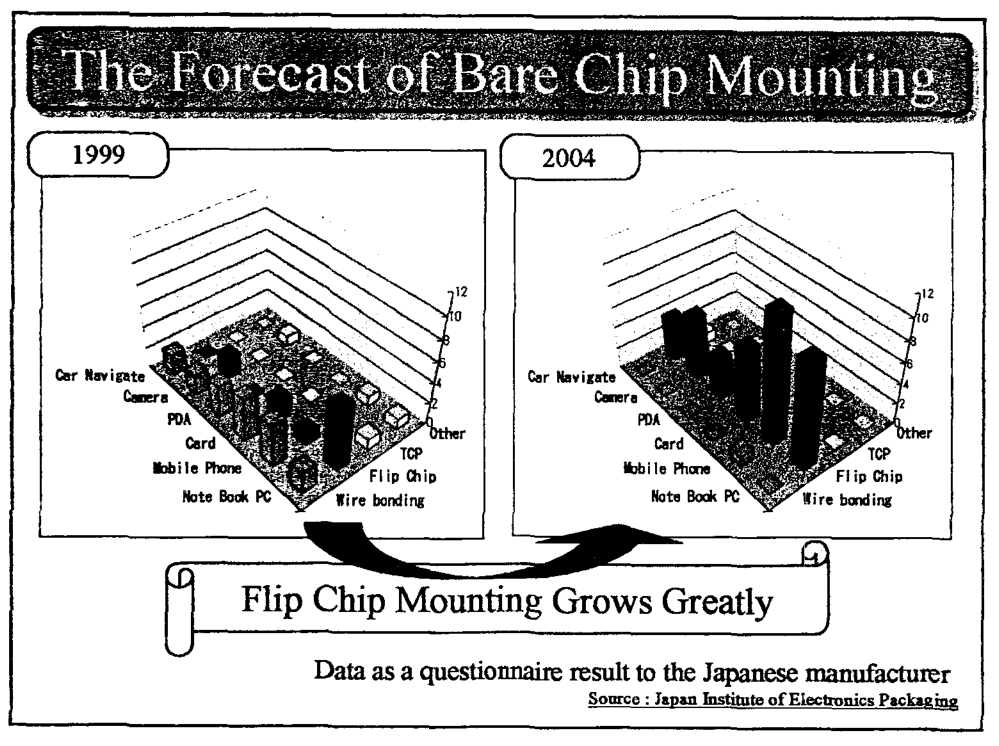


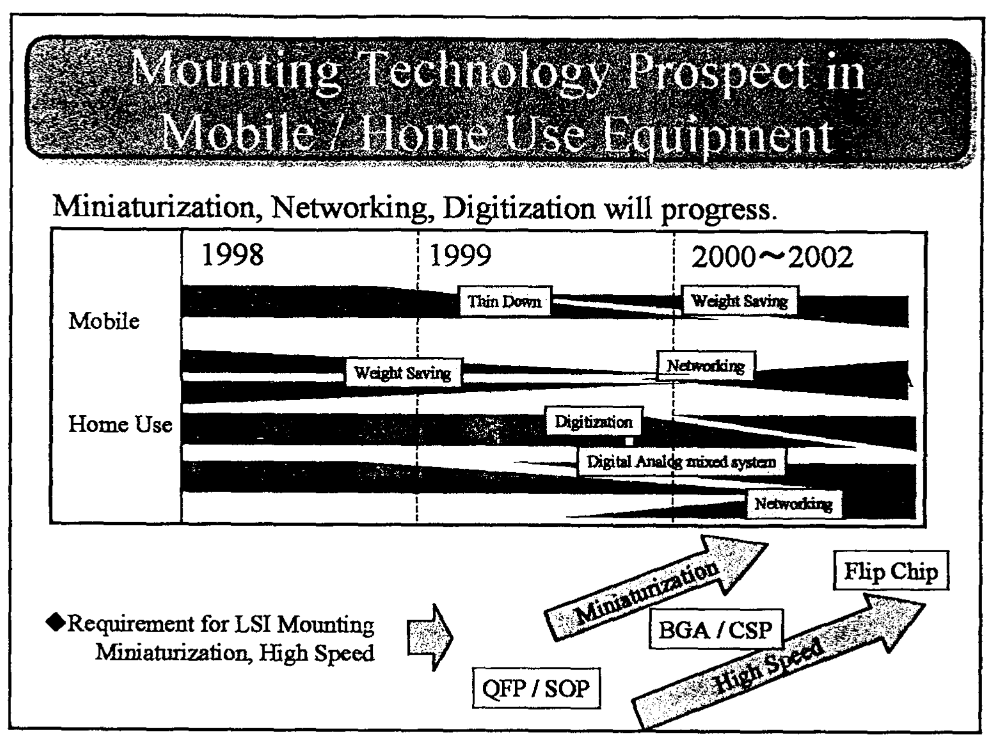
2. Trends of Semiconductor Chip Assembly

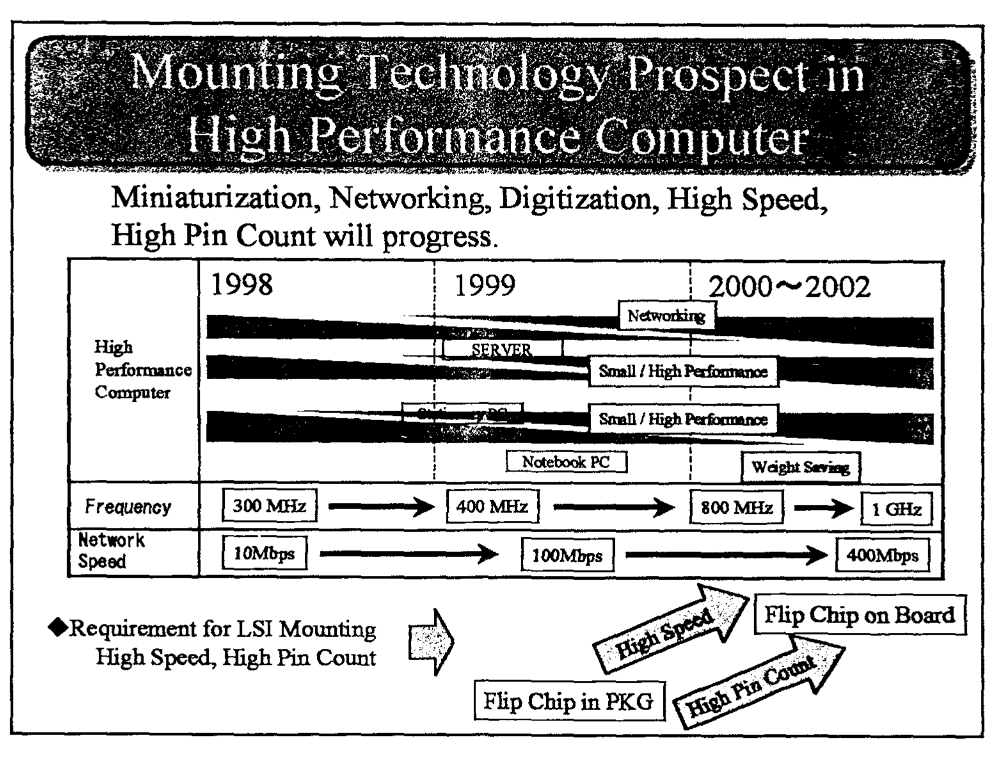

Assembly Trend and PKG Transition
SMD PKG(QFP etc.)
Value Added Separates
Assembly
PWB
SMD(BGA/CSP)
Bare Chip
Assembly
PWB
System on Module
System on Chip
Bare Chip
Value Added is Shared
~1995
1996~2000
2001~
Bare Chip will Glow.
Others
CSP 1%
DIP
BGA
QFP 30%
4, 877
SOP 50%
CC 1%
1998
CSP 3%
DIP 3%
Bare Chip 10%
QFP 27%
BGA 9%
7, 339
SOP 46%
2002
Source : Dataquest

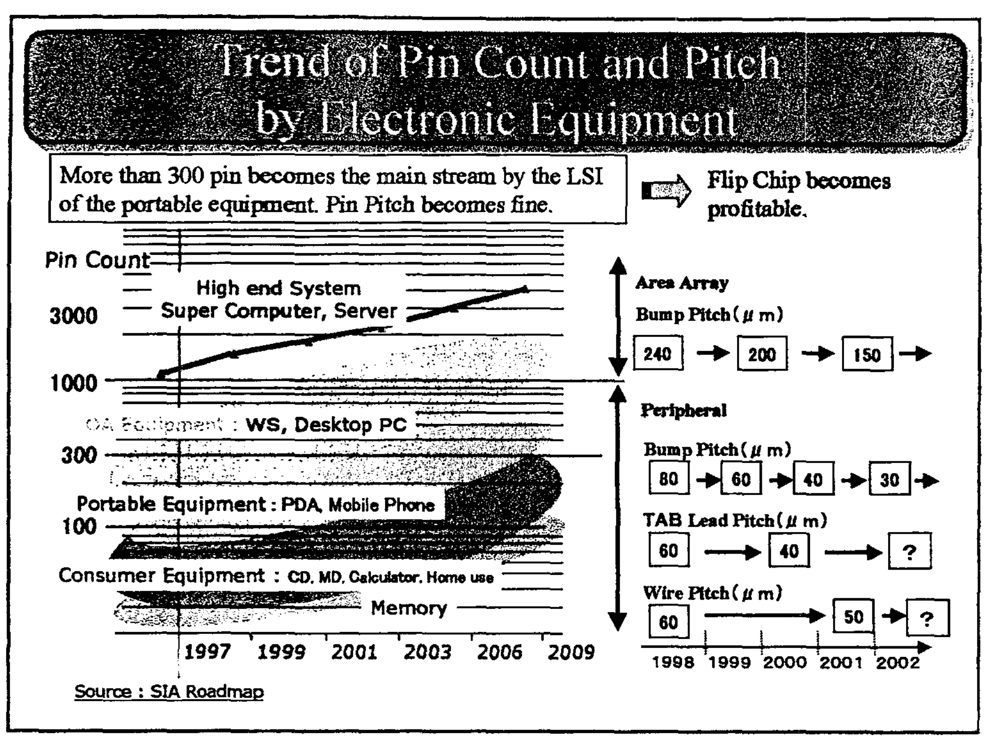

Bare Chip Application Category in Japan
Automobile
Main Frame Server, WS
Consumer
5%
12%
16%
Backbone Network Equipment
Card
16%
Mobile Phone
Notebook PC, PDA
Source : Akihiro Dohya (Protec Forum '99)

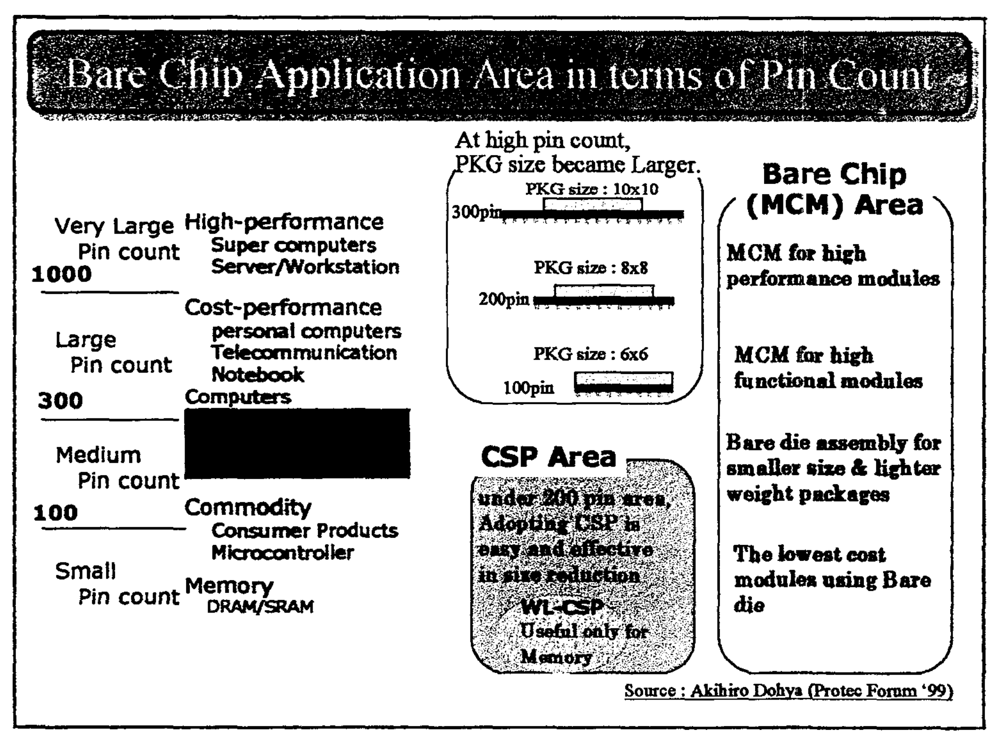

Structure Bare Chip Assembly in Japan
Single Chip Module
Bare Chip on Board
30%
34%
Multi Chip Module
Source : Akihiro Dohya (Protec Forum '99)

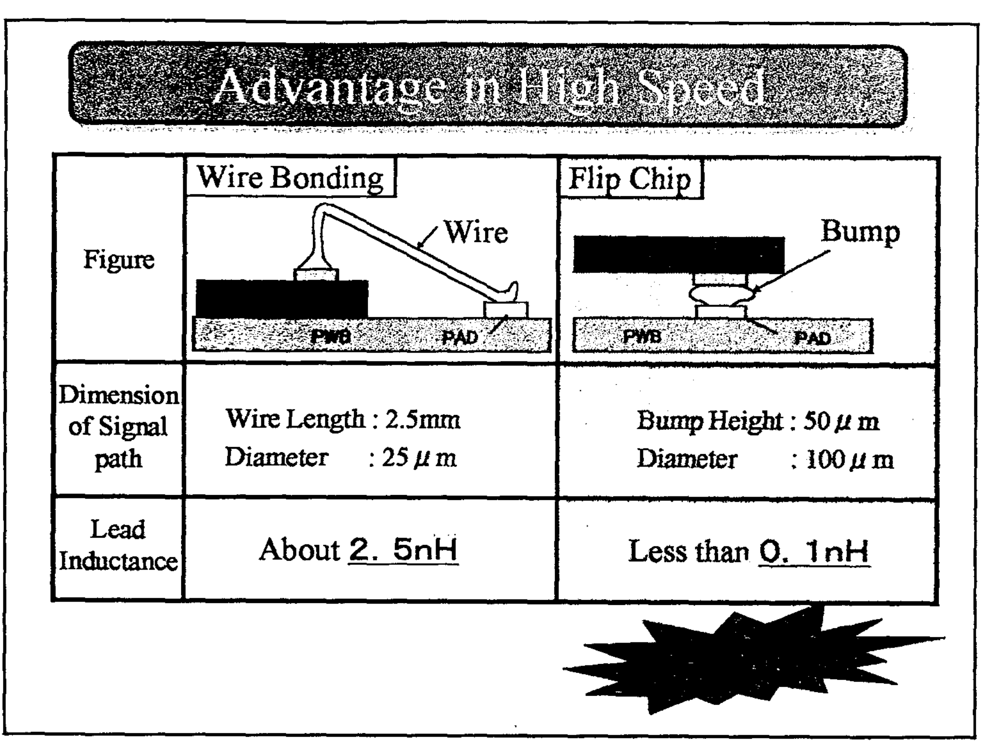

The Forecast of Bare Chip Mounting
1999
2004
Car Navigate
Camera
PDA
Card
Mobile Phone
Note Book PC
Other
TCP
Flip Chip
Wire bonding
12
10
8
6
4
2
0
Flip Chip Mounting Grows Greatly
Data as a questionnaire result to the Japanese manufacturer
Source : Japan Institute of Electronics Packaging

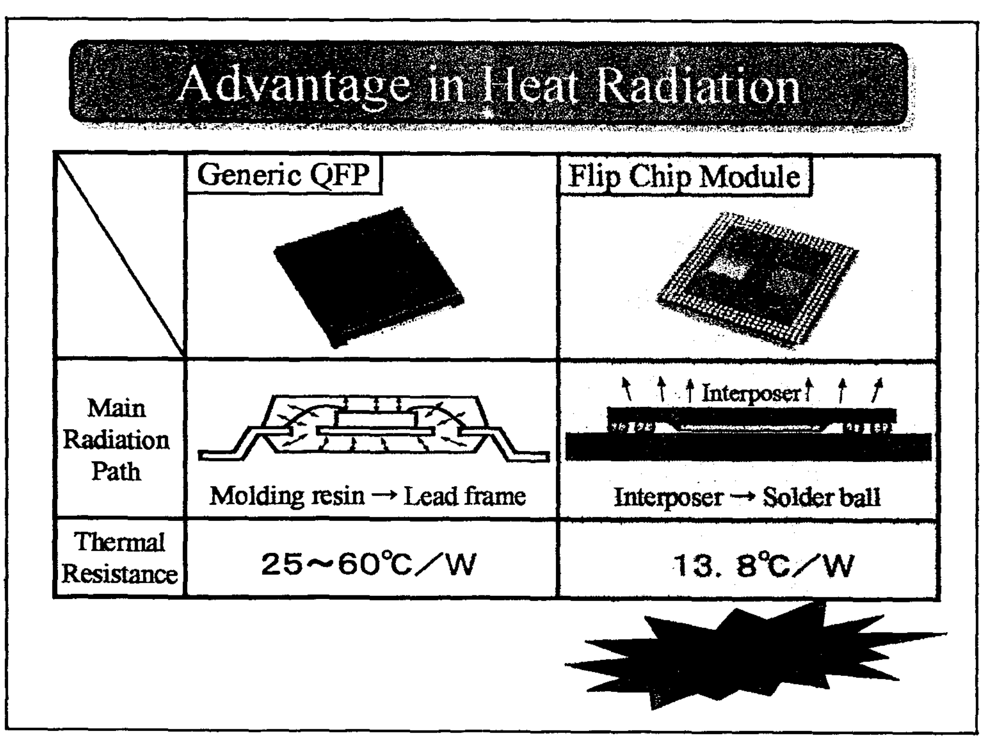

Mounting Technology Prospect in Mobile / Home Use Equipment
Miniaturization, Networking, Digitization will progress.
1998
1999
2000~2002
Mobile
Thin Down
Weight Saving
Weight Saving
Networking
Home Use
Digitization
Digital Analog mixed system
Networking
Miniaturization
Flip Chip
◆Requirement for LSI Mounting
Miniaturization, High Speed
BGA / CSP
QFP / SOP
High Speed


Mounting Technology Prospect in High Performance Computer
Miniaturization, Networking, Digitization, High Speed,
High Pin Count will progress.
1998
1999
2000~2002
High Performance Computer
Networking
SERVER
Small / High Performance
Small / High Performance
Notebook PC
Weight Saving
Frequency
300 MHz
400 MHz
800 MHz
1 GHz
Network Speed
10Mbps
100Mbps
400Mbps
◆Requirement for LSI Mounting
High Speed, High Pin Count
High Speed
Flip Chip on Board
Flip Chip in PKG
High Pin Count


Trend of Pin Count and Pitch by Electronic Equipment
More than 300 pin becomes the main stream by the LSI of the portable equipment. Pin Pitch becomes fine.
Flip Chip becomes profitable.
Pin Count
High end System
Super Computer, Server
3000
1000
: WS, Desktop PC
300
Portable Equipment : PDA, Mobile Phone
100
Consumer Equipment : CD, MD, Calculator, Home use
Memory
1997
1999
2001
2003
2006
2009
Source : SIA Roadmap
Area Array
Bump Pitch (μm)
240
200
150
Peripheral
Bump Pitch (μm)
80
60
40
30
TAB Lead Pitch (μm)
60
40
?
Wire Pitch (μm)
60
50
?
1998
1999
2000
2001
2002

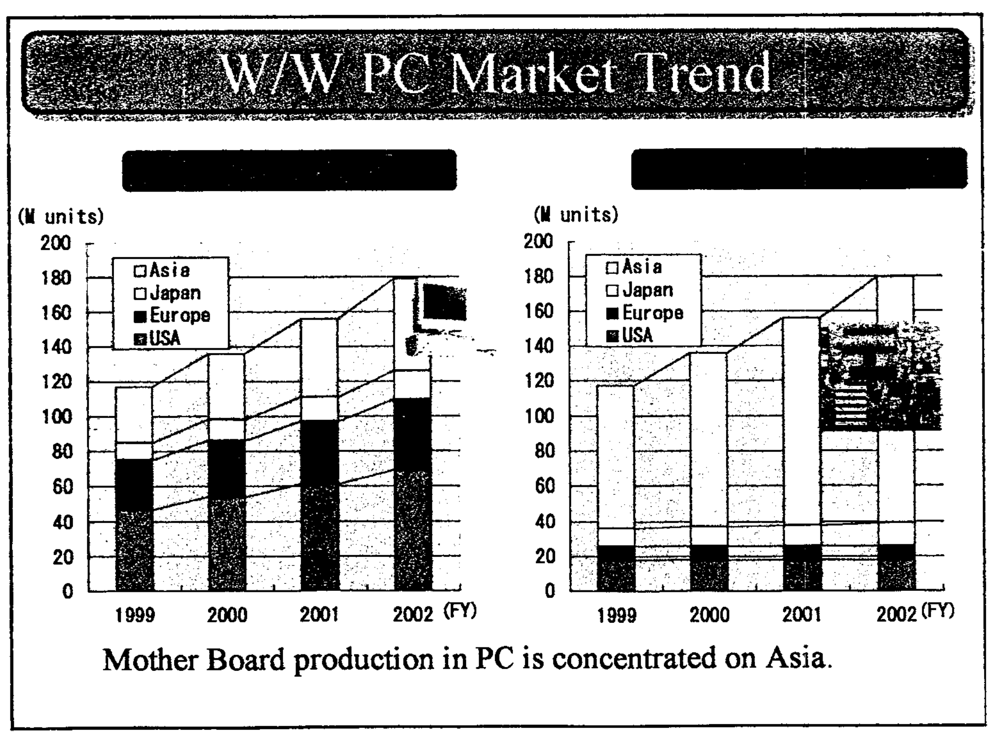

Bare Chip Application Area in terms of Pin Count
Very Large Pin count
1000
Large Pin count
300
Medium Pin count
100
Small Pin count
High-performance
Super computers
Server/Workstation
Cost-performance
personal computers
Telecommunication
Notebook
Computers
Commodity
Consumer Products
Microcontroller
Memory
DRAM/SRAM
At high pin count, PKG size became Larger.
PKG size : 10x10
300pin
PKG size : 8x8
200pin
PKG size : 6x6
100pin
CSP Area
under 200 pin area, Adopting CSP is easy and effective in size reduction
WL-CSP:
Useful only for Memory
Bare Chip (MCM) Area
MCM for high performance modules
MCM for high functional modules
Bare die assembly for smaller size & lighter weight packages
The lowest cost modules using Bare die
Source : Akihiro Dohya (Protec Forum '99)


Advantage in High Speed
Figure
Wire Bonding
Wire
PWB
PAD
Flip Chip
Bump
PWB
PAD
Dimension of Signal path
Wire Length : 2.5mm
Diameter : 25 μm
Bump Height : 50 μm
Diameter : 100 μm
Lead Inductance
About 2. 5nH
Less than 0. 1nH

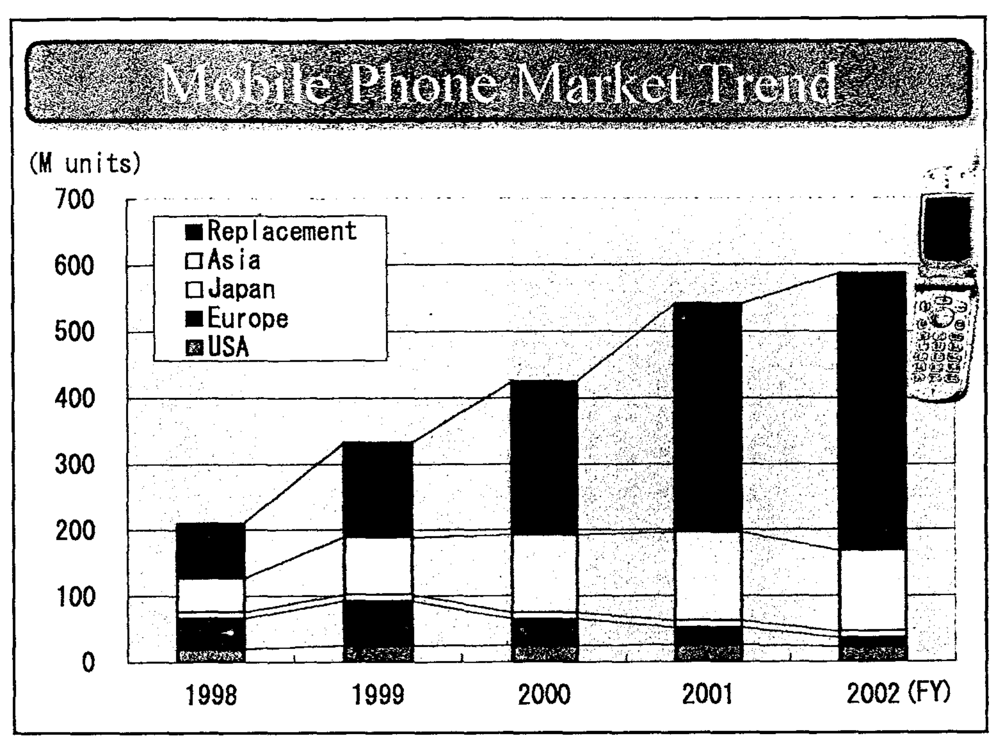

Advantage in Heat Radiation
Generic QFP
Flip Chip Module
Main Radiation Path
Molding resin → Lead frame
Interposer
Interposer → Solder ball
Thermal Resistance
25～60℃/W
13. 8℃/W

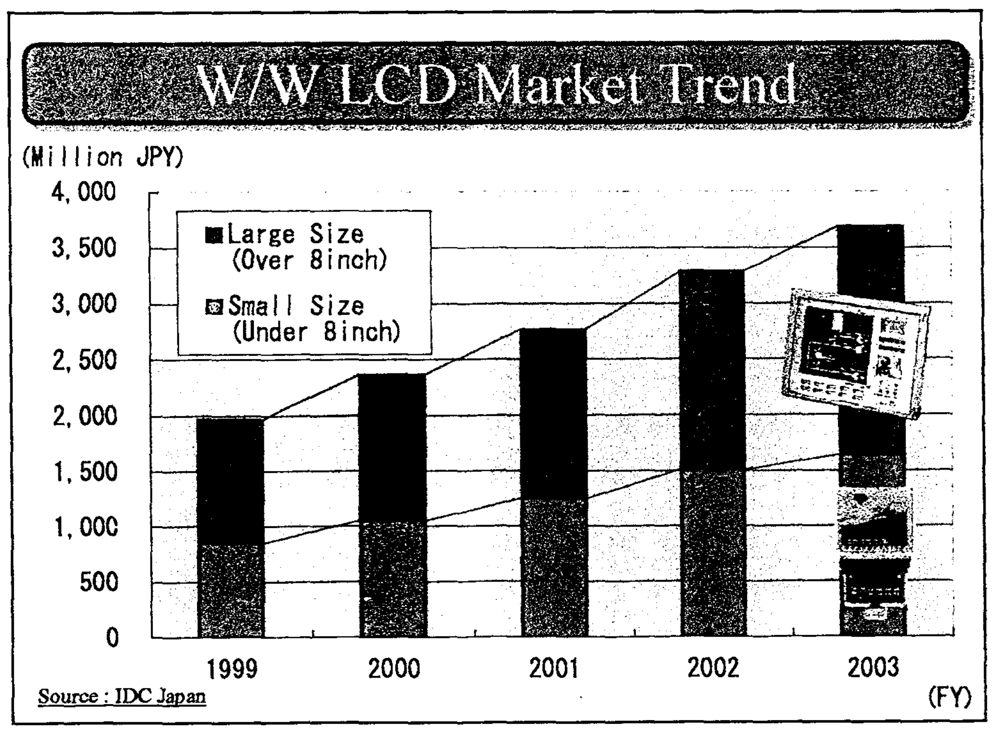
3. Trends of Application Market

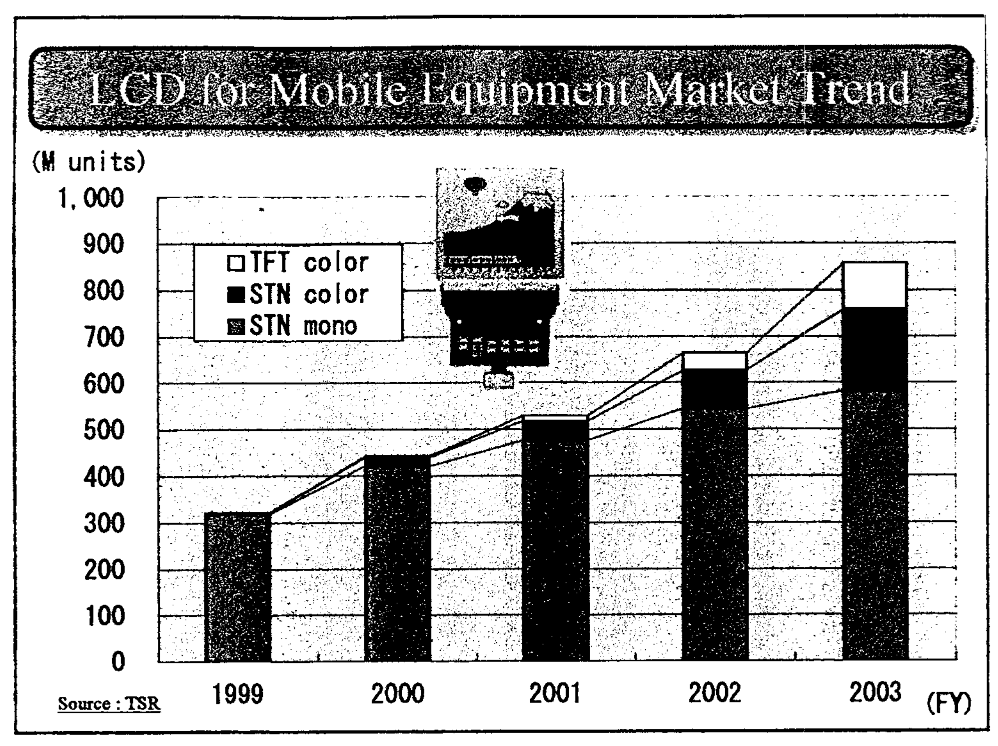
W/W PC Market Trend

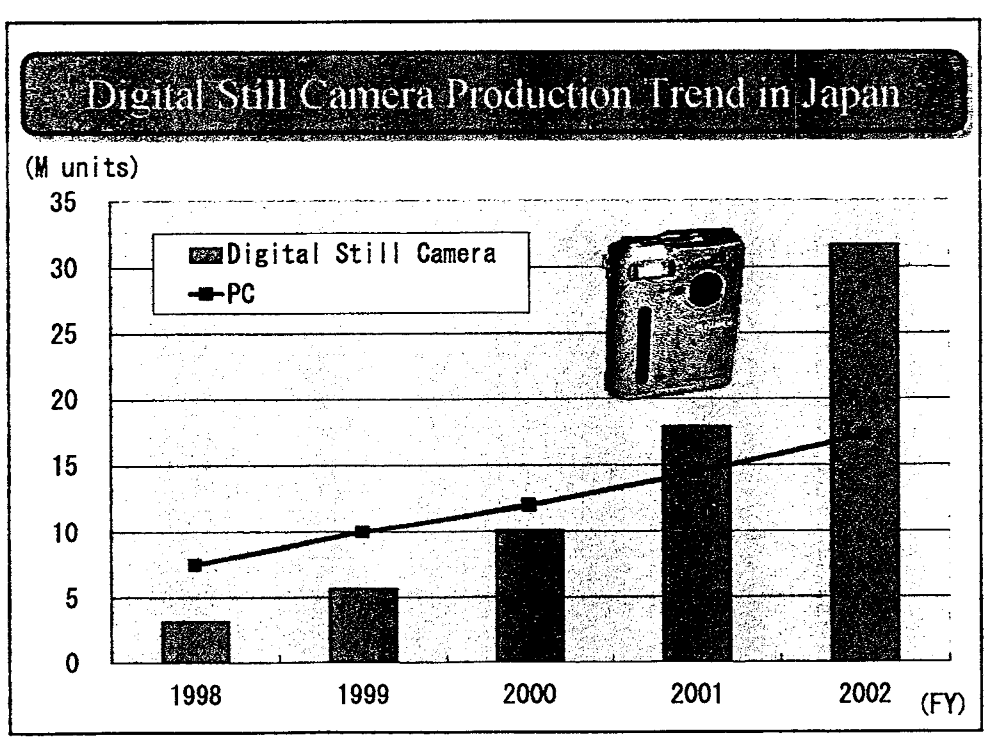


Mother Board production in PC is concentrated on Asia.

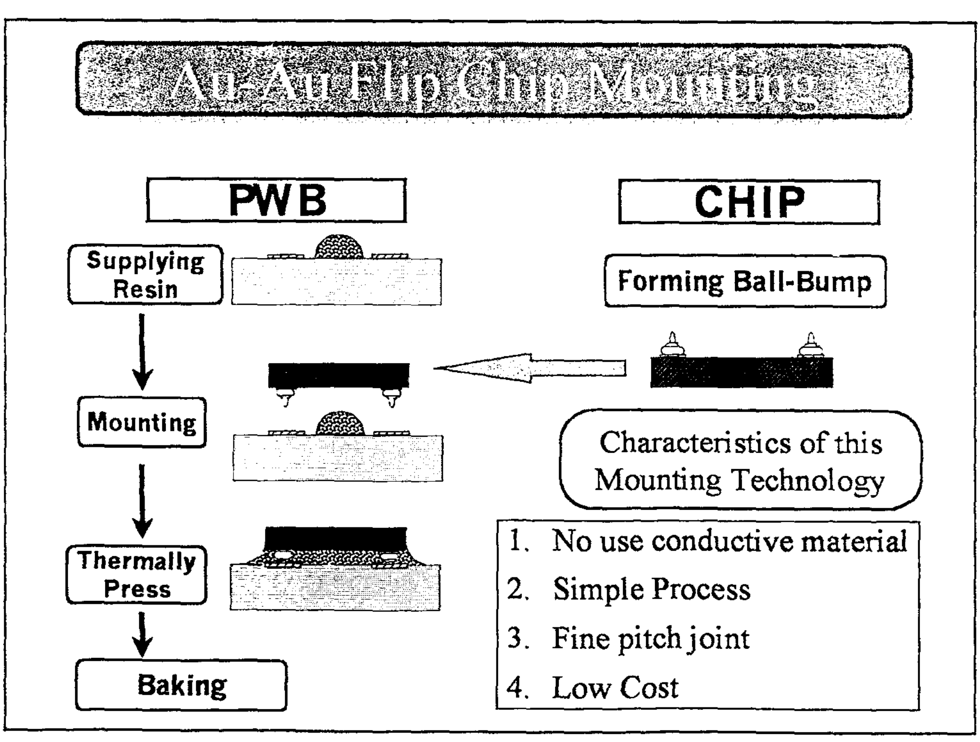

Mobile Phone Market Trend
(M units)
700
600
500
400
300
200
100
0
Replacement
Asia
Japan
Europe
USA
1998
1999
2000
2001
2002 (FY)

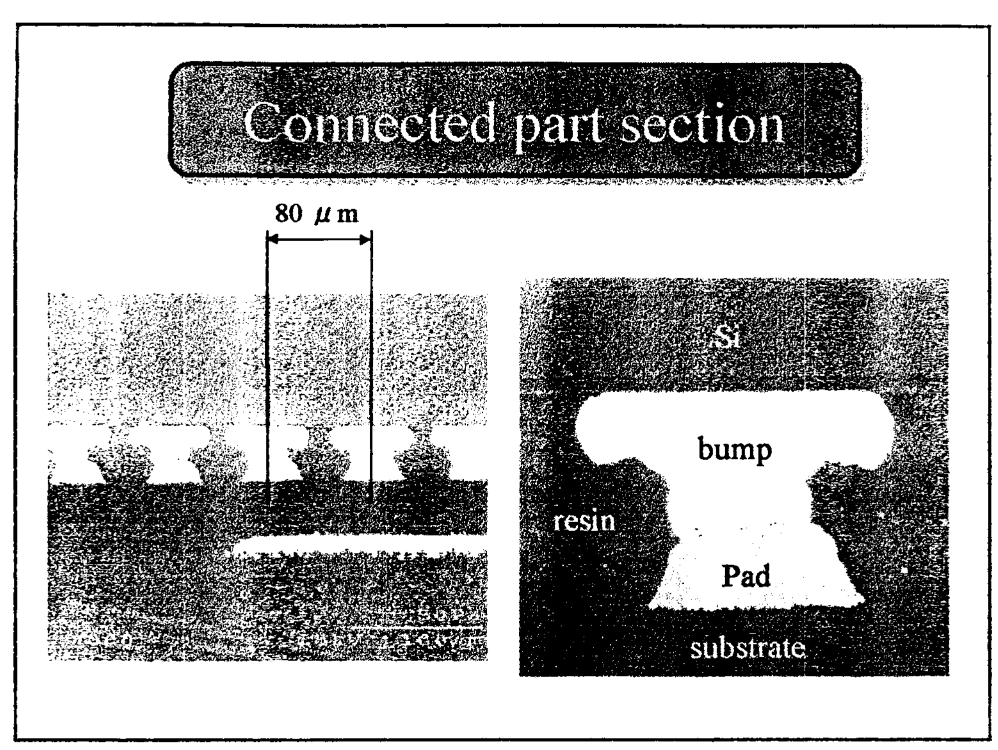

W/W LCD Market Trend
(Million JPY)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Large Size
(Over 8inch)
Small Size
(Under 8inch)
1999
2000
2001
2002
2003
Source : IDC Japan
(FY)

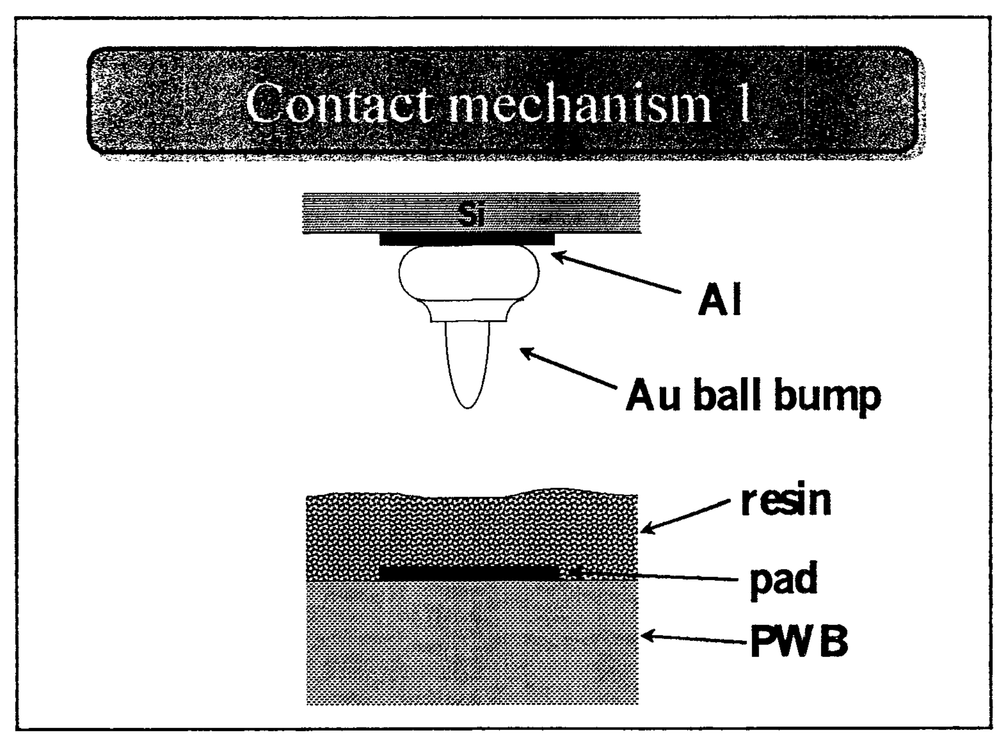

LCD for Mobile Equipment Market Trend
(M units)
1,000
900
800
700
600
500
400
300
200
100
0
TFT color
STN color
STN mono
1999
2000
2001
2002
2003
(FY)
Source : TSR

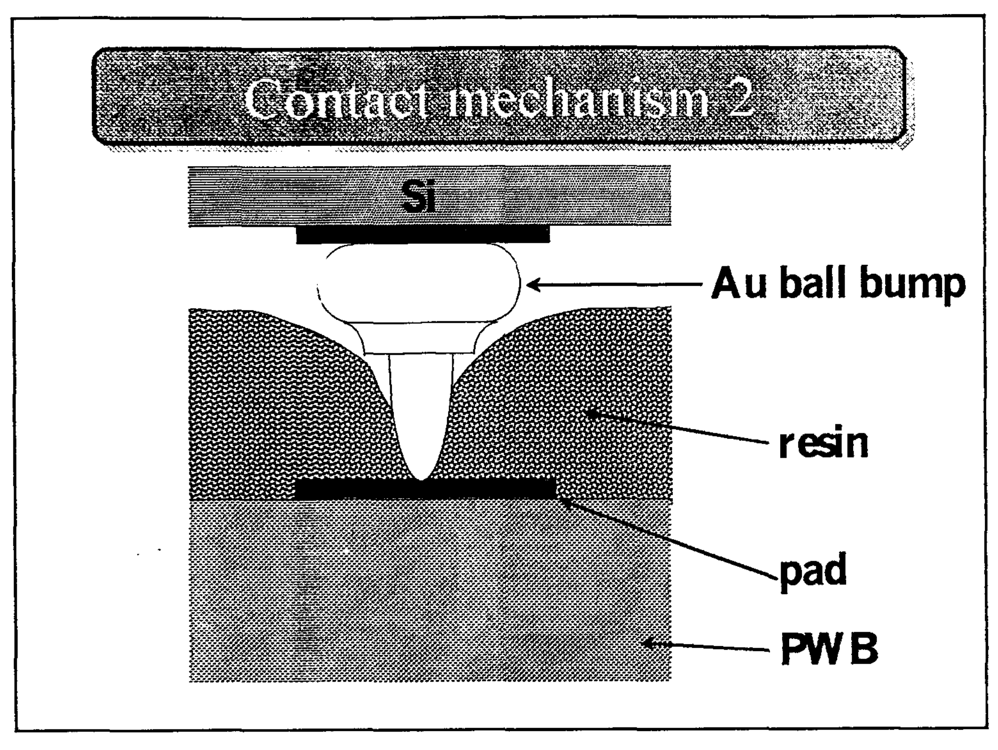

Digital Still Camera Production Trend in Japan
(M units)
35
30
25
20
15
10
5
0
Digital Still Camera
PC
1998
1999
2000
2001
2002
(FY)

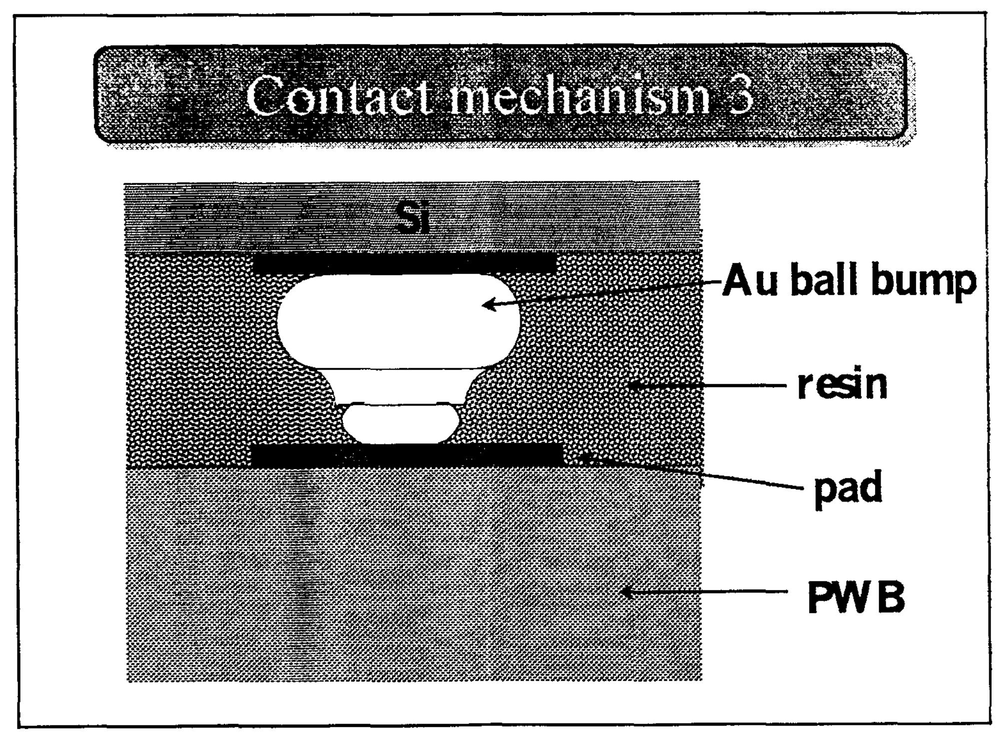
4. Outline of this Technology




Connected part section
80 μm
Si
bump
resin
Pad
substrate

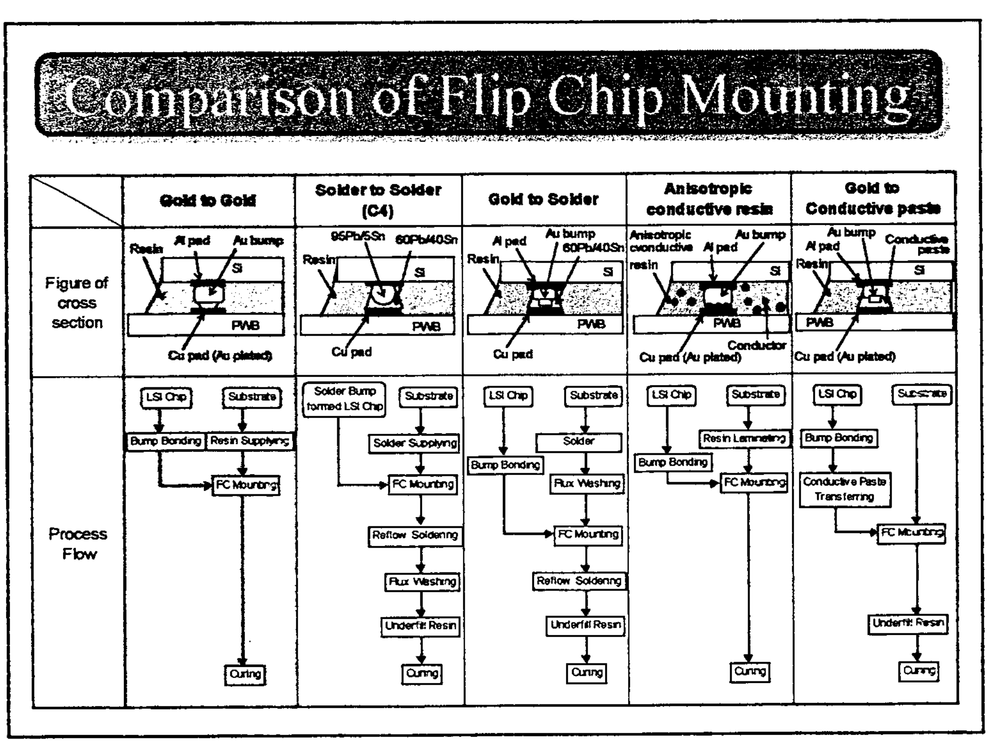

Contact mechanism 1
Si
Al
Au ball bump
resin
pad
PWB


Contact mechanism 2
Si
Au ball bump
resin
pad
PWB


Contact mechanism 3
Si
Au ball bump
resin
pad
PWB

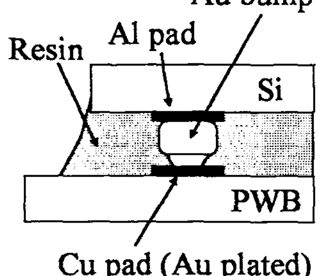
5. Advantages of this Technology

Comparison of Flip Chip Mounting



	Gold to Gold	Solder to Solder (C4)	Gold to Solder	Anisotropic conductive resin	Gold to Conductive paste
Figure of cross section	Resin, Al pad, Au bump, Si, PWB, Cu pad (Au plated)	95Pb/5Sn, 60Pb/40Sn, Resin, Si, PWB, Cu pad	Al pad, Au bump, 60Pb/40Sn, Resin, Si, PWB, Cu pad	Anisotropic cvonductive resin, Al pad, Au bump, Si, PWB, Conductor, Cu pad (Au plated)	Au bump, Al pad, Conductive paste, Resin, Si, PWB, Cu pad (Au plated)
Process Flow	LSI Chip → Bump Bonding; Substrate → Resin Supplying; → FC Mounting → Curing	Solder Bump formed LSI Chip; Substrate → Solder Supplying; → FC Mounting → Reflow Soldering → Flux Washing → Underfill Resin → Curing	LSI Chip → Bump Bonding; Substrate → Solder → Flux Washing; → FC Mounting → Reflow Soldering → Underfill Resin → Curing	LSI Chip → Bump Bonding; Substrate → Resin Laminating; → FC Mounting → Curing	LSI Chip → Bump Bonding → Conductive Paste Transferring; Substrate; → FC Mounting → Underfill Resin → Curing

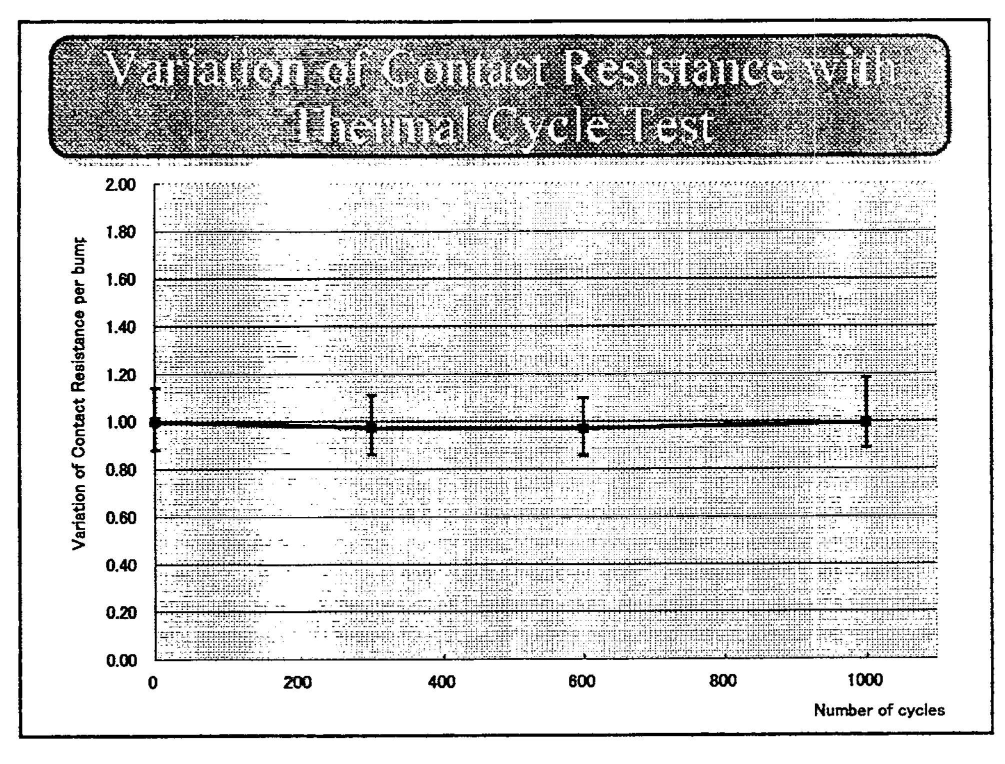
Advantages of Au - Au FC Mounting

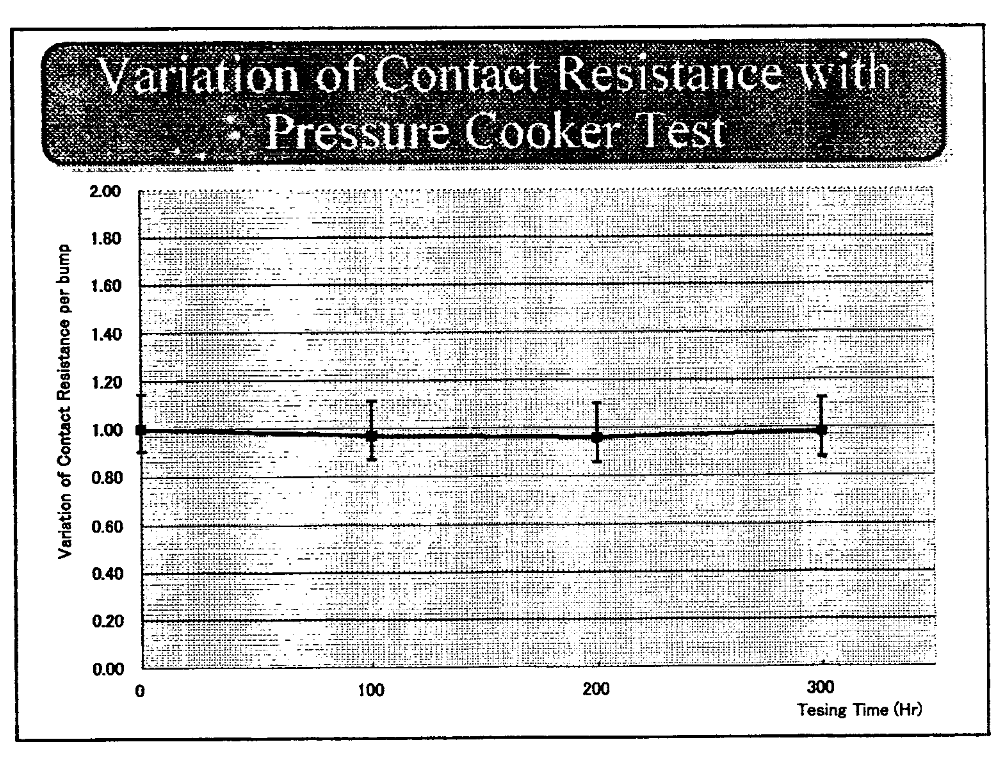


1. Fine pitch connection
   80 μm pitch was confirmed previously.
   Depend on performance of the PWB.
2. Usable Conventional Chip
   General Chip for wire bonding is usable.
   Need no Rewiring or UMB.
3. Usable Various Substrate
   Buildup PWB, Glass Epoxy PWB, Polyimide Tape.
4. Lead Free

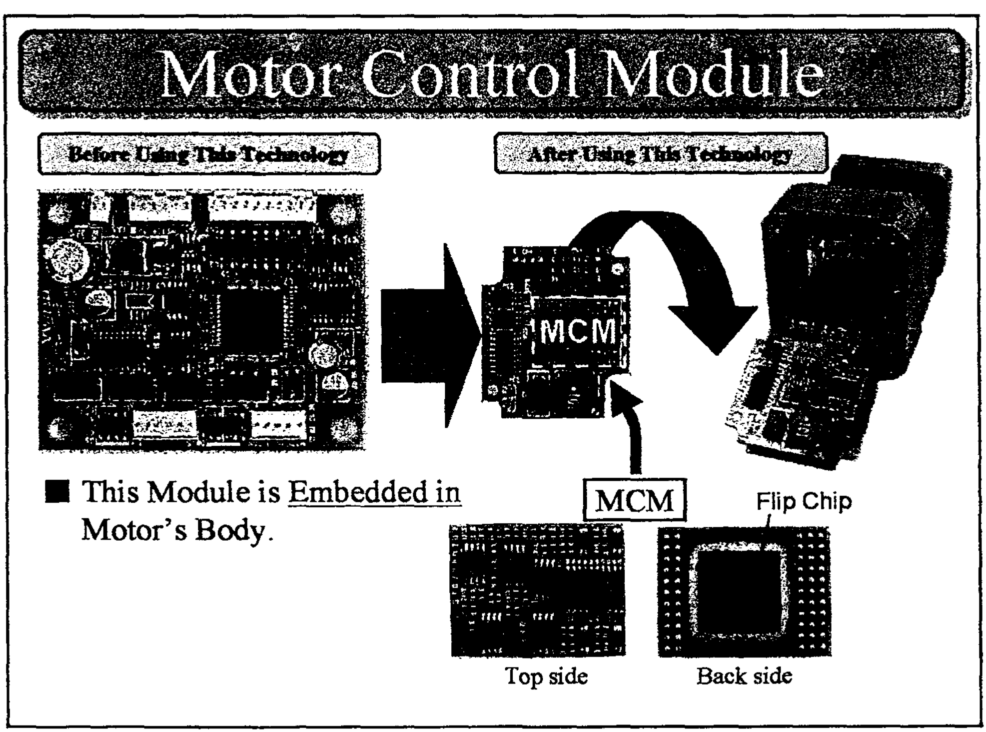
Reliability Test Results

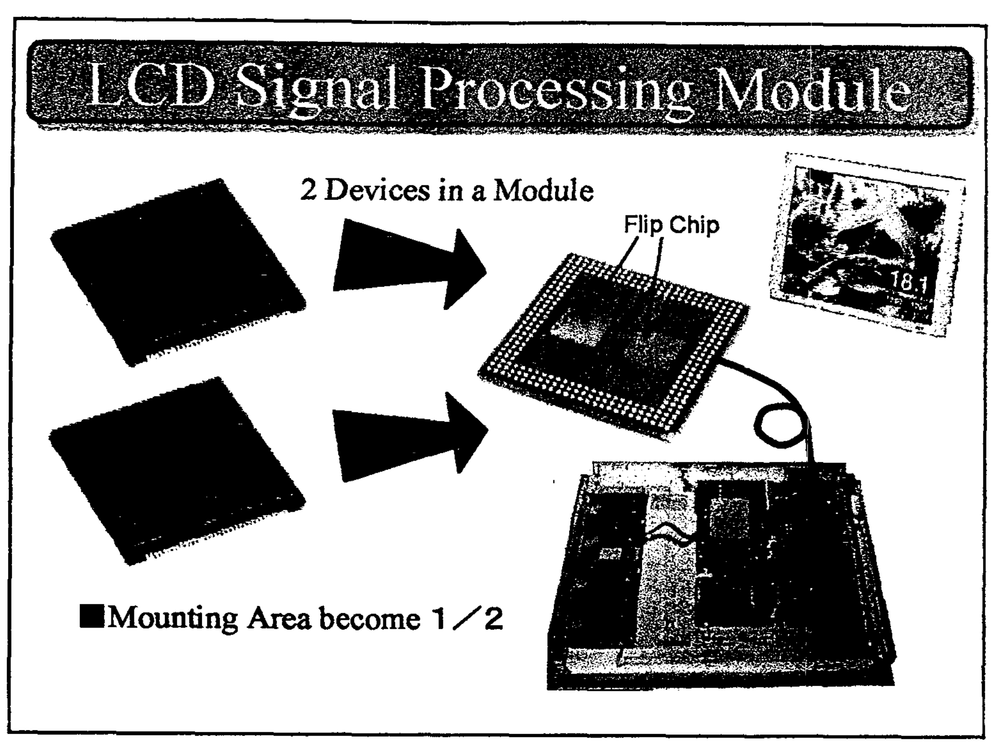
Parameter	Test Conditions	Test Results	
Thermal Cycle Test	-40℃～125℃	1000cy	Pass
Pressure Cooker Test	110℃, 85%, 1.2atm	300Hr	Pass
High temperature High humidity Test	85℃, 85%	1000Hr	Pass
High temperature Strage Test	125℃	1000Hr	Pass
High temperature High humidity Bias Test	85℃, 85%, 5.5V	1000Hr	Pass
Low temperature Strage Test	-40℃	1000Hr	Pass

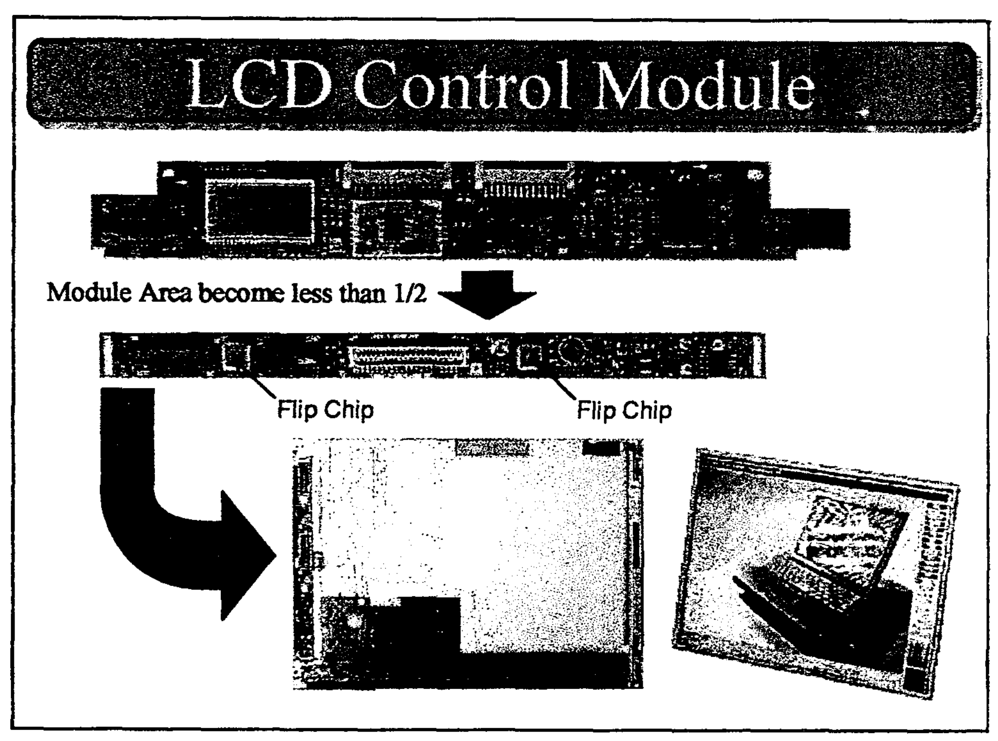

Variation of Contact Resistance with Thermal Cycle Test
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Variation of Contact Resistance per bump
0
200
400
600
800
1000
Number of cycles

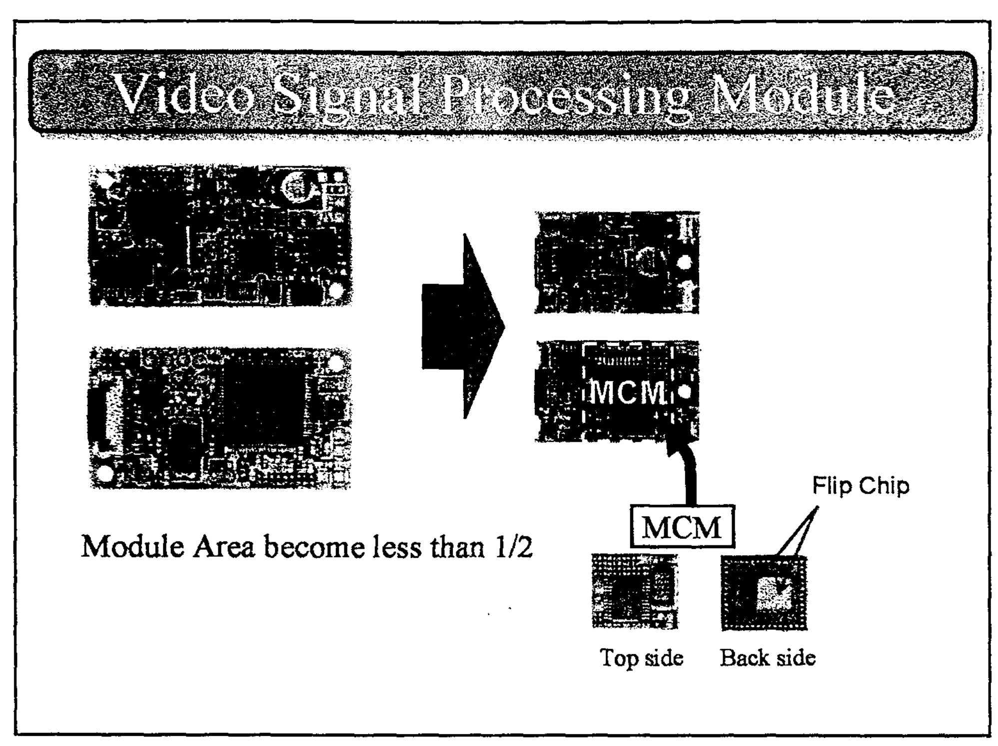

Variation of Contact Resistance with Pressure Cooker Test
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Variation of Contact Resistance per bump
0
100
200
300
Tesing Time (Hr)

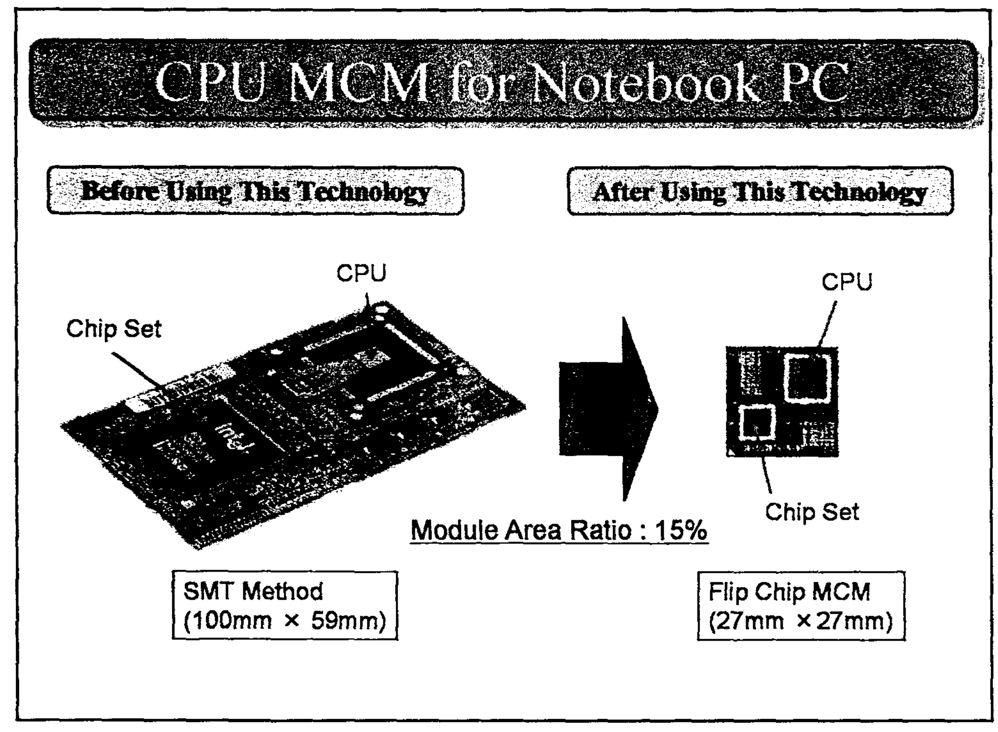
6. Example of Applications



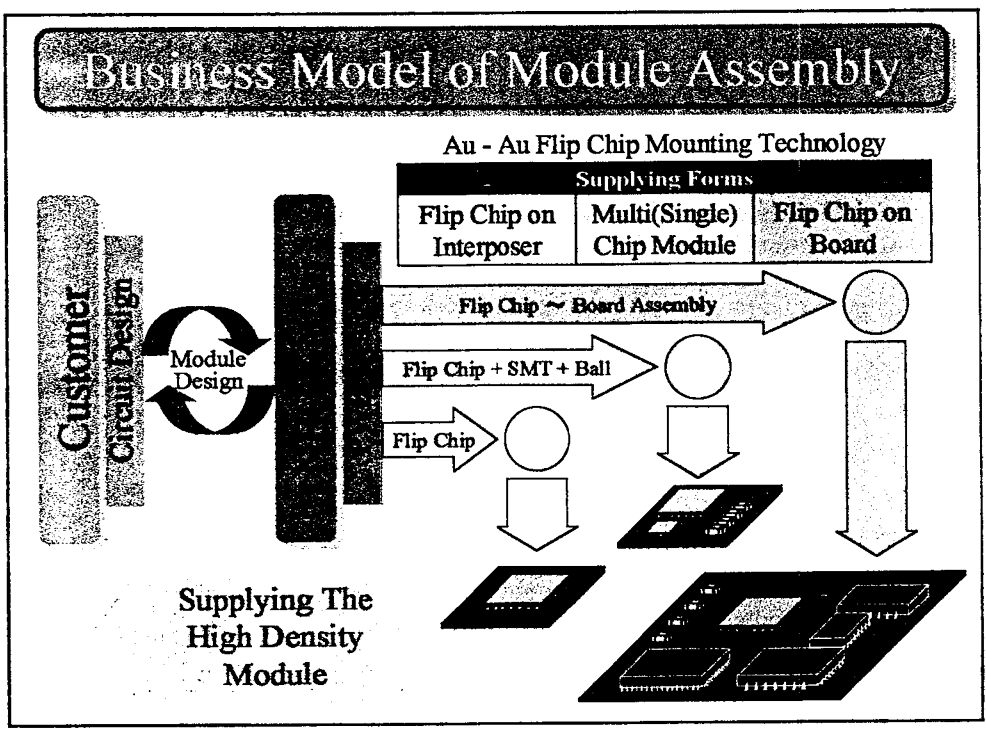

LCD Signal Processing Module
2 Devices in a Module
Flip Chip
18.1
■Mounting Area become 1／2

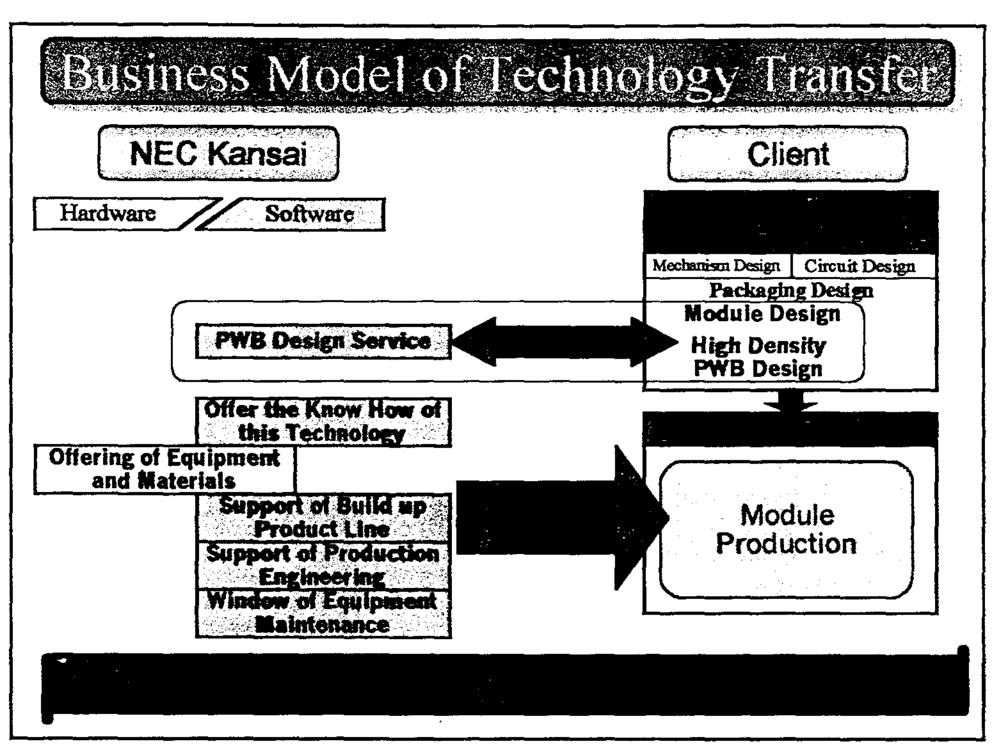

LCD Control Module
Module Area become less than 1/2
Flip Chip
Flip Chip


Video Signal Processing Module
MCM
MCM
Flip Chip
Module Area become less than 1/2
Top side
Back side


CPU MCM for Notebook PC
Before Using This Technology
After Using This Technology
CPU
Chip Set
CPU
Chip Set
Module Area Ratio : 15%
SMT Method
(100mm × 59mm)
Flip Chip MCM
(27mm ×27mm)

7. Our Business Policy




Business Model of Technology Transfer
NEC Kansai
Client
Hardware
Software
Mechanism Design
Circuit Design
Packaging Design
Module Design
High Density
PWB Design
PWB Design Service
Offer the Know How of this Technology
Offering of Equipment and Materials
Support of Build up Product Line
Support of Production Engineering
Window of Equipment Maintenance
Module Production