
Sustainable PCB Manufacturing

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Introduction

First electronic computer



1946

First PC



1981

Micro PC

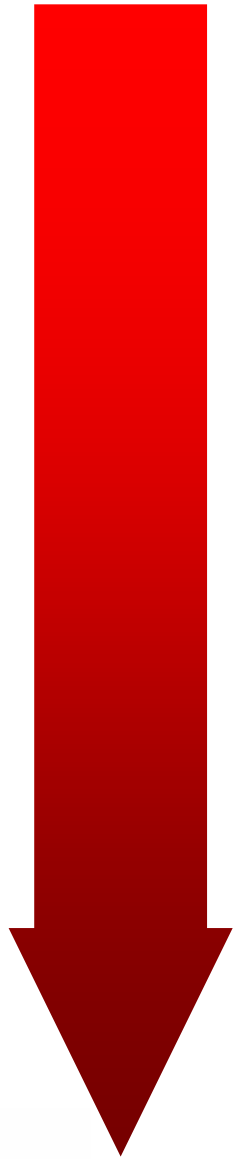


2008

How to support the miniaturization?



Evolution of PCB



Point-to-Point Construction



- Electronic components are connected by terminal strips
- Sequential assembly is needed

Single Sided PCB



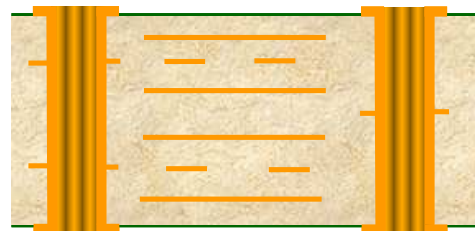
- Electronic components are connected by etched copper wires on the board

Double Sided PCB



- Circuit can be printed on both sides of the board to double the utilisation area

Multilayer PCB



- Occupy space of unconnected layers
- Resonance stub creates signal integrity issues

High Density Interconnect (HDI)

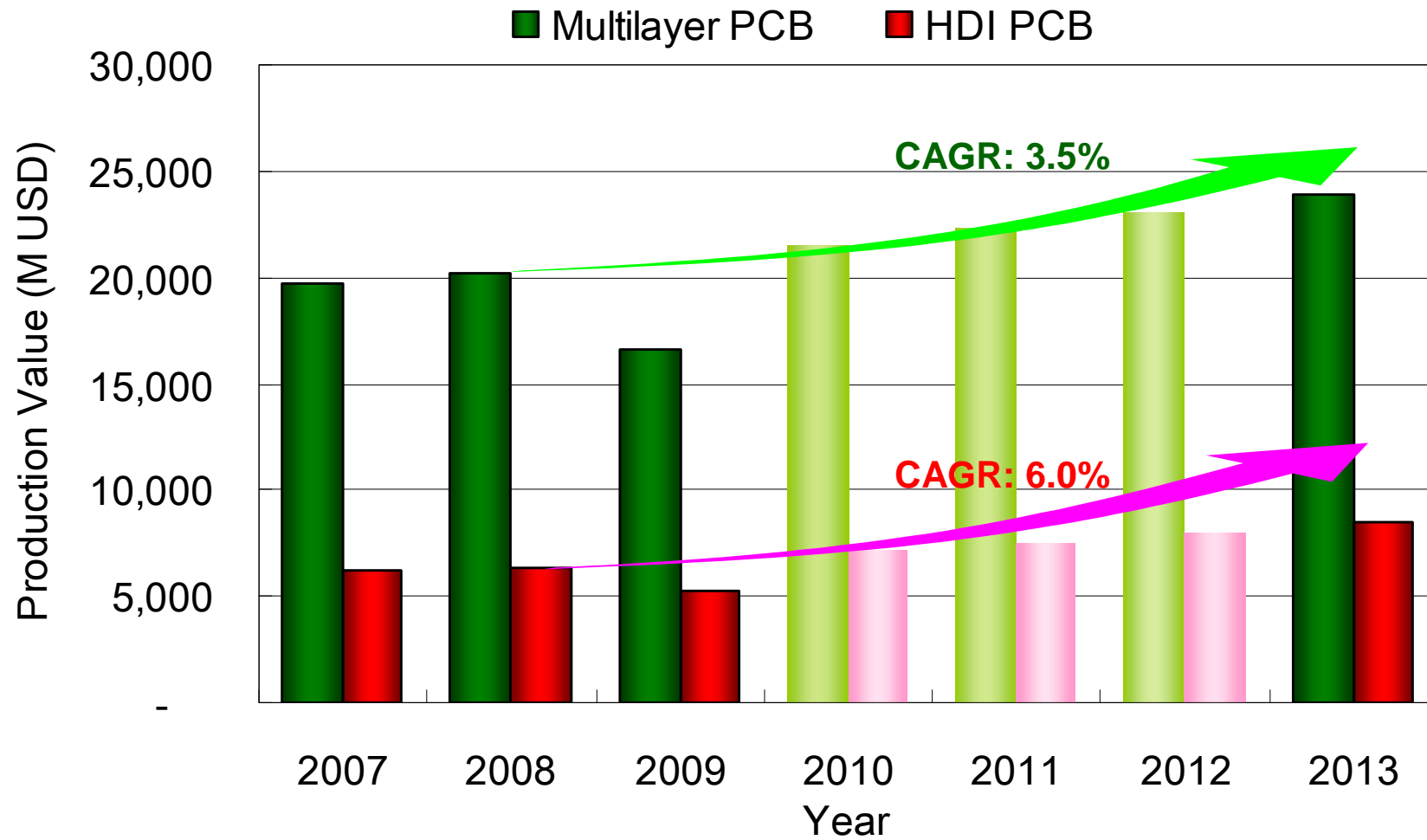


- Increase circuit density
- Reduce board size, layer count
- Reduce cost
- Eliminate resonance stub



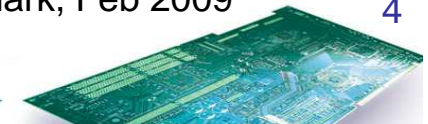
HDI Market

Global Multilayer and HDI PCBs Market Trend

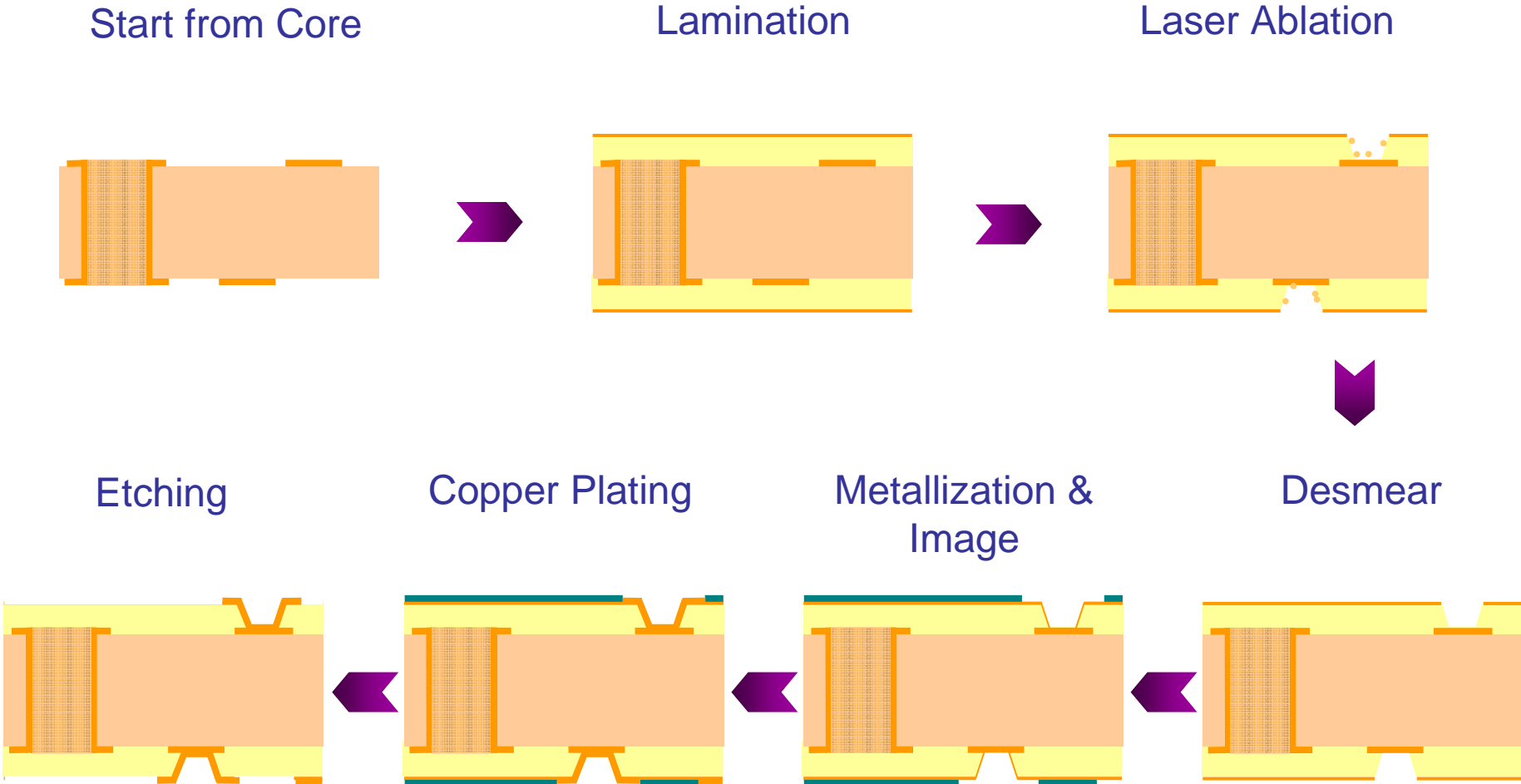


CAGR: Compound Annual Growth Rate

Source: Prismark, Feb 2009



HDI Fabrication



Role Model of Sustainable HDI PCB Manufacturing Site

Elec & Eltek Kai Ping HDI Center



- State-of-the-art technology and facilities
- Full range of Experts

HDI Capability

2009	
Build up Materials	Aramid, BT, FR4, LD Prepreg, RCC
Structure	
- Sequential Build-up - Sequential Lamination	Up to 3+N+3 with IVH Up to 3 X IVH (micro via)
Minimum Line Width/ Spacing	2mil / 2mil
Minimum/ Maximum Laser Via Size	2mil / 8mil
Laser Via Formation Method	Conformal Mask, Direct Drilling
Laser Via Filling	Copper Plating
Aspect Ratios	1:1
Impedance Control	+/- 5%



How to Ensure that HDI PCB Manufacturing is Sustainable ?

Production with no hazardous emissions and wastage of natural resources

- Material Selection

Material for PCB manufacturing and assembly should not contain any hazardous substance

- Pollution Control

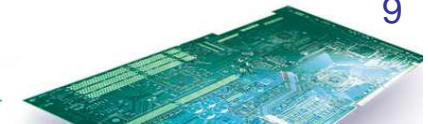
Production process should not generate any pollutant

- Resources Usage Control

Resources should not be wasted in production



Material Selection



Environmental Policies

Restriction of Hazardous Substances Directive (RoHS)

- **Adoption Date:** February 2003 by the European Union
- **Effective Date:** 1 July 2006
- **Restricted materials:**
 - Lead
 - Mercury
 - Cadmium
 - Hexavalent chromium (CR⁶⁺)
 - Polybrominated biphenyls (PBB)
 - Polybrominated diphenyl ether (PBDE)
- **Applicable categories:** household appliances; IT equipment; telecom. equipment; consumer equipment; lighting; electronic and electrical tools; toys, leisure and sports equipment; automatic dispensers
- **Exemption:** medical devices (by the end of 2013); monitoring and control instruments (by the end of 2016)



What's Wrong with PCB Materials?

Flame Retardant

- **UL Standard:** Flame retardant PCBs are required in electronic applications
- **Common type:** Halogenated flame retardant typically based on bromine (eg. PBDE, TBBPA)

Brominated Flame Retardant

- **Working Mechanism:** Produce hydrobromic acid which interferes in the radical chain reaction of the oxidation reaction of fire
- **Hazard:** Toxic, bioaccumulation in humans

Public Concern

- The European Union decided to ban the use of two categories of flame retardants, PBDEs and PBBs, in electric and electronic devices.

Solution to Hazardous Flame Retardant – Halogen Free

Phosphorous Type Flame Retardant

- Working Mechanism: form carbon layer on insulator's surface to cut off oxygen supply for burning

Advantages

- Environmentally friendly
- Higher decomposition temperature

Challenges

- Higher moisture absorption
- Lower thermal reliability
- Brittle
- Lower Conductive Anodic Filament (CAF) resistance

What's Wrong with Assembly Process

Tin-Lead Solder

- Advantage: Low melting range
- Hazard: poisonous metal that can damage nervous connections and cause blood and brain disorders in humans

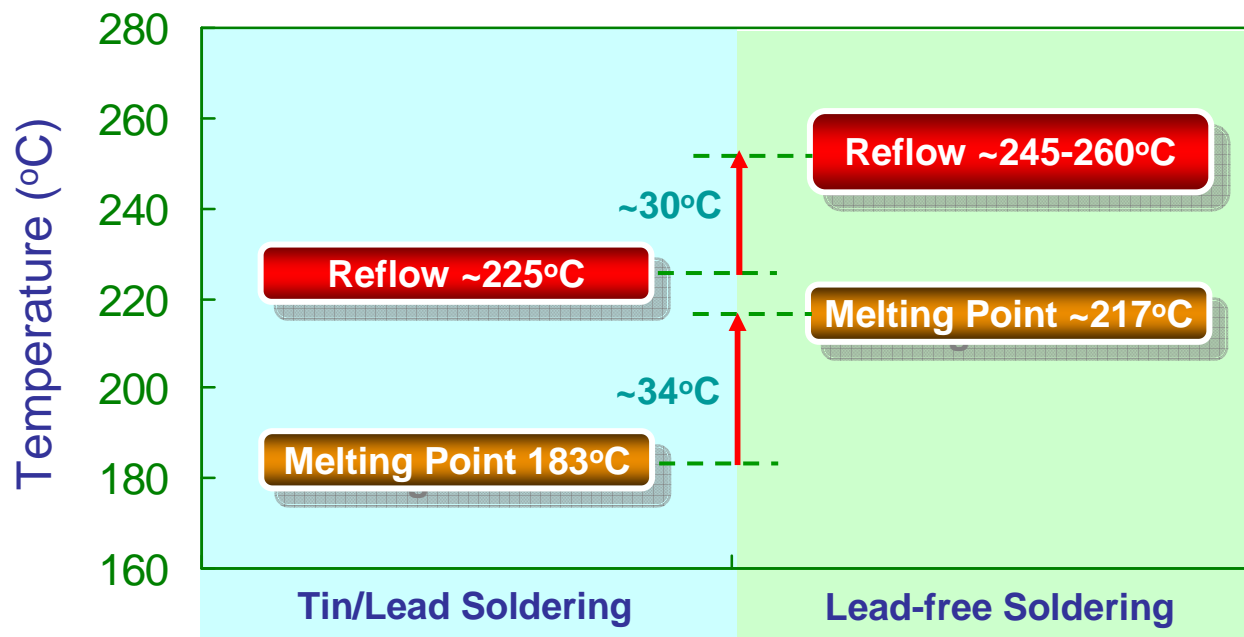
Solution – Lead Free Solder

- Common types:
 - ◆ Tin-Silver-Copper Alloy (SAC)
 - ◆ Tin-Copper eutectic
 - ◆ Tin-Silver eutectic
 - ◆ Tin-Zinc
 - ◆ Tin-Bismuth-Silver

Challenge of Lead Free Soldering

Higher required thermal mass

- Higher reflowing temperature
- Longer reflow time



PCB Laminates for Lead Free Process

Criteria

- Low Z-axis Coefficient of Thermal Expansion (Z-CTE)
- High Thermal Decomposition Temperature (Td)
- Long T260 & T288 Time to Delamination
- High CAF Resistance

Competitive Edges of E&E Kai Ping HDI Center

- Internal Material Supply
 - ◆ Various kinds of material (Halogen free, Dicy free, filled and etc...)
 - ◆ Full range of Tg's (Glass Transition Temperature)



PIC – Kaiping, China



PIM – Rojana, Thailand



PIC – Shenzhen, China

- Comprehensive In-House Material Evaluation
 - ◆ Professional research and development team with full range of experts

Pollution Control & Resources Usage Control

Chinese Government's Policies

Main Ideas

- Restrict the growth of industrial consumption of water.
- Restrict the growth of inefficient power consumption and high pollution industries
- Raise the thresholds for pollution emission approvals.

Challenges to PCB Manufacturers

- More capital investment required to lower pollutants emission.
- Need to increase the percentage of recyclable water usage.
- Need to improve raw material utilization rate
- Need to upgrade the production facilities to achieve better efficiency

Standards of Wastewater Treatment in China

Items for monitoring	Standards set by Chinese Government	Performance of E&E HDI Center
pH	6 - 9	7.5 – 8.5
SS	≤ 50	50
Colority	$\leq 60X$	40X
COD _{Cr}	≤ 80	60
NH ₃ -N	≤ 15	10
Cu ²⁺	≤ 0.5	0.3
Ni ²⁺	≤ 0.5	0.3
S ²⁻	0.5	0.5
CN ⁻	0.3	0.1



Wastewater Treatment

Utilisation of the Recycled Wastewater

- Make use of chemical properties of wastewater to perform neutralisation

Lower material consumption of waste treatment



Automatic Control



Auto Dosing System

Wastewater Recycle

- Recycle wastewater in the production line after treatment (Deposition, filtering and purification)

75% of wastewater can be reused in production, and 5% can be used for irrigation

Water Saving

- Using filtered river water as the source, utilizing RO+DI water treatment systems to produce purified water.
- The key materials of RO+DI system chosen are the best available products, the yield rate is higher than 80%
- The remaining 20% concentrate is collected and is used for cleaning, toilet flushing and irrigation.



Filtering System



RO System



DI System

Material recycling

Etching Chemical Copper Recycling System

- Extract copper from the used etching solution for recycling
- The remaining copper-free etching solution can be reused for production

Excessive Copper Foil Recycling

- Excessive copper foil generated after pressing is collected and recycled internally.

Effective Coating System

- Use E-spray coating instead of screen printing to eliminate the requirement for silk screens

Etc..

Scrap Reduction

High Performance Equipment for HDI plating

High Performance Horizontal
Plating Line



Conventional Vertical
Plating Line



Advantages

- Improved copper distribution with better plating characteristics
- Better surface for imaging processes
- Lower waste generation
- Reduced process steps

Scrap Reduction (Cont')

Automatic Photo Imaging

Fully Automatic Exposure



Conventional Manual Exposure



Advantages

- Higher resolution
- Improved registration capability
- Better yield for photo imaging – less waste!!

Scrap Reduction (Cont')

Effective Coating System

Advanced E-Spray Coat



Conventional Manual Screen Printing



Advantages

- Improve solder mask distribution
- Improve yield – less waste!!
- Less material waste generation

Energy Saving

Air Conditioning System

- Utilise fully automated control systems to monitor and adjust the room temperature and humidity
- Apply high-accuracy sensors for temperature, humidity and air pressure monitoring
- Use high efficiency water chillers with advanced functions to adjust input power according to the loading requirement

Advantages:

- Avoid power wastage from over cooling/heating.
- Ensure the stability of the production environment for stable and consistent performance – less waste!!
- Maintain a desirable material storage condition to prevent any deterioration of material condition to avoid negative impact on production yield

Energy Saving (Cont')

Power supply

- Use high performance transformers
- Separate transformer distribution systems to shorten cable length and hence reducing circuit losses.

Lighting

- Use highly efficient fluorescent lights to increase total efficiency by about 25%
- Design the lighting control system to provide illumination with minimal power consumption

Efficient processes

Highly automated system for process linkage

- For example solder mask pretreatment line linked with E-spray coat machine, the cycle time will be reduced from about 4 hours to 1.5 hours.

Computerized production recording

- With ERP system, progress of each lot of boards can be monitored through the intranet giving improved control and planning.

Summary

- Concern about global warming and pollution have driven companies to seriously consider the impact of manufacturing on local environment
- To become a sustainable PCB manufacturer, PCB companies not only need to focus on technology development but also need to consider the possible impact of waste emissions from production processes.
- As an environmentally friendly PCB manufacturer and a responsible company, we are endeavoring to produce “green” PCBs with stringent standards on:
 - ◆ Material Selection
 - ◆ Pollution Control
 - ◆ Resources Usage Control



Your Achievement

Our Commitment

Thank You

