

PCB Prototyping

Target: 5 iterations with 2 PCBs each, 16mil width/spacing, single layer

Type	Fix Costs	Iteration		Total		1x Stencil	Solderable	Reflow	Reference
		Costs	Duration	Costs	Duration				
toner+silver adhesive	20,00 €	0,50 €	00:10:00	22,50 €	00:50:00	no	no	yes	https://www.youtube.com/watch?v=mwwA1d2s2OQ https://en.wikipedia.org/wiki/Flexible_electronics
manufacturer	0,00 €	5,00 €	1680:00:00	25,00 €	8400:00:00	16,00 €	yes	yes	https://www.smart-prototyping.com/PCB-Prototyping.html
toner+etching	20,00 €	10,00 €	01:00:00	70,00 €	05:00:00	no	yes	yes	https://www.mikrocontroller.net/articles/Platinenherstellung_mit_der_Tonertransfermethode https://www.youtube.com/watch?v=HB1xvwZ_0og https://www.instructables.com/id/Modification-of-the-Lexmark-E260-Laser-Printer-for/ https://github.com/fruchti/haxmark
pen+etching	100,00 €	10,00 €	01:00:00	150,00 €	05:00:00	no	yes	yes	https://www.youtube.com/watch?v=oPVc9ixj0iU
inkjet with graphene ink	260,00 €	0,50 €	00:01:00	262,50 €	00:05:00	no	no	yes	https://www.instructables.com/id/Print-Conductive-Circuits-With-An-Inkjet-Printer/ https://cambridgenanosystems.com/product/camink-sp/ https://www.youtube.com/watch?v=W_ouYLeIkoo
standard 3D printer	300,00 €	5,00 €	04:00:00	325,00 €	20:00:00	5,00 €	no	no	https://www.blackmagic3d.com/Conductive-p/grphn-pla.htm
laser+etching	300,00 €	10,00 €	01:00:00	350,00 €	05:00:00	2,00 €	yes	yes	https://www.youtube.com/watch?v=1hFNj86L7sk https://www.youtube.com/watch?v=ZzO9skEYqwY
laser+curing	300,00 €	10,00 €	01:00:00	350,00 €	05:00:00	3,00 €	yes	yes	https://www.youtube.com/watch?v=Z228xymQYho
inkjet with silver nano particle ink	350,00 €	0,50 €	00:01:00	352,50 €	00:05:00	no	no	yes	https://www.instructables.com/id/Print-Conductive-Circuits-With-An-Inkjet-Printer/ http://diamond-jet.com/silvernanoinkjetsystem.aspx
laser cutter (15W blue laser)	400,00 €	5,00 €	00:30:00	425,00 €	02:30:00	5,00 €	yes	yes	https://de.aliexpress.com/item/Assembled-15W-laser-15000MW-diy-laser-engraving-machine
CNC mill for PCB	1.600,00 €	5,00 €	01:00:00	1.625,00 €	05:00:00	5,00 €	yes	yes	https://www.zippyrobotics.com/
special 3D printer	3.000,00 €	20,00 €	01:00:00	3.100,00 €	05:00:00	unneeded	yes	included	https://www.voltera.io/store/
laser cutter (50W fiber laser)	6.000,00 €	5,00 €	00:30:00	6.025,00 €	02:30:00	5,00 €	yes	yes	https://de.aliexpress.com/item/Raycus-IPG-faserlaser-50-Watt-laserbeschriftungsanlage-faser

Etching Techniques

CuCl can be recycled by electrolysis

Type	Chemicals	Reference
Standard	FeCl ₃	https://www.youtube.com/watch?v=tWnfnt2rNO0
Standard	Na ₂ S ₂ O ₈	https://www.youtube.com/watch?v=fCUWmfDF_ho
Standard	MnO ₂ , HCl	https://www.youtube.com/watch?v=qE-PBOXzpbQ
Sponge	FeCl ₃	https://www.youtube.com/watch?v=M0Gy8ISjvhE
Electrolysis	H ₂ O, NaCl	https://www.youtube.com/watch?v=L4KyRhFN4qU https://www.youtube.com/watch?v=ANwnmT1PLH8