DESIGN FOR MANUFACTURING 2008

“NO DESIGN FOR MANUFACTURING”

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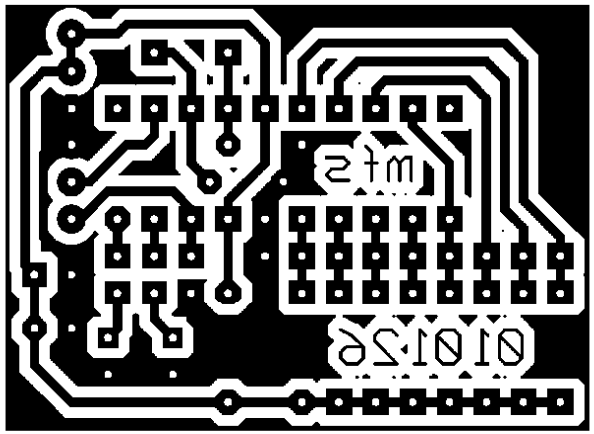
Introduction

- **Concept**



- **Electronic goods have an electrical circuit.**
- **Interconnection of resistors, inductors, capacitors, and etc.**
- **Conduction line does not have cross section.**

  → **Substrate needs sufficient space**
- **Insulator on a cross point**

Introduction (cont.)

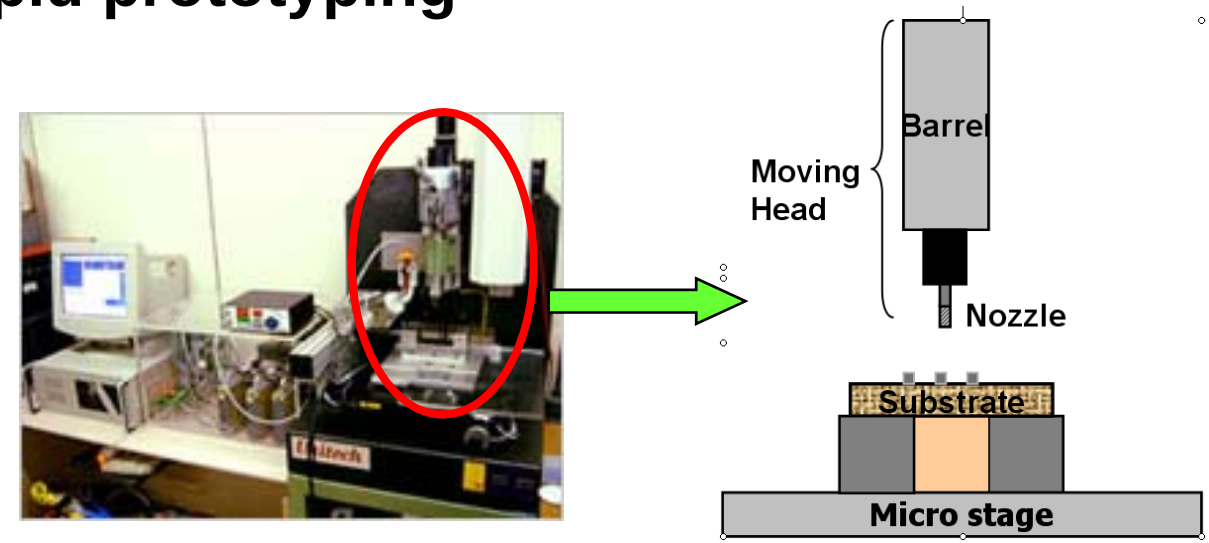
- **Objectives**
  - **To connect all element by straight line having cross sections.**

  → **Making small electric circuit with easy way.**

  → **New technique for an easy & fast way to make an electrical circuit.**

Fabrication Method

- **Rapid prototyping**

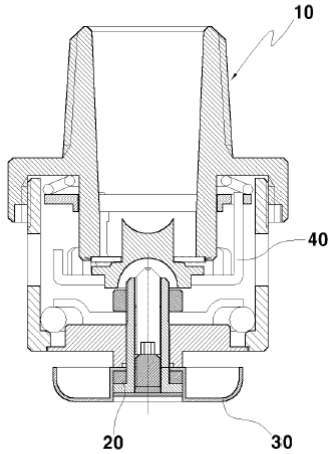
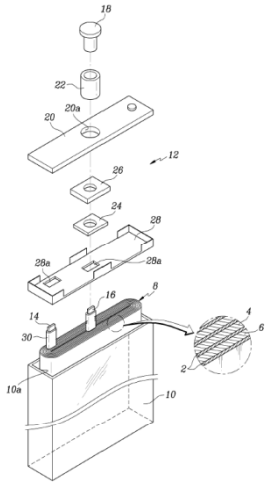
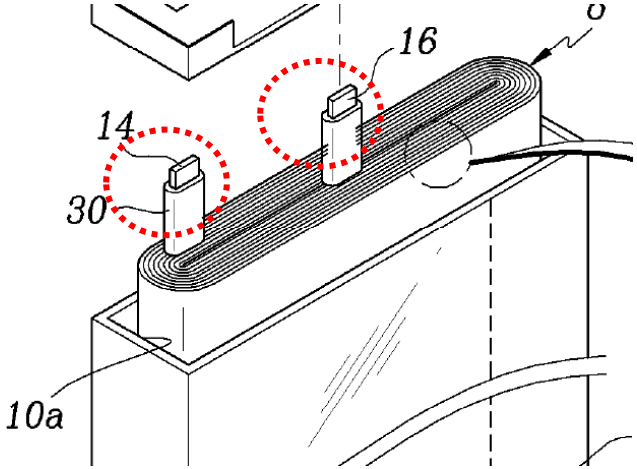


- **Experimental conditions**

Nozzle speed	Nozzle Dia.	Cylinder Temp.	Air pressure	Height (from nozzle to board)
1.5 mm/s	500 ㎛	160℃	11 KPa	47 mm

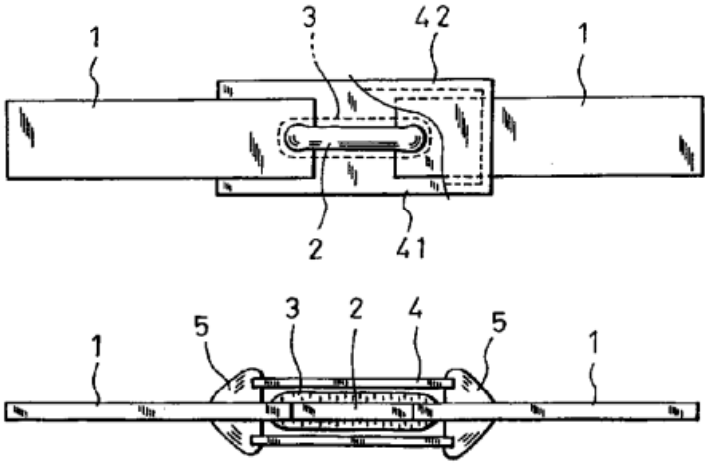
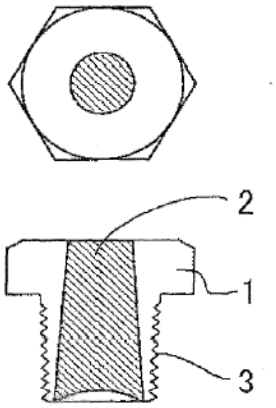
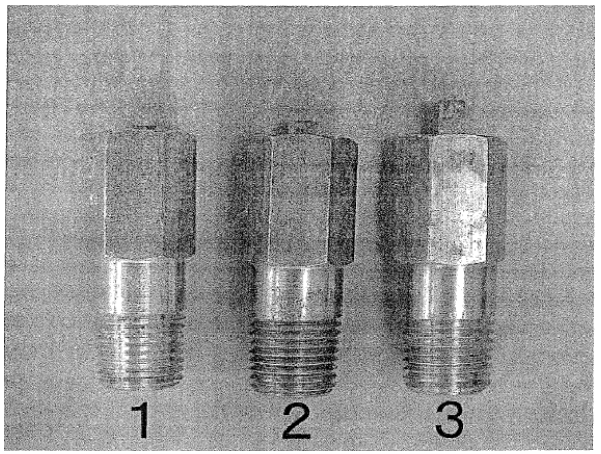
Studiing literature

- **Patents: internal**

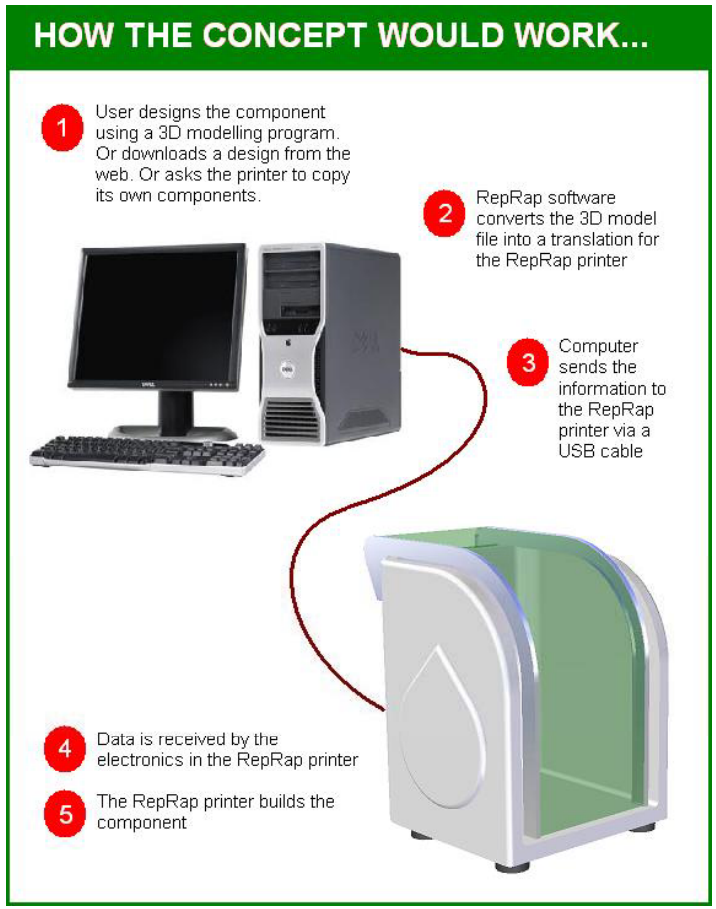
Detector of springcooler (10-2008-0023001)		
Soldering method in secondary battery (10-2003-0039571)		

Studiing literature (cont.)

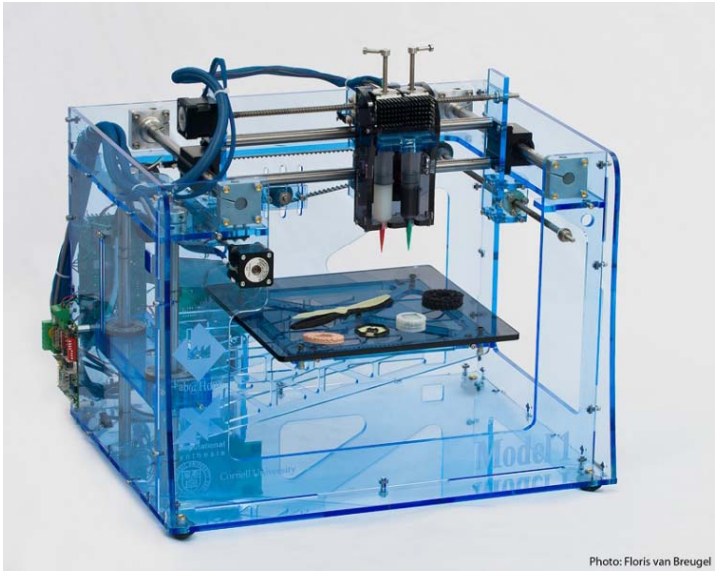
- **Patents: international**

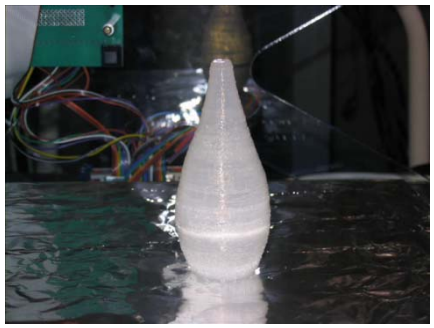
Thermal Fuse (US 6,911,892,B2)	
Fusible plug (WO 2006/ 057029)	 

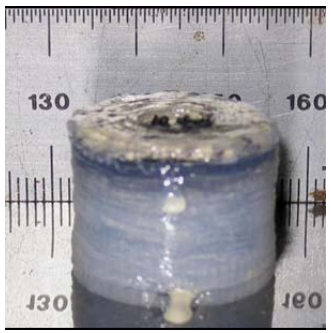
Studiing literature (cont.)



The concept of 3D printer



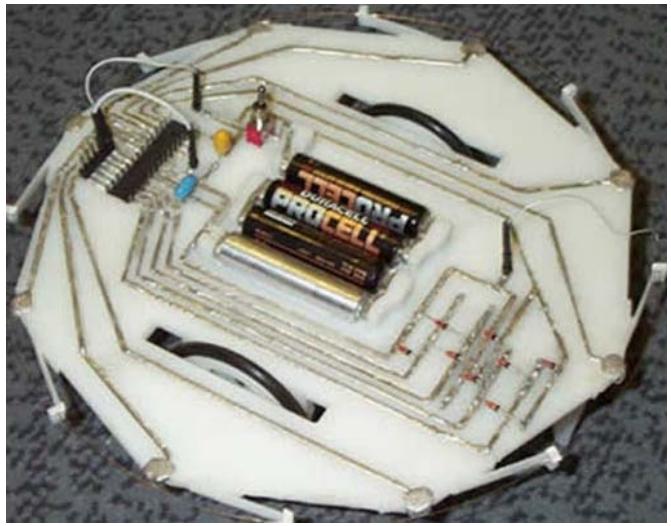




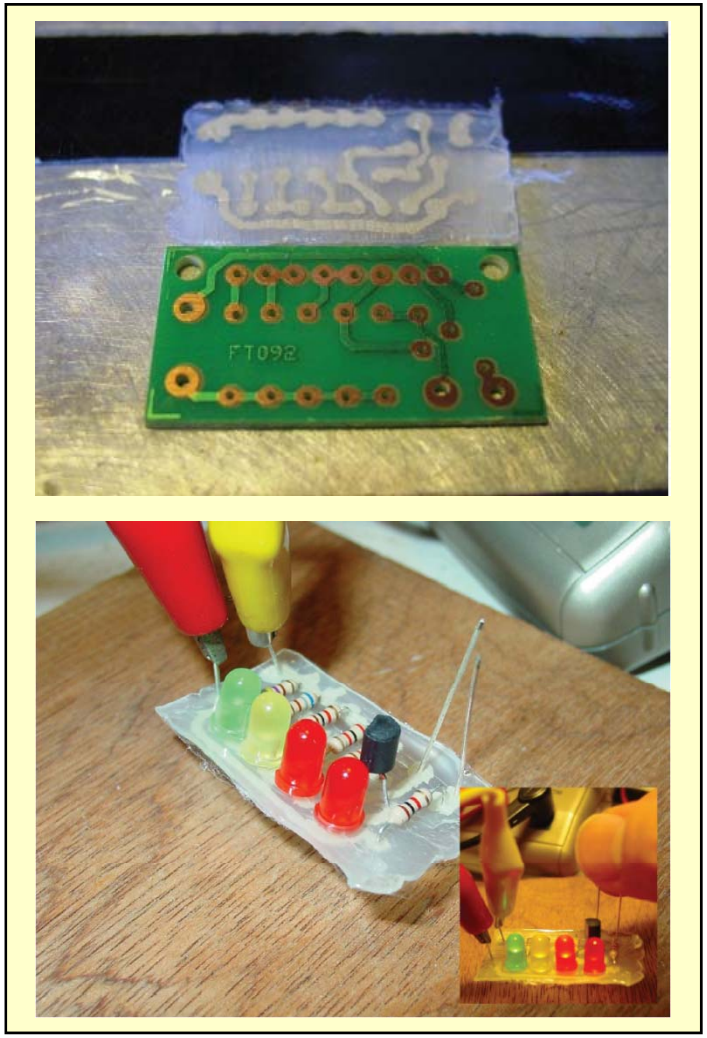
3D printer & stuffs

Ref.> Fab@Home

Studiing literature (cont.)

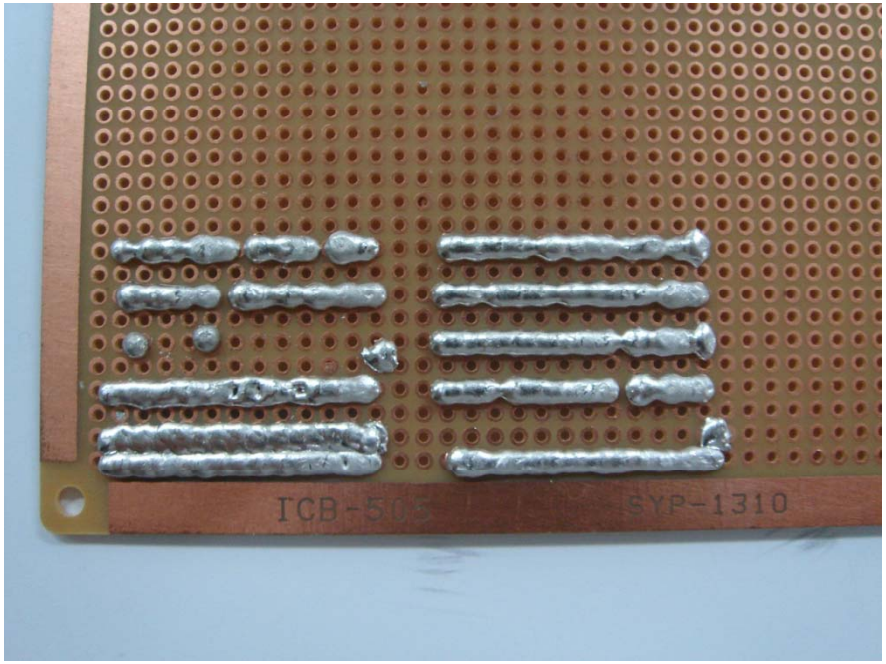


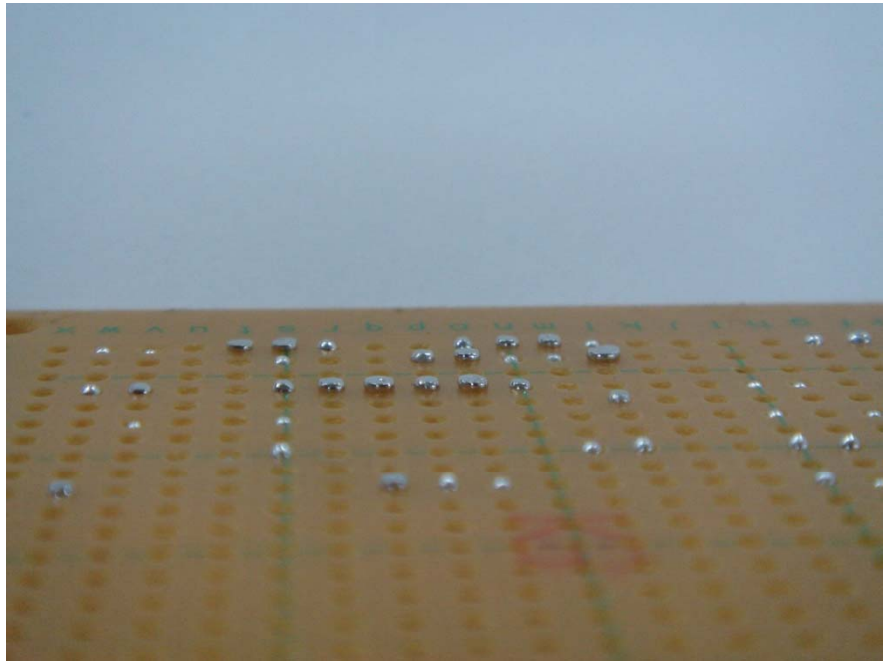
Printed circuit with fusible alloy
Ref.> http://reprap.org/bin/view/Main/AdrianBowyer



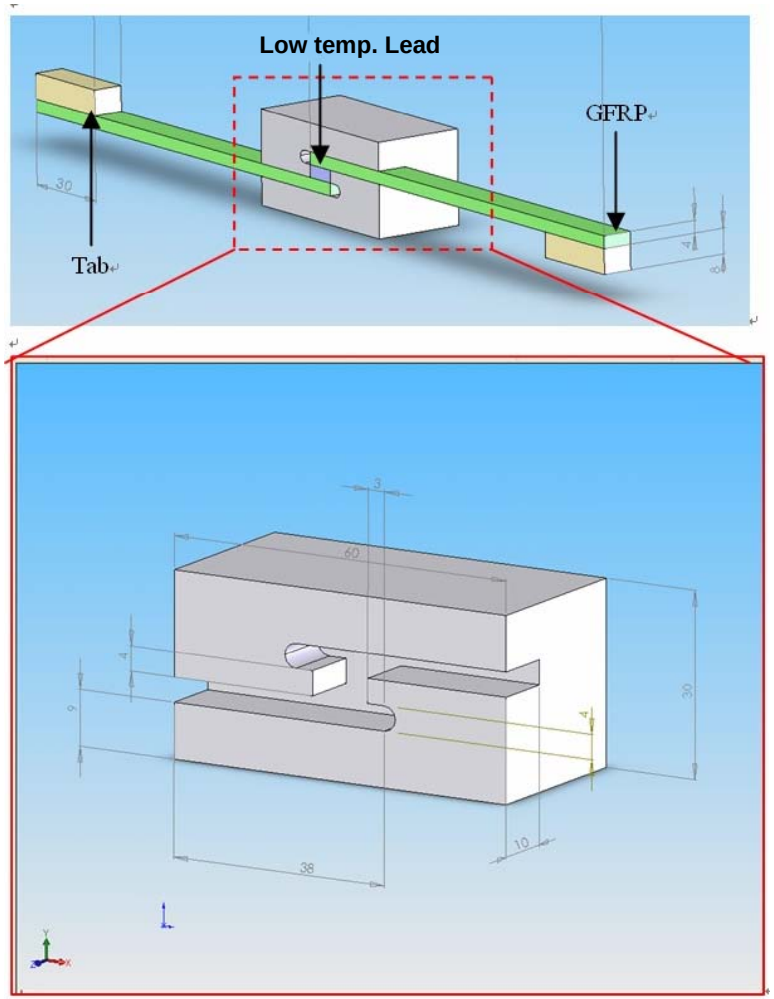
Construction of PCBs Using Sliver Paint and EVA Hot-Melt Glue
Ref.> diamond ace solution LTD.

Bonding Mechanism

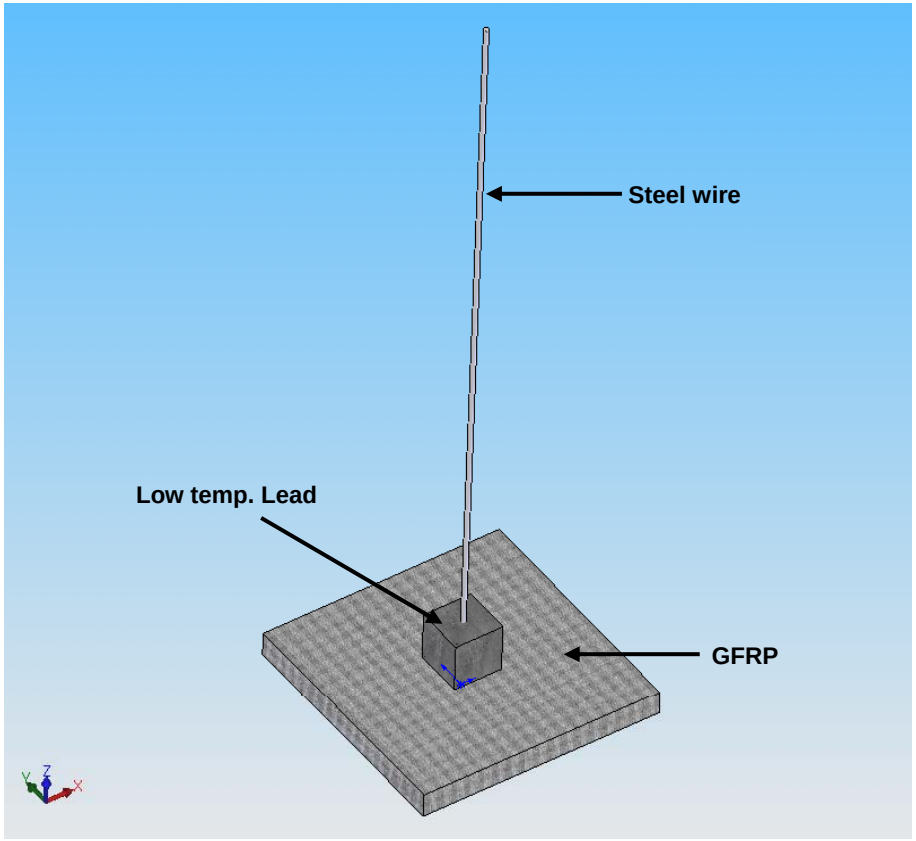




Bonding Test



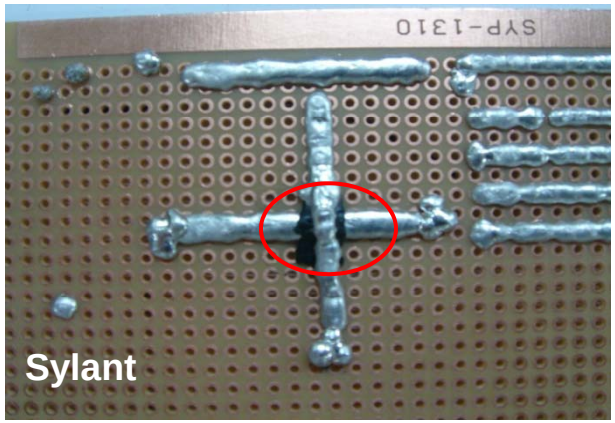
< Plan 1 >

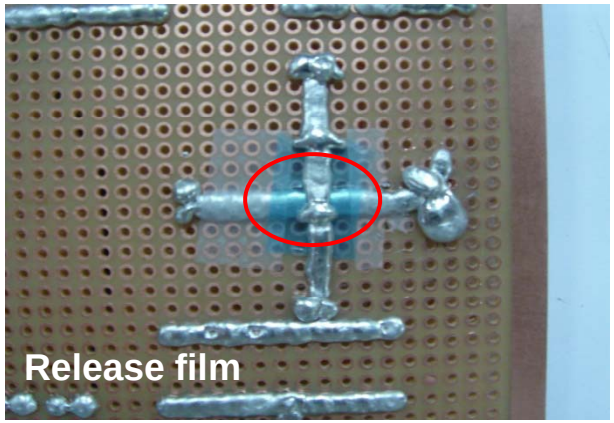


< Plan 2 >

Cross point checking

- **Cross point should be checked.**
  - A short is an accidental low-resistance connection between two nodes of an electrical circuit.
  - A short can cause circuit damage, overheating, fire or explosion
- **Requirements of insulation material**
  - **Don’t melt at 160℃**
  - **Good bonding with line**
  - **Insulation material : Sylant , Release film**

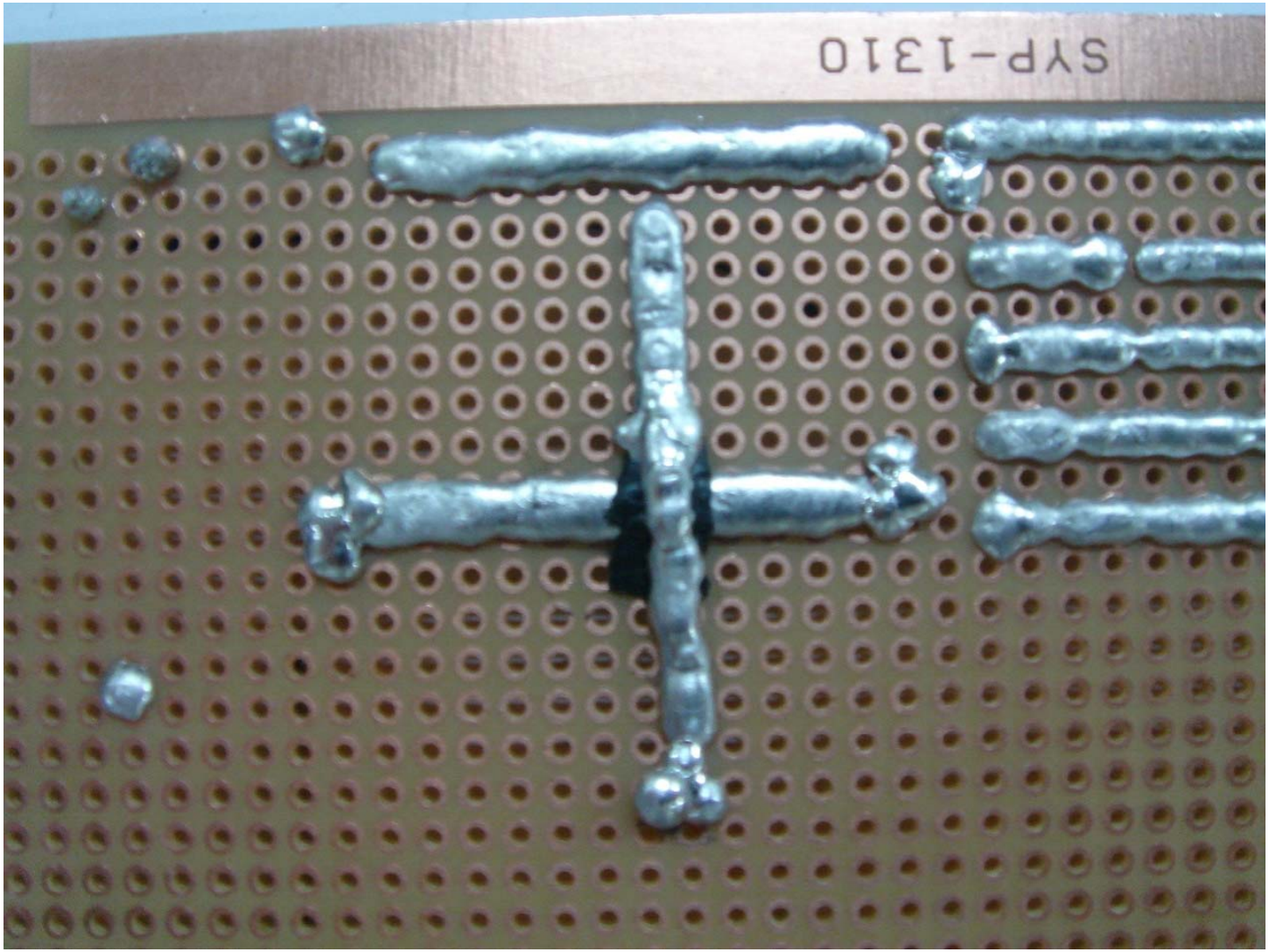




- **Each line have a good conductivity.**

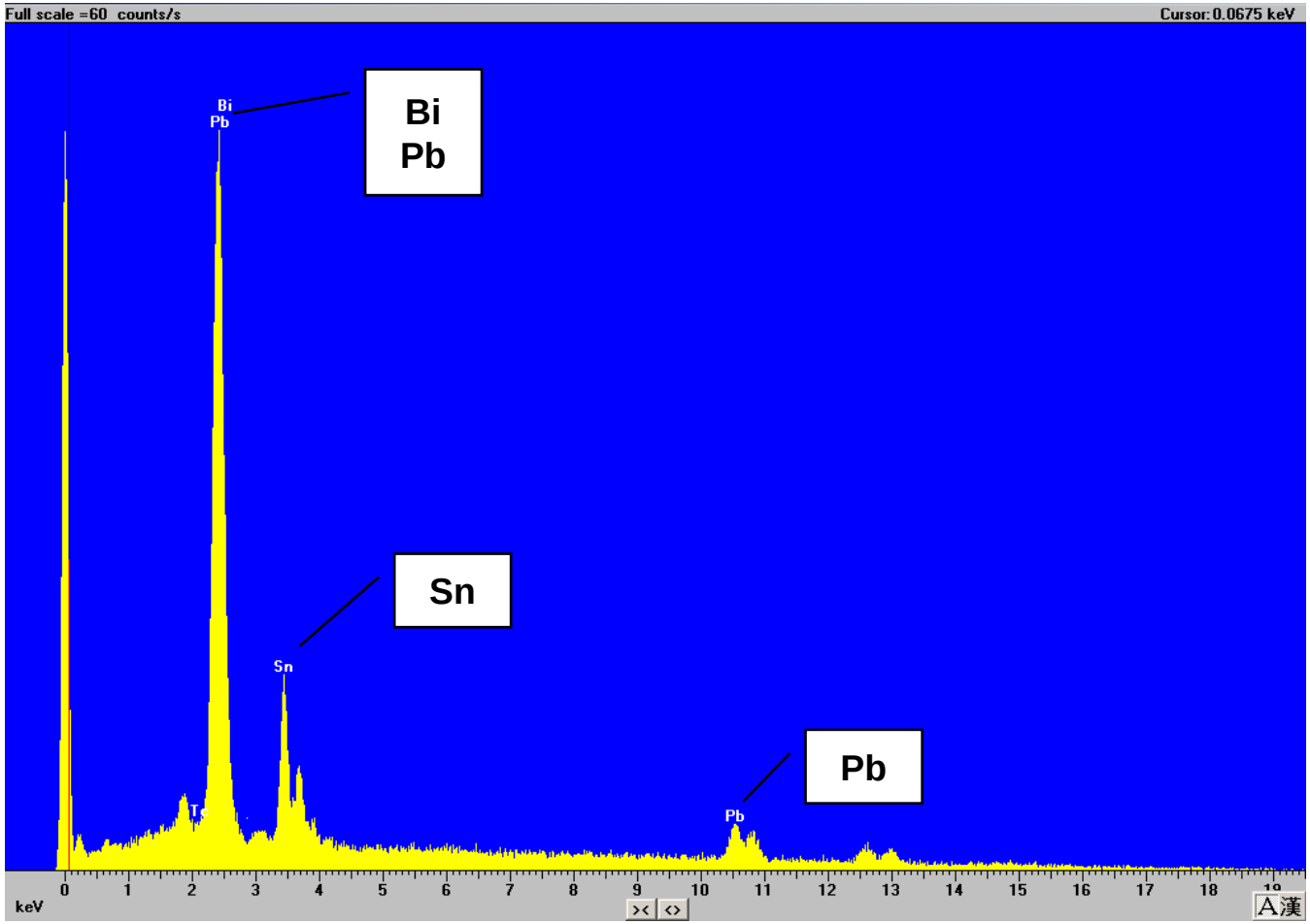
Ref>http://en.wikipedia.org/wiki/Short_circuit

Conductivity Test



Composition analysis

- Low melting point lead
- Melting temp. : 105℃



Cost analysis

- **Cost model**
  - The total cost of plate fabrication: $C_{total} = C_w + C_f$

Material cost	*Fabrication cost*
C_w	C_f
$C_w = V\rho C_{um}$	$C_f = WT_f$

***V*: material volume**
ρ: density
C_{um}: unit price of material

***W*: wage per hour**
T_f: preparation time (hour)

Item	Hand made		RP printing	
C_w (Material cost)	Perf board (₩3,100 /100mm×100mm) Element (₩5,000 /1set) Soldering lead(₩21,100 /1kg)	₩3,100 ₩5,000 ₩1,050	Perf board (₩1100 /50mm×50mm) Element (₩5,000 /set) Low temp. lead (₩35,000/1kg)	₩1,100 ₩5,000 ₩3,500
Subtotal		₩9,150		₩9,600
C_p (Preparation cost)	T_p, heating a small heart-shaped iron T_p, assembling elements T_m, Soldering wire and elements	5min 20 min 30min	T_p, heating RP machine T_p, assemble elements T_m, Printing on a perf board	10 min 5min 5min
	W	₩6,550 / hr	*W*	₩6,550 / hr
Subtotal		₩6,010		₩2,180
Total		***₩15,160 /ea***		***₩11,780 /ea***

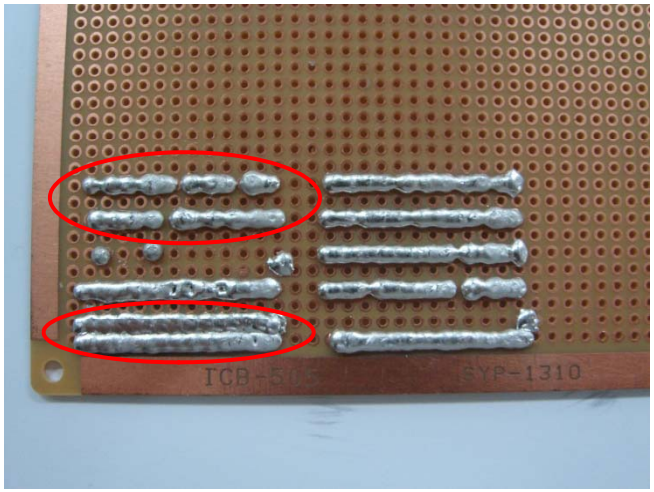
Cost analysis (cont.)

- **Cost estimation**
  - Per part cost of hand made and RP printing
    - Hand made circuit (₩15,160), RP printing (₩11,780)
  - Cost of RP printing
    - Mass production cost of 1,000 unit
      - Material cost: $C_w \times 1{,}000$
      - Preparation cost: assembling cost × 1,000 + printing cost × 1,000 + Heating cost
      - Per part cost: ***₩10,255***

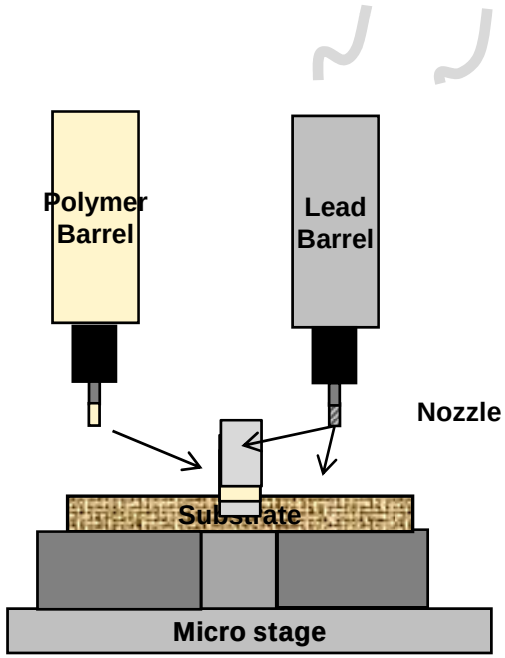
- **Assumption**
  - Labor cost : 6,550 won/hour
  - Market research : http://elparts.co.kr/
  - Depreciation cost : no considering

Future work

- **Improvement line shape**
  - Make more thin and beautiful line



- **Improvement insulation material and method**
  - **Sylant , Release film → Polymer**
  - **Attach by hands → Deposition**



- **Bonding test**

Thank you