
Innovate UK
Project Lead:
JIVA
ReCollect
Efficient Manufacturing of Recyclable Composite Laminates for Electrical Goods
COMMERCIAL IN CONFIDENCE


Project Summary

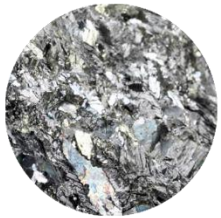
Problem

Waste PCBs

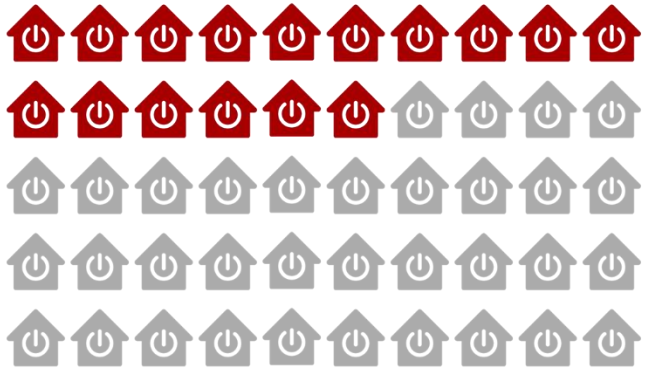
Components

Gold

Silver



Palladium



32%

of all e-waste consists of small domestic equipment

Source: The Global E-Waste Monitor 2020

Targets

- **Project Focus:**

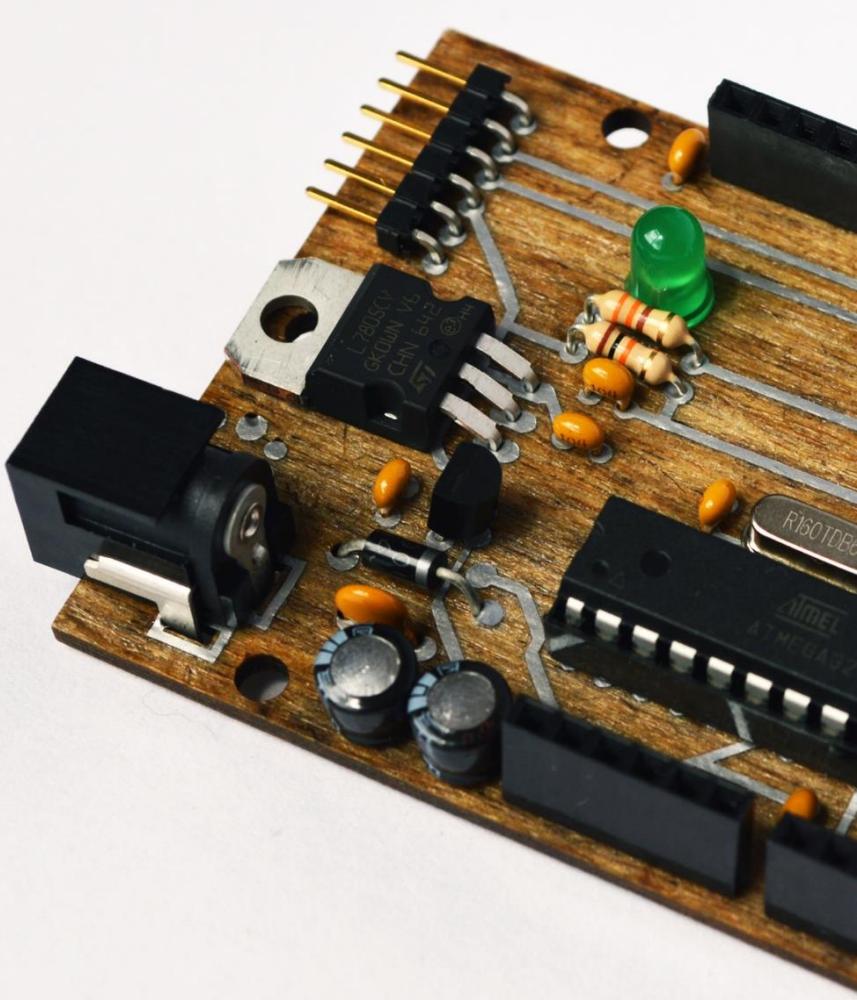
  To develop an alternative way of managing end-of-life circuit boards by removing difficult-to-recycle fibreglass + epoxy PCBs from the supply chain.

- **Primary Target:**

  To demonstrate the feasibility of producing a PCB substrate in high volumes with comparative performance levels to CEM-1 + FR-4 within the UK.

- **Secondary Target:**

  To ensure that the PCB substrate is compatible with existing aqueous processes of PCB fabrication i.e. etching + electroplating.



Partners

JIVA

- Jiva is leading the specification and development of the PCB substrate, as well as managing the conversion of the laminate into working circuit boards.

Coventive Composites

- Coventive Composites is focusing on the development of commercially-viable, scalable manufacturing processes for converting raw materials into substrates.

Institute of Circuit Technology

- The Institute of Circuit Technology (ICT) is supporting dissemination of project progress and stimulating wider UK industry feedback.

Soluboard®

International Patent: WO 2018/234801

Solution

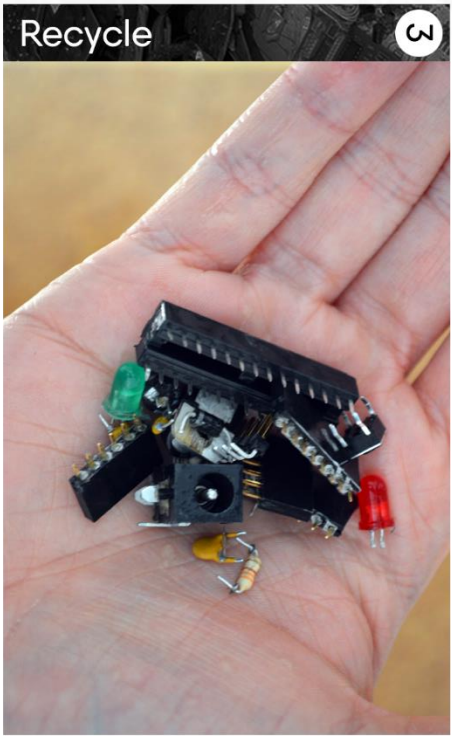
Dissolves in hot water

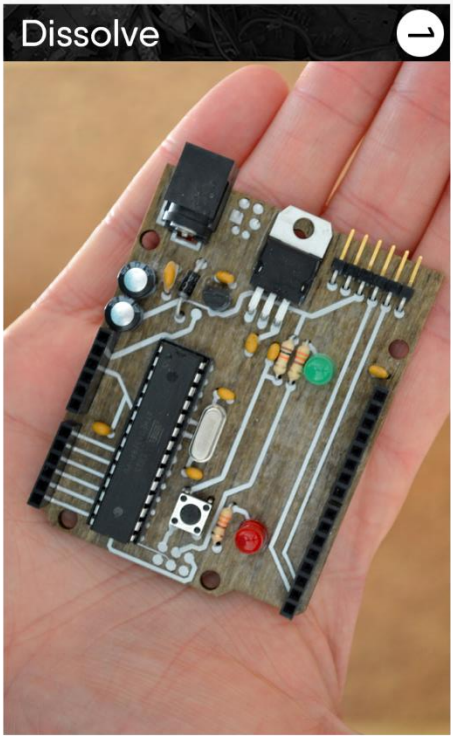
Recyclable components

Biodegradable + non-toxic

Comparable to market leaders

Recovery





Circular Economy

- Manufacture
- Product Use
- End of Life
- Collection
- Recycling

Target

A Soluboard® PCB has a

60%

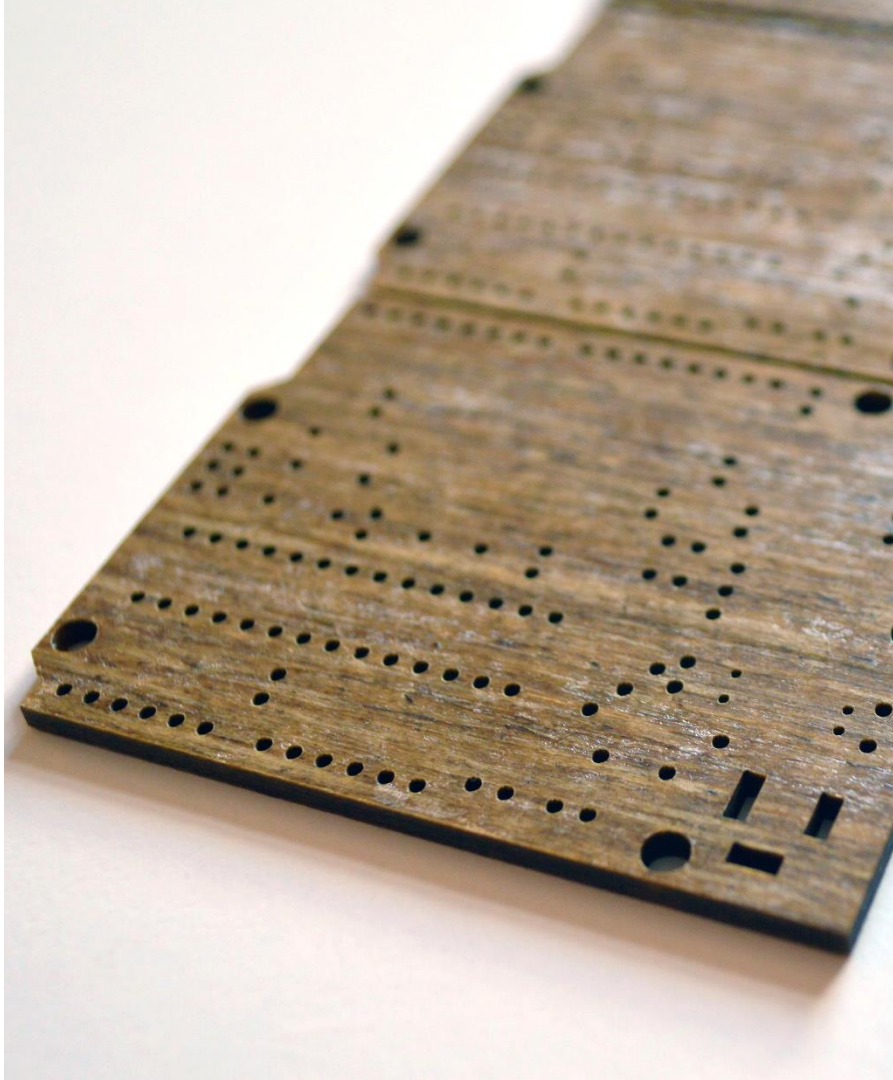
lower carbon footprint compared to an FR-4 PCB

Source: Environmental Resources Management 2020

Carbon Savings

- The carbon footprint of one square metre of Soluboard® is equivalent to **7.1 kg CO2e**.
- The carbon footprint of one square metre of standard FR-4 PCB is equivalent to **17.7 kgCO2e**.
- The total net saving is **10.51 kg CO2e** – this is a **60%** reduction in carbon footprint per square metre.
- The plastic saving per square metre of Soluboard® compared to FR-4 is equivalent to **620 g/m²**.

Source: Environmental Resources Management 2020



Traction

- Second place in Postcode Lotteries Green Challenge 2020.
- €200,000 prize secured and results aired on Dutch TV.
- Multiple enquiries received from potential customers in wide range of market segments.
- Prize money enables Jiva to:
  - ✓ Increase Speed of Development;
  - ✓ Increase Speed to Market;
  - ✓ Optimise Supply Chains;
  - ✓ Increase Working Capital.


Product Development

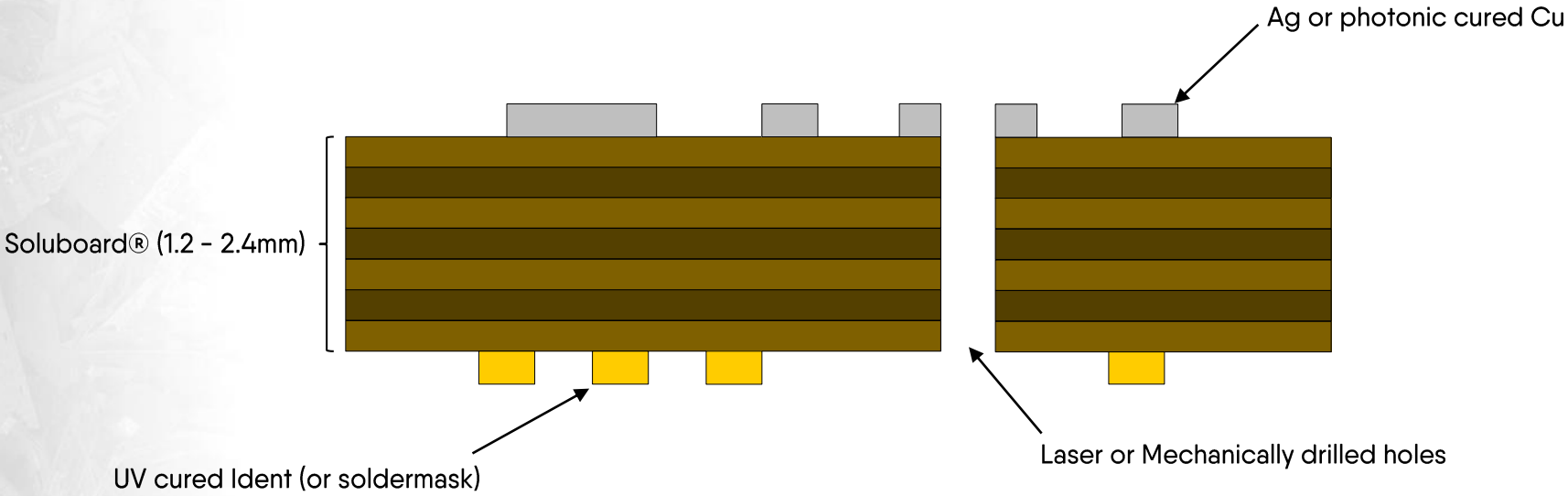
Hampshire Lab

Processing Area

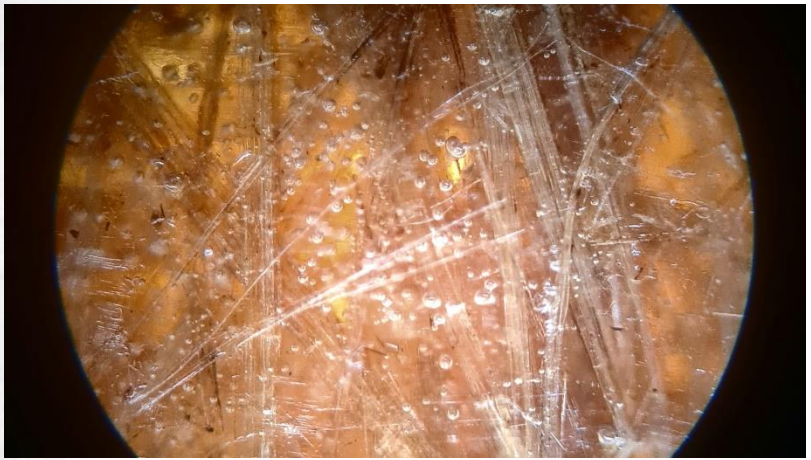
Lamination Area

Printed Electronics

- Single or double-sided printed - without side-to-side connectivity.
- Assembled using conductive silver epoxy – low temperature solder processing in development.



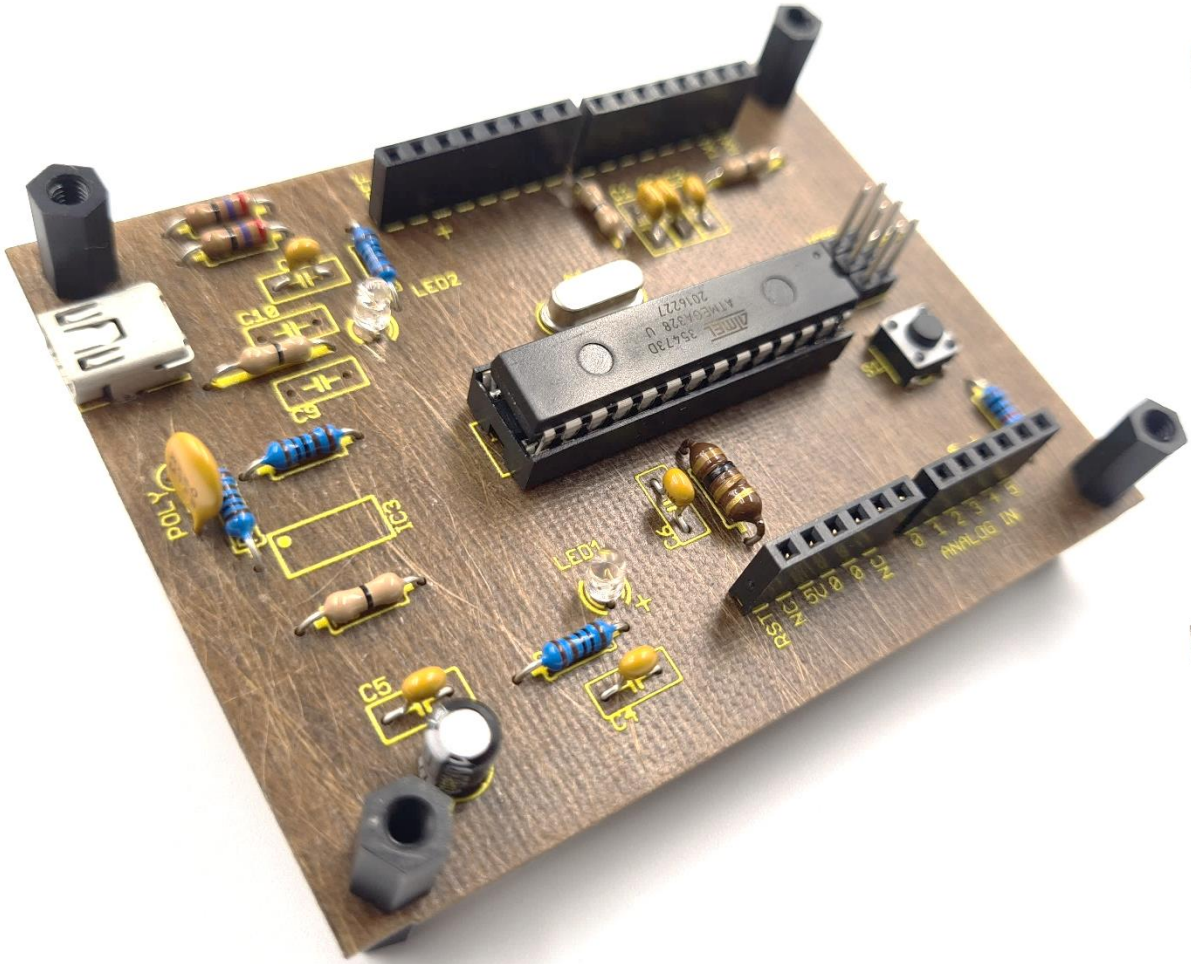
Printed Electronics

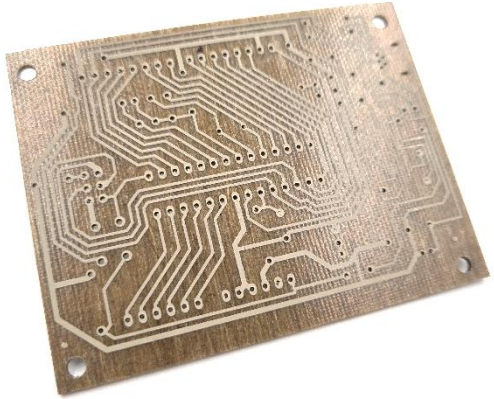


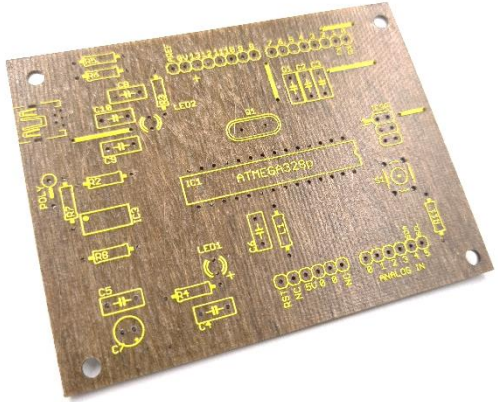
Stray fibres + polymer bubbles

Improved fibre orientation + minimal bubbles

Printed Electronics

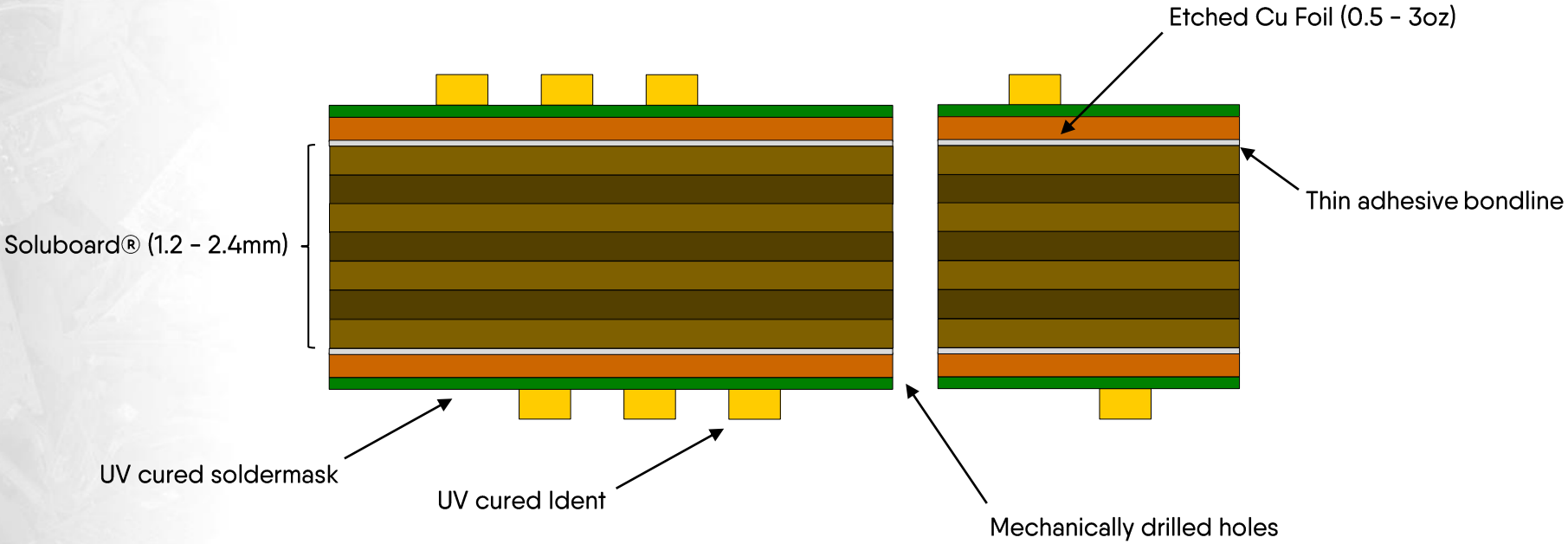






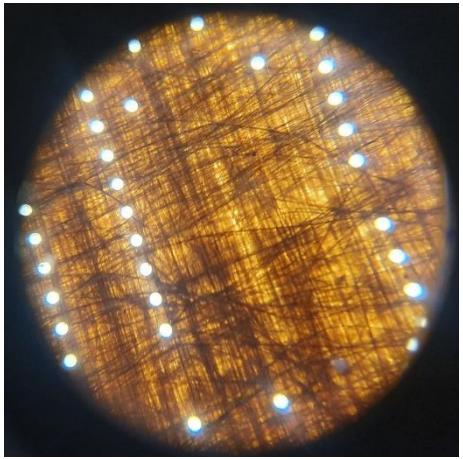
Copper Clad Laminate

- Single or double-sided - through-hole connectivity in development.
- Assembled using low-temperature solder or conductive silver epoxy.



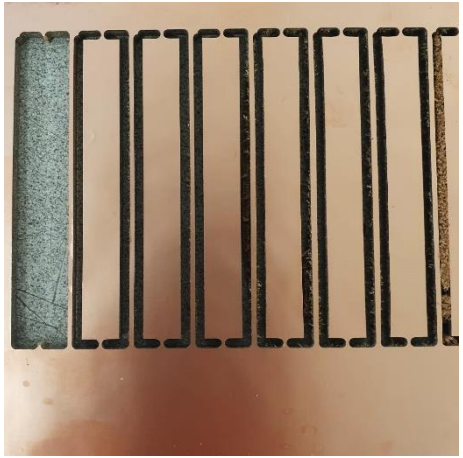
Drilling + Routing

Acceptable drill bit condition



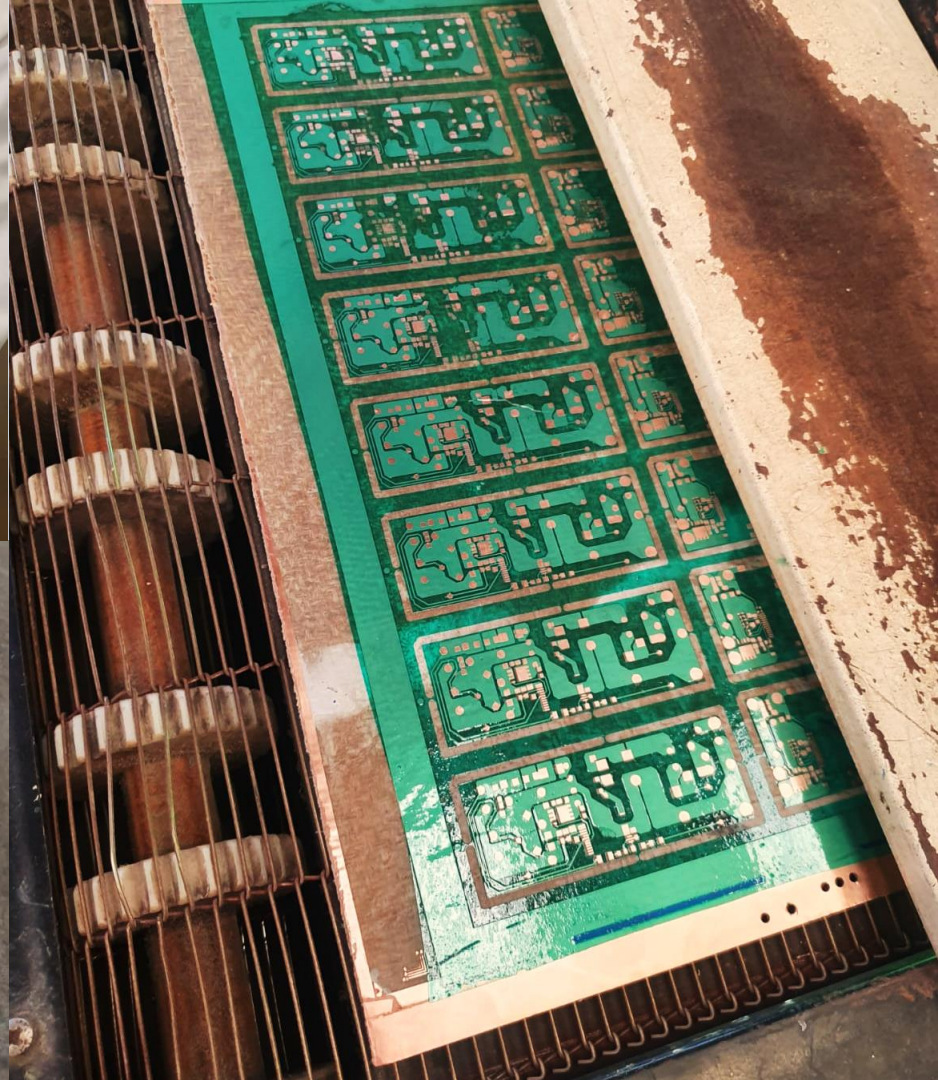
Clean drill holes

Drilled + routed substrate



Routed Copper Clad Laminate

Copper Clad Laminate



Key Progress

- Drilling + routing parameters established
  - enables integration into existing fabrication processes.
- Produced multiple Arduino prototypes using additive technology – surface topography is key.
- Etched the copper off the UV cured substrate
  - resistance to wet processes demonstrated.
- Printed UV cured soldermask + ident on the substrate
  - avoids elevated thermal excursion processes.
- Traction gained with white goods, LED lighting and computer peripherals industries.

Testing Data

Soluboard® Testing Data									
Specifications									
Test No.	Characteristic	Unit	Conditioning	Test Method	FR-4	Spec	CEM-1	Spec	Soluboard®
1	Volume Resistivity	Mohm-cm	C-96/35/90 (Time/Temp/RH)	2.5.17	5E8 - 5E9	> 5E6	4.60E+09	> 1E6	2.65E+06
2	Surface Resistivity	Mohm	C-96/35/90	2.5.17	5E6 - 5E7	> 1E5	4.20E+08	> 1E4	3.84E+04
3	Permittivity (1 MHz)	-	C-24/23/50	2.5.5.9	4.5 - 4.7	< 5.4	4.4	< 5.4	5.47
4	Permittivity (1 GHz)	-	C-24/23/50	2.5.5.9	4.0 - 4.2	-	-	-	4.13
5	Loss Tangent (1 MHz)	-	C-24/23/50	2.5.5.9	0.01 - 0.016	< 0.035	0.03	< 0.035	0.044
6	Loss Tangent (1 GHz)	-	C-24/23/50	2.5.5.9	0.01 - 0.016	-	-	-	0.047
7	Arc Resistance	SEC	D-48/50+D-0.5/23 (Time/Temp)	2.5.1	> 120	> 60	-	-	65
8	Dielectric Breakdown	KV	D-48/50	2.5.6	> 60	> 40	> 60	> 40	32
9	Moisture Absorption	%	D-48/50	2.6.2.1	0.05 - 0.10	< 0.35	< 0.15	< 0.5	
10	Flammability	-	D-48/50	UL94	94V0	94V0	94V0	94V0	94V0
11	Peel Strength (1 oz)	lb/in	288°Cx10" (Solder Floating)	2.4.8	8 to 12	> 6	11	> 6	
12	Thermal Stress	SEC	288°C (Dipping)	2.4.13.1	> 200	> 10	> 80	> 40	
13	Flexural Strength (LW)	N/mm²	A	2.4.4	480 - 550	> 415	300 - 400	> 242	142
14	Flexural Strength (CW)	N/mm²	A	2.4.4	415 - 480	> 345	200 - 300	> 172	96
15	Dimensional Stability (X-Y axis)	%	E-0.5/170 (Time/Temp)	2.4.39	0.005 - 0.030	< 0.05	< 0.065	0.11 (Max)	
16	Glass Transition Temperature	C	DSC	2.4.25	140 +/- 5	N/A	100	N/A	126
17	Z-axis (Before Tg)	ppm/C	TMA	2.4.24	50 - 70	N/A	-	-	
18	Z-axis (After Tg)	ppm/C	TMA	2.4.24	250 - 350	N/A	-	-	
19	Punchability	kg/cm²	ASTM D-732 (Shear Strength)	ASTM D-732	-	-	900	N/A	227
20	Comparative Tracking Index	V	C-96/20/65	ASTM D-3638	600	PLC 0 (> 600)	> 600	N/A	PLC 0 (600V)
C= Humidity Conditioning; D= Immersion Conditioning in Distilled Water; E= Temperature Conditioning									

* All remaining tests to be completed by end of Q3 2021

Testing & Progress

- Q3 2021: Processing Guidelines completed.

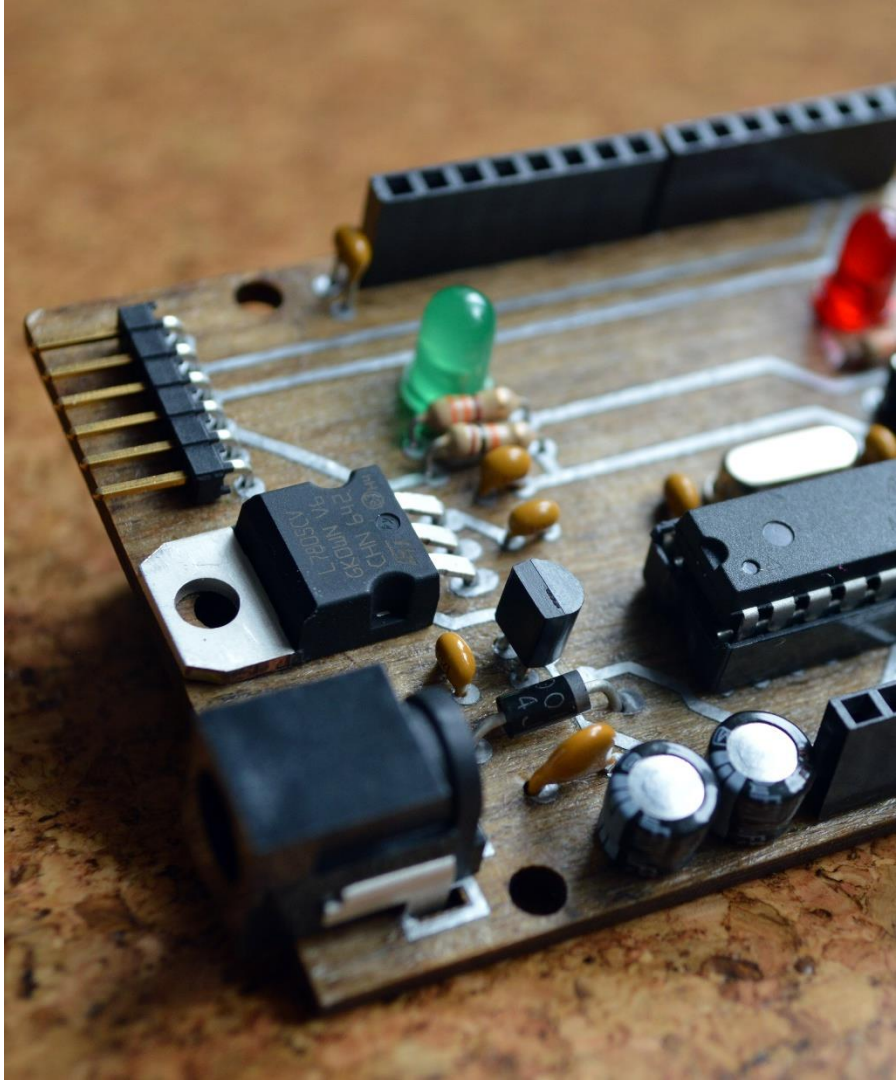
  Testing + preparation of MSDS completed.

- Q4 2021: Submission for UL approval + reliability testing.

Highlights:

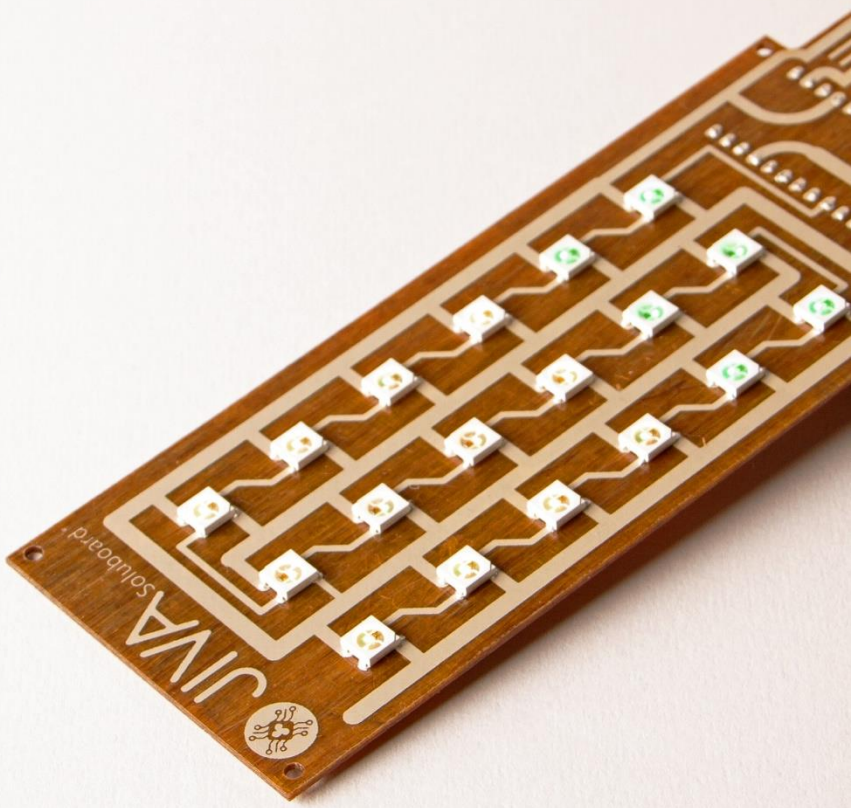
- Flame retardance in-line with UL 94 V0 rating.
- Mechanical properties comparable to CEM-1.
- Electrical properties comparable to CEM-1 + FR-4:

  CTI PLC 0 @ 600 V



Next Steps

- Continue development of woven jute variation of the substrate to minimise laminate layup.
- Maintain high quality surface finish to achieve process compatibility with woven substrate variation.
- Optimise v-scoring parameters on the substrate to increase production capacity.
- Identify surface mount technology (SMT) only PCBs for printed electronics prototyping.
- Generate a set of Processing Guidelines to enable the substrate to be processed by OEMs.



THANK YOU

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