	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
copper	low toxicity as a metal. however, toxic in oxidized form.	Toxic effluents (waste water) during chemical etching processes	can act as a precursor for the formation of dioxines if it is burnt together with PVC (plastic in el. insulation) in open fires (during recycling). Toxic effluents (waste water) during chemical etching processes (backyard recycling)	not so scarce, but nevertheless considered critical (large scale supply could become a problem in future)	
Silver	none toxic and good biocompatible.			yes	acts as a driver for backyard recycling
Steel	none toxic and good biocompatible, Nickel-alloys might cause allergic skin irritation			no	

	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
Nickel	can cause allergic skin irritation			yes (moderately)	
Gold	none toxic and good biocompatible	Gold mining causes wide-spread deforestation and biodiversity loss, river pollution with mercury and cyanides, health impacts and social disruption to indigenous people.	The recovery of gold is often based on the use of hazardous substances (acids, mercury, cyanides) and entails hazardous emissions	yes, but scarcity is more related to financial specu-lation	Gold acts as a driver for backyard recycling in developing countries.
Carbon Graphite	none toxic and good biocompatible			no	

	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
Amorphous carbon	Amorphous carbon (soot, carbon black) can cause health impacts if released in form of dust			no	
Carbon Nanotubes	Carbon Nanotubes (CNT) have to be treated with precaution - their toxicity is still matter of research. There are warnings for adverse health and environmental impacts of free CNT.	The synthesis process is quite energy intensive	liberation of CNT from products during recycling (e.g. shredding, open burning) can cause health hazards if the CNT are released in form of dust	no	CNT are often expected to be a future replacement materials for scarce elements such as Indium. CNT may even substitute silicon based electronics in future. The environmental / safety implications of this innovation are uncertain
Indium Tin Oxide	none toxic and good biocompatible		Indium Tin Oxide (ITO) is hardly recyclable thus far	yes (Indium is highly critical -> mid term supply shortages and rapidly growing demand)	

	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
PEDOT	(3,4-ethylenedioxythio-phene)			not related to resource scarcity but maybe limits in industrial supply	

Key words:

Backyard recycling

informal recycling businesses in developing countries, usally a very dirty undertaking:
open burning of e-waste, leaching precious metals wit acids etc.

RoHS

EU Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
restricts the use of the following six substances in electrical goods:

- Lead (Pb)
- Mercury (Hg)
- Cadmium (Cd)
- Hexavalent chromium (Cr6+)
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ether (PBDE)

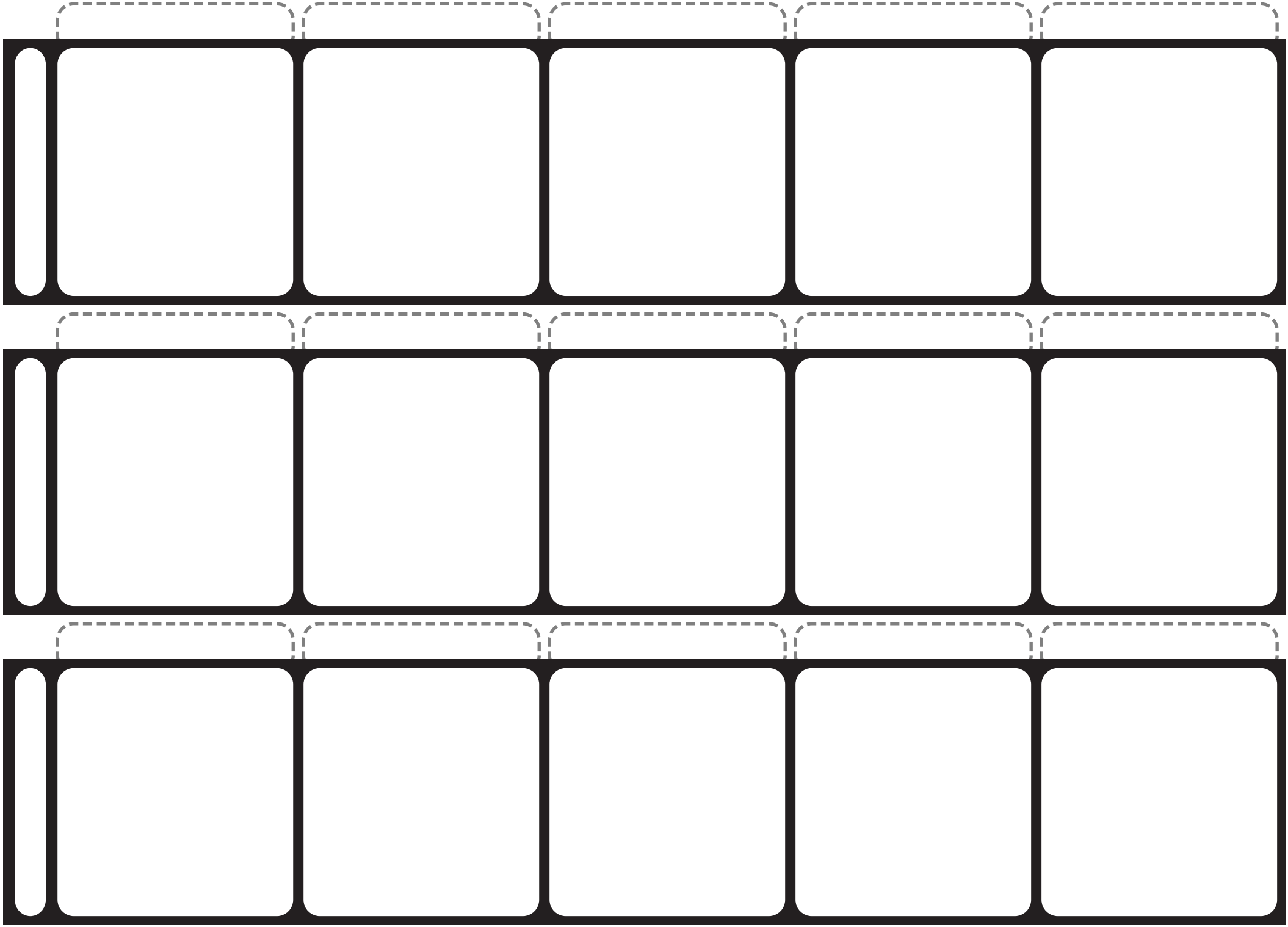
	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
alkaline battery	most common primary battery. Not particular toxic or resource relevant		waste problem due to large amounts		
zinc–carbon batteries	zinc is a heavy metal and moderately toxic but it is used widespreadly anyhow				
rechargeable nickel cadmium (NiCd)	Cadmium is toxic (now prohibited) These batteries will disappear from the market				

	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
rechargeable nickel metal hydride (NiMH)	May have only a niche market because lower performance as LI-ion		waste problem due to large amounts		
rechargeable lithium ion (Li-ion)	zinc is a heavy metal and moderately toxic but it is used widespreadly anyhow			Lithium is scarce but recycling is technically problematic, more interest-ing for recycling is the content of cobalt	
rechargeable lithium ion polymer	Cadmium is toxic (now prohibited) These batteries will disappear from the market			Lithium is scarce but recycling is technically problematic, more interest-ing for recycling is the content of cobalt	

	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
solar cell	depends of the type of PV. Organic thin film PV seem to be no problem		it adds to the general problem of plastic foil disposal, especially when they become mass products (they may float in the ocean of for an eternity along with all other types of plastic)		

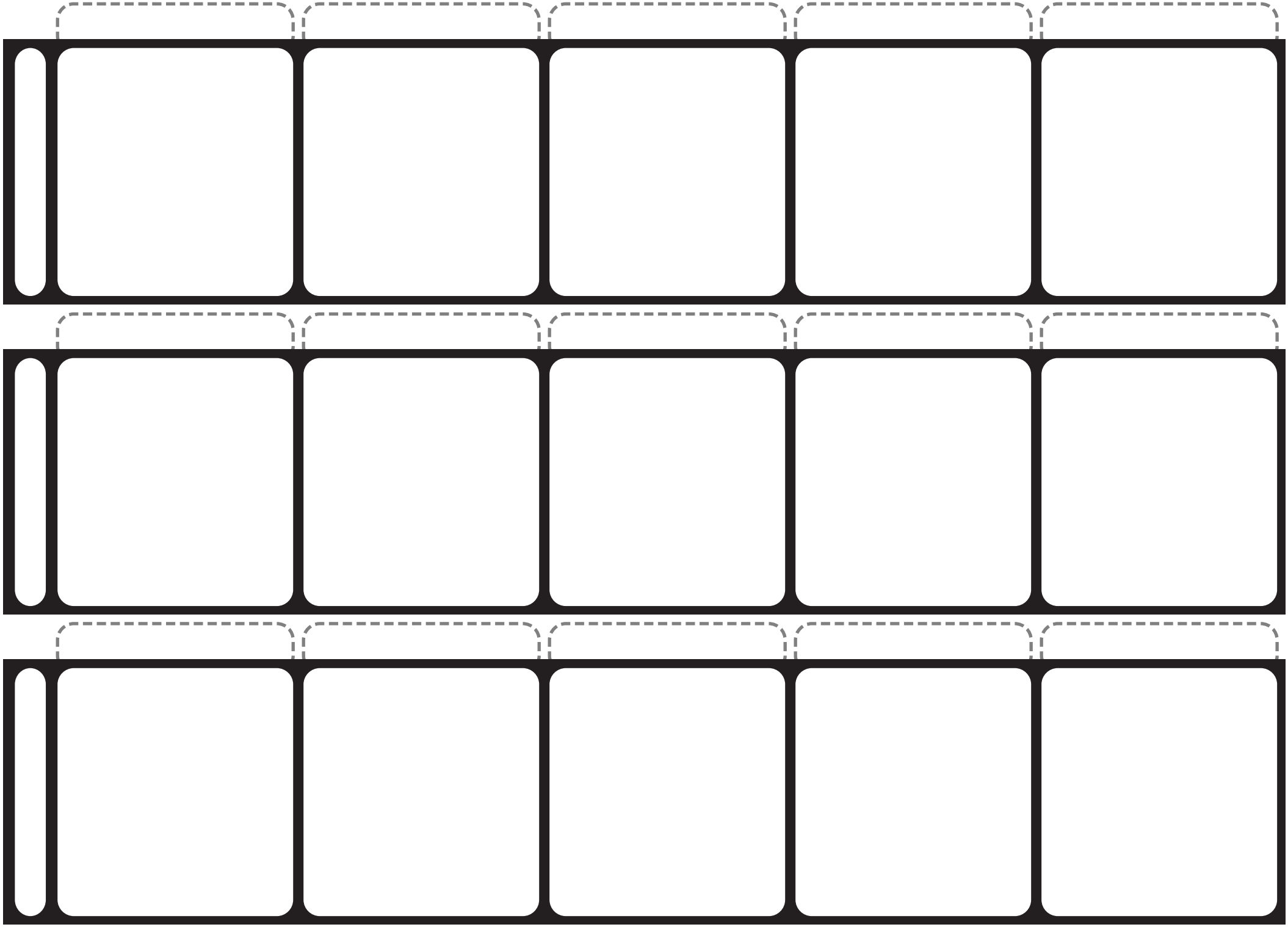
	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
resistor	mostly ceramic (not toxic) New types of flexible passive components might be used for smart textiles (e.g. carbon based)		Electronic packaging contains epoxy resins, plastic softeners, stabilizers, adhesives etc... These materials are not extremely toxic but can act as contaminants if they enter the wrong material fraction in recycling.	solders contain tin, antimony, bismuth silver (all metals are more or less critical)	
capacitor				In case of Tantalum capacitors: highly critical	
LED				GaAs (Gallium is scarce, Arsenic is toxic) But very small amounts per LED	

	material toxicity	toxicity in production process	toxicity in recycling process	scarcity	other impact
Circuitry	Lead in solders is forbidden in Europe but still on the market in some countries etc..		Electronic packaging contains epoxy resins, plastic softeners, stabilizers, adhesives etc... These materials are not extremely toxic but can act as contaminants if they enter the wrong material fraction in recycling.	solders contain tin, antimony, bismuth silver (all metals are more or less critical)	
PWB (printed wiring boards)			can contain brominated flame retardants (act as precursor of dioxin formation is burnt in open fire)		
flexible PWB			they usually consist of aramide or silicon elastomers - these are not toxic materials. But little is known on their composition and additives in them		



	material characteristic	environmental impacts in production process	environmental impacts in recycling process	scarcity	other impact
Cotton	- It is soft and comfortable. - It wrinkles easily - It absorbs perspiration quickly. - It has good colour retention and is good to print on. - Cotton is also strong and durable.	environmental impacts of cotton farming (soil erosion, fresh water depletion, salinisation, etc.) depend on the country of origin. Increasing use of genetically modified cotton. Processing of cotton (bleaching, dying, etc.) causes environmental pollution		there are increasing supply shortages to be expected in future due to demand increase	
Wool	- It is hard wearing and absorbs moisture. - It does not burn over a flame but smoulders instead. - It is lightweight and versatile. - Wool does not wrinkle easily. - It is resistant to dirt and wear and tear				
Nylon	- It is strong and elastic. - It is easy to launder. - It dries quickly. - It retains its shape. - It is resilient and responsive to heat setting.			could be affected by the Peak-oil problem because made from mineral oil	

	material characteristic	environmental impacts in production process	environmental impacts in recycling process	scarcity	other impact
Polyester	- It is resists wrinkling. - It is easy to launder. - It dries quickly. - It is resistant to stretching and shrinking			there are increasing supply shortages to be expected in future due to demand increase	
Viscose	- It is hard wearing and absorbs moisture. - It does not burn over a flame but smoulders instead. - It is lightweight and versatile. - Wool does not wrinkle easily. - It is resistant to dirt and wear and tear				
Silk	- It is versatile and very comfortable. - It absorbs moisture. - It is cool to wear in the summer yet warm to wear in winter. - It can be easily dyed. - It retains its shape and is relatively smooth. - It has a poor resistance to sunlight exposure. - It is the strongest natural fiber and is lustrous.				



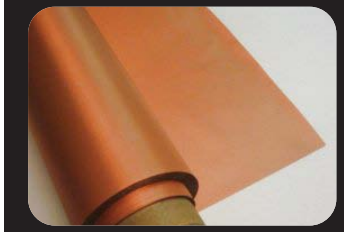
Plasma plating	highly energy intensive process
Chemical plating	state of the art with usual environmental impacts (chemical use, water pollution, corrosive exhausts, etc)
Weaving	more energy intensive the lower dtex
gluing, laminating	some adhesives can contain problematic substances, such as organic solvents, peroxides etc Glued components are difficult to disassamble.
Spinning	

Knitting	energy consumption (but lower than weaving)
dying natural fiber	chemical use, water pollution, corrosive exhausts - Lower than synthetic fiber dyeing
dying synthetic fiber	chemical use, water pollution, corrosive exhausts - Higher than natural fiber dyeing
dying synthetic fiber	chemical use, water pollution, corrosive exhausts - Higher than natural fiber dyeing

Stretch Conductive Fabric

Spec
Surface resistivity: <0.5 Ohm/sq. (unstretched)
characteristics
high conductivity, stretches in both directions.
active component
Silver
method
plated
textile material
76% Nylon 24% elastic fiber fabric

Pure Copper Polyester Taffeta Fabric

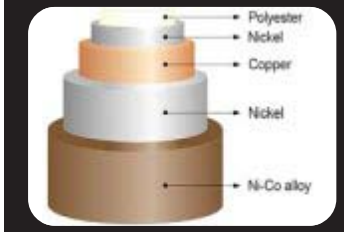


Spec
Surface Resistivity: 0.05 Ohm/sq.
characteristics
high conductivity, tarnish resistant finish
active component
Copper
method
coated
textile material
nylon

SOFT&SAFE Shielding Fabric

Spec
Surface resistivity: <1 Ohm/sq
characteristics
high conductivity, cotton like texture
active component
Silver (30%silver)
method
woven
textile material
70%Bamboo fiber

COBALTEX



Spec
Resistivity: < 0.1 Ohm/sq.
characteristics
because of the Cobalt alloy top coating, this material offers remarkable radiofrequency magnetic shielding in difficult near field conditions
active componentv
Nickel/Copper/Cobalt
method
plated
textile material
Polyester

Ripstop Silver Fabric

Spec
Surface resistivity: < 0.25 Ohm/sq
characteristics
high conductivity
active component
Silver
method
coated
textile material
nylon

Nickel/Copper Ripstop Fabric

Spec
Surface Resistivity: 0.03 Ohm/sq
characteristics
high conductivity. Superior tarnish and corrosion resistance due to Nickel content. Nickel may produce skin allergies
active component
Copper and Nickel
method
coated
textile material
nylon

SILVERELL Fabric

Spec
Surface resistivity: <5 Ohm per sq
characteristics
knit into a soft fabric, not as conductive
active component
Silver
method
Plied and knitted
textile material
16% Silver/nylon + 84% Rayon

Resistive thread 66 Yarn 22+3ply 110 PET

Spec
Resistance: <1000 Ohm/10cm
characteristics
higher resistance
active component
silver
method
plated
textile material
Nylon

SHIELDITTM SUPER

Spec
Resistivity: 1 Ohms per square
characteristics
coated on one side with a non-conductive hot melt adhesive
active component
Nickel/Copper
method
plated
textile material
Polyester

Lame Lifesaver

Spec
0.65 ohm / cm, or 20 ohm / foot
characteristics
very conductive
active componentv
silver
method
coated
textile material
Polyester

Silver Plated Nylon 117/17 2ply (234/34 4ply)

Spec
Resistivity: < 0.0025 Ώ/sq.cm Lineal Resistance: 50 Ώ/Meter
characteristics
active component
silver
method
plated
textile material
polyester and cotton

Gunze & Mitsufuji (ETC SI30)

Spec
characteristics
very conductive
active component
Gold
method
plated
textile material
Polyester

High Flex Copper

Spec

characteristics
very conductive, solder-able, strong against heat, can use as heat elements
active component
copper
method
coated
textile material
Polyester

Bekinox BK 50/2

Spec

characteristics
high resistance. good for knitting
active component
20% stainless steel fiber
method
Spinned
textile material
80% polyester

High Flex Silver

Spec

characteristics
very conductive, solder-able, strong against heat, can use as heat elements
active component
copper, silver
method
coated
textile material
Polyester

Soieries Elite Elinox

Spec

characteristics
has variety in colors, not so conductive
active componentv
stainless steel
method
plied
textile material
core of viscose, polyamid or polyester and gimped with a metalloplastic thread

Bekinox VN12/1*275 /100Z

Spec

characteristics
very conductive, strong against heat, can use as heat elements
active component
100% stainless steel
method

textile material

THS conductive thread

Spec

characteristics

active component
copper (thin wire)
method
plied
textile material
cotton

Shieldex 110f 34 Z 100 HT HC+B

Spec
Liner Resistance: < 100 Ω/M
characteristics

active component
silver
method
plated
textile material
nylon

schappe carbone HR/PA 12 69/31

Spec

characteristics

active component
carbon
method

textile material

SILVERPAM 250 dtex

Spec
198 Ohms/m
characteristics
very conductive, solder-able, strong against heat, can use as heat elements
active component
silver
method
plated
textile material
Nylon

Orbital fibernoks

Spec

characteristics

active componentv
stainless steel 0,035 or 0.05 mm
method
plied
textile material
Ne 60/2 cotton

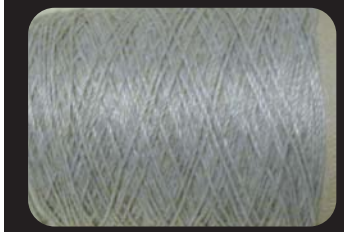
Schoeller conductive wool yarn

Spec

characteristics
not so conductive

active component
8% stainless steel
method
spinned
textile material
92% wool

plug and wear Nm10/3 Conductive Yarn



Spec
Surface resistance < 104 Ω
characteristics
not so conductive. good for knitting stretch sensor. RohS Compliant
active component
20% Stainless Steel 12 micron
method
spinned
textile material
80% Polyester