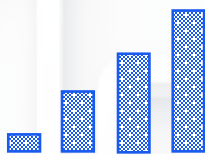


Digital vs. Screen Printing: Advantages



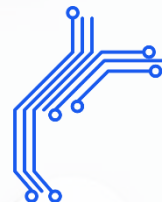
Cost Saving

Better electrical properties,
less manual labor.



Variable Thicknesses

In any given pattern,
same layer/sheet.



Thin Metal Features

as low as $0.8\ \mu\text{m}$ (x7 thinner
than with screen printing).



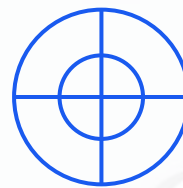
Dense Electronics

Narrow patterns: width & pitch
 $70\ \mu\text{m}$ (inkjet), $20\ \mu\text{m}$ (airbrush).



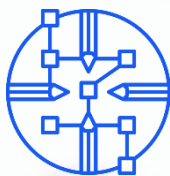
No Substrate Contact

Print on thin, flexible
rough & brittle materials.



Superior Accuracy

Maximum $\pm 5\ \mu\text{m}$,
Average $\pm 2.1\ \mu\text{m}$.



Quick Digital Set-up

No masks, screens, no
maintenance, easy to
implement designs.



Embedded Components

Print passive components,
multi-materials support.



Print on Inner Layers

Metal print & fill vias (2-
sides electronics).



Non-Flat Substrates

For example: print
antennas on phone covers,
wearable devices, etc.



Low Sintering Temperature

Down to 130°C .
Resistivity $< 10\ \mu\Omega\text{cm}$.
IR, NIR, laser and photonic
sintering compatible.



Higher Yield

Print more patterns with
variable designs.

Digital vs. Screen Printing: Cost Calculation

Property	Total Cost		
	Screen Printer	DemonJet*	Mass Inkjet Printer**
Throughput loss due to set up time, %	10%	2%	2%
Actual throughput [substrates per year]	134,028	10,424	145,942
Equipment depreciation [\$/year]	\$100,000	\$14,000	\$240,000
Labor cost***			
Ink/Paste cost	\$2,014,500	\$112,500	\$1,504,500
Screen cost or print heads	\$31,025	\$3,000	\$15,000
Total [\$/year]	\$2,145,525	\$129,500	\$1,759,500
Total [\$/print]	\$16.0	\$12.4	\$12.1

* [DemonJet spec sheet](#)

** Based on 3 mass production printers.

*** Labor cost is country dependent and significantly higher in screen printing where manual labor is more necessary.

Data and Assumptions

Printing Equipment, Per One Printer				Throughput Per Printer		
	Screen Printer	DemonJet	Mass Inkjet Printer	Shifts per day	1	
Equipment price [\$]	\$500,000	\$70,000	\$400,000	DemonJet	14	minutes per stage
Depreciation time [years]	5	5	5	MPIP	3	
				Screen Printing	1	
Ink/Paste Consumption						
Kg/year	4,029	75	334			
Gram/substrate	25.7	6.9	6.6			

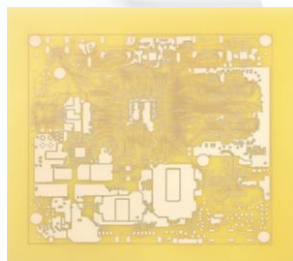
Printed Area		
% Printed (coverage)	40	%
Substrate size		
Mass Inkjet Printer [inches]	21	19
DemonJet Inkjet Printer [inches]	16.8	25
Screen Printing [inches]	21	19

Sicrys™ Inkjet Silver Ink		
Ink resistivity	10	μΩcm
Thickness	4	μm
Ink price	1500	\$/kg
Silver in ink	50	%
Pattern density	8	g/ml
Ink yield	98	%
Shelf life	> 12	months
Sintering conditions*	130°/60 min	

Silver Paste*		
Paste resistivity	62.5	μΩcm
Thickness	25	μm
Paste price	500	\$/kg
Silver in paste	85	%
Pattern density	8.5	g/ml
Paste yield	95	%
Shelf life	6 (cooling)	months
Sintering conditions	130°/30 min	Drying required

* **Lead-Ink:** https://www.alibaba.com/product-detail/Printing-Silver-Paste-for-Touch-Screen_2007842390.html?spm=a2700.7735675.normalList.4.dnqane&s=p50%20m%E2%84%A6/q;%2012.5%20C2%B5m%20thick

Examples of Digital Printed Electronics



Inkjet Printed on FR4
Resistivity <math>< 10 \mu\Omega\text{cm}</math>, Thickness 10 μm . Maximum board size: 20" x 20". 20 boards/hour.



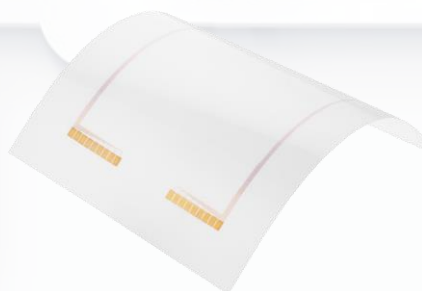
Solar Cell
Inkjet printed fingers on silicon crystalline solar cell. Minimum linewidth 50 μm . Resistivity <math>< 3 \mu\Omega\text{cm}</math>.



Four-layers PCB
Inner layers are inkjet printed. Resistivity <math>< 6 \mu\Omega\text{cm}</math>, Thickness 20 μm .



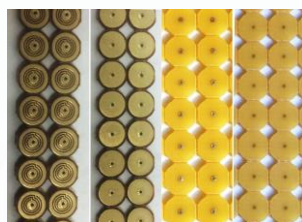
Flexible Heater (Kapton®)
Linewidth 150 μm . Thickness 2 μm .



Flexible Touchscreen
Inkjet printed on PET.



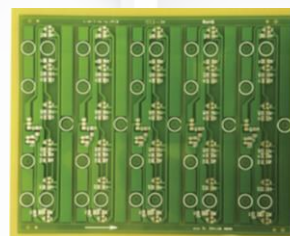
Flexible Print on Paper
Medical application. Resistance <math>< 20\Omega / 100\text{mm}</math> Throughput > 100 samples / hour.



Print in Vias
Enabling conductive patterns on both sides, in and around 3D vias.



Phone Antenna
Printed on 3D surface using Aerosol technology. Resistivity <math>< 12 \mu\Omega\text{cm}</math>.



1-Layer PCB
Printing 3 types of inks: metal, solder mask & legends on one board.



Touchscreens
Inkjet printed on Glass.



Automotive Electronics
Demisters, antennas, etc. Bus Bars Resistivity: 1.5 $\text{m}\Omega/\square$. Fine Lines Width <math>< 0.6 \text{ mm}</math>.



18 Turns Coil
Dense coil pattern. Linewidth 70 μm . Pitch 70 μm .