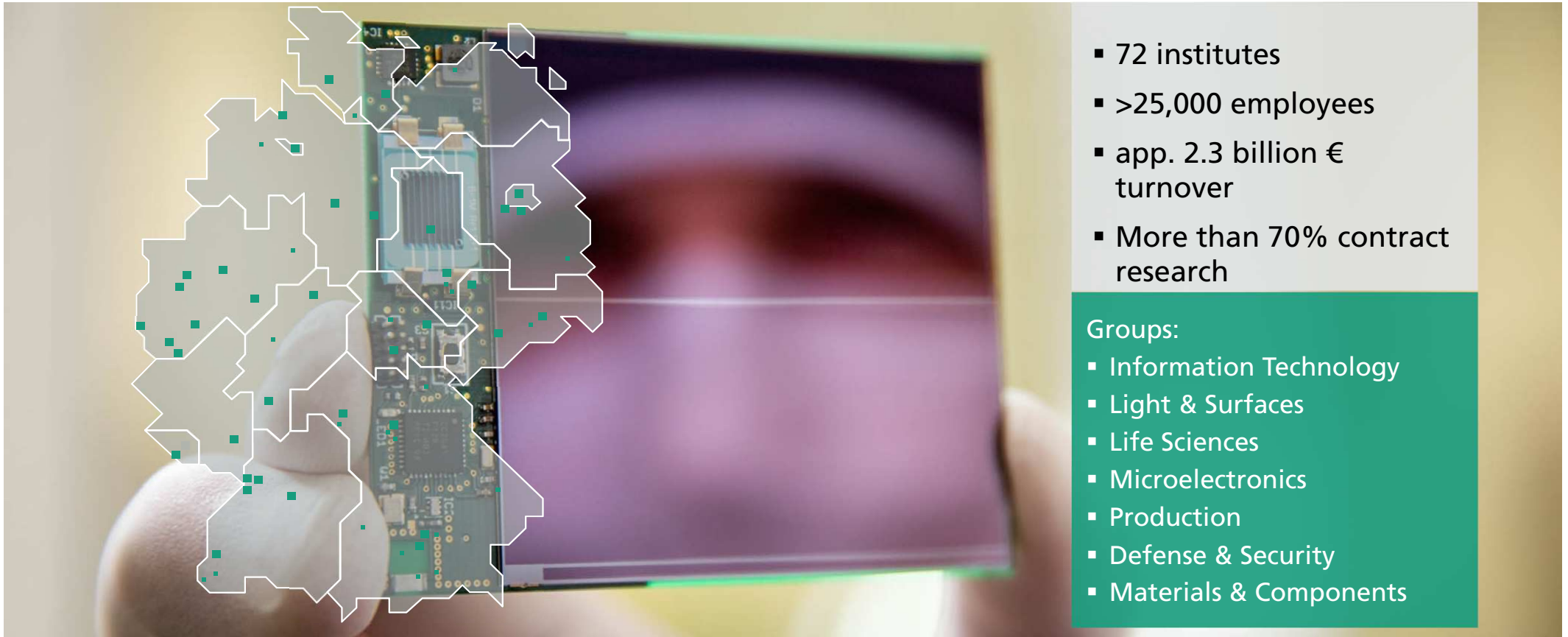


Strategies for more Circularity in the Life Cycle of Mobile Information Technology

Karsten Schischke, Marina Proske, Miquel Ballester,
Julia Reinhold, Klaus-Dieter Lang, Max Regenfelder

Overview Fraunhofer Gesellschaft



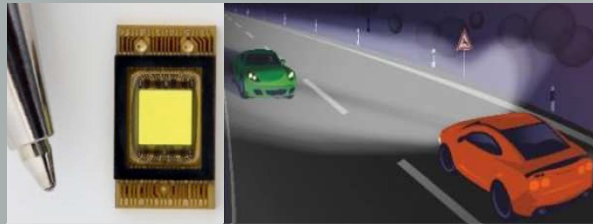
- 72 institutes
- >25,000 employees
- app. 2.3 billion € turnover
- More than 70% contract research

Groups:

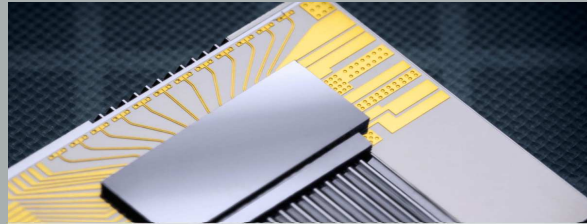
- Information Technology
- Light & Surfaces
- Life Sciences
- Microelectronics
- Production
- Defense & Security
- Materials & Components

Schischke, Environmental and Reliability Engineering

Fraunhofer IZM in a Nutshell: Advanced Technologies for Microelectronic Packaging



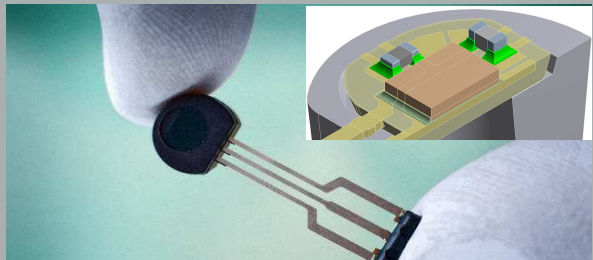
Automotive: Adaptive headlight system



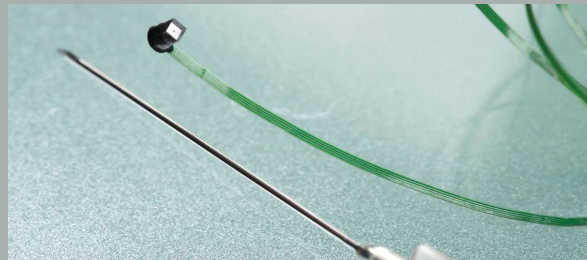
ICT: Optical module for the fastest communication system



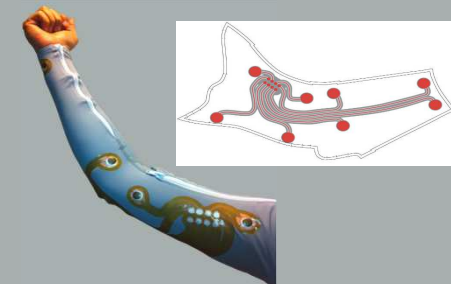
Industrial: Autarkic sensors for power line monitoring



Automotive: Magnetic sensor packages



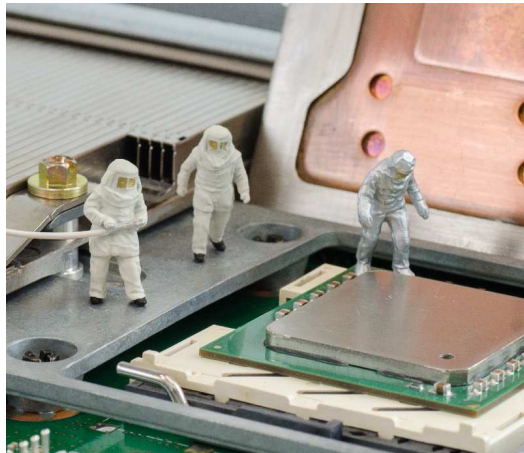
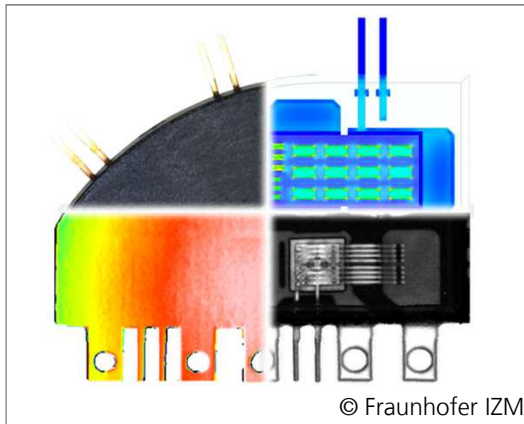
Medical: smallest camera module in the world



Medical: T-Shirt for muscle stimulation therapy

Schischke, Environmental and Reliability Engineering

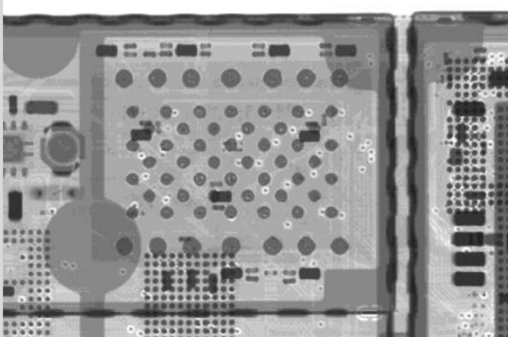
Environmental and Reliability Engineering @ Fraunhofer IZM



- Ageing mechanisms of microelectronics (thermal, mechanical, moisture)
 - Combined load lifetime testing, accelerated test
 - Assessment of warpage issues
 - Corrosion issues in microelectronics
 - Condition monitoring and lifetime estimation
-
- Lifecycle environmental assessments (LCA, PCF)
 - Ecodesign concepts for products and ICT systems
 - Resource utilization and critical materials in electronics
 - Circular economy, obsolescence, and design for recycling

Schischke, Environmental and Reliability Engineering

sustainablySMART



■ Project website

■ www.sustainably-smart.eu

■ Partners

■ Fairphone, Circular Devices, MicroPro, AT&S, ITR, Semicon, Refind Technologies, Pro Automation, Blancco, Grant4Com, ReUse, iFixit, Speech, TU Wien, SAT, PrimeTel, Fraunhofer IZM

■ **Project starting date:** September 2015

■ **Project end date:** October 2019

■ Funding:

■ The project sustainablySMART has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 680640.

Project Objectives

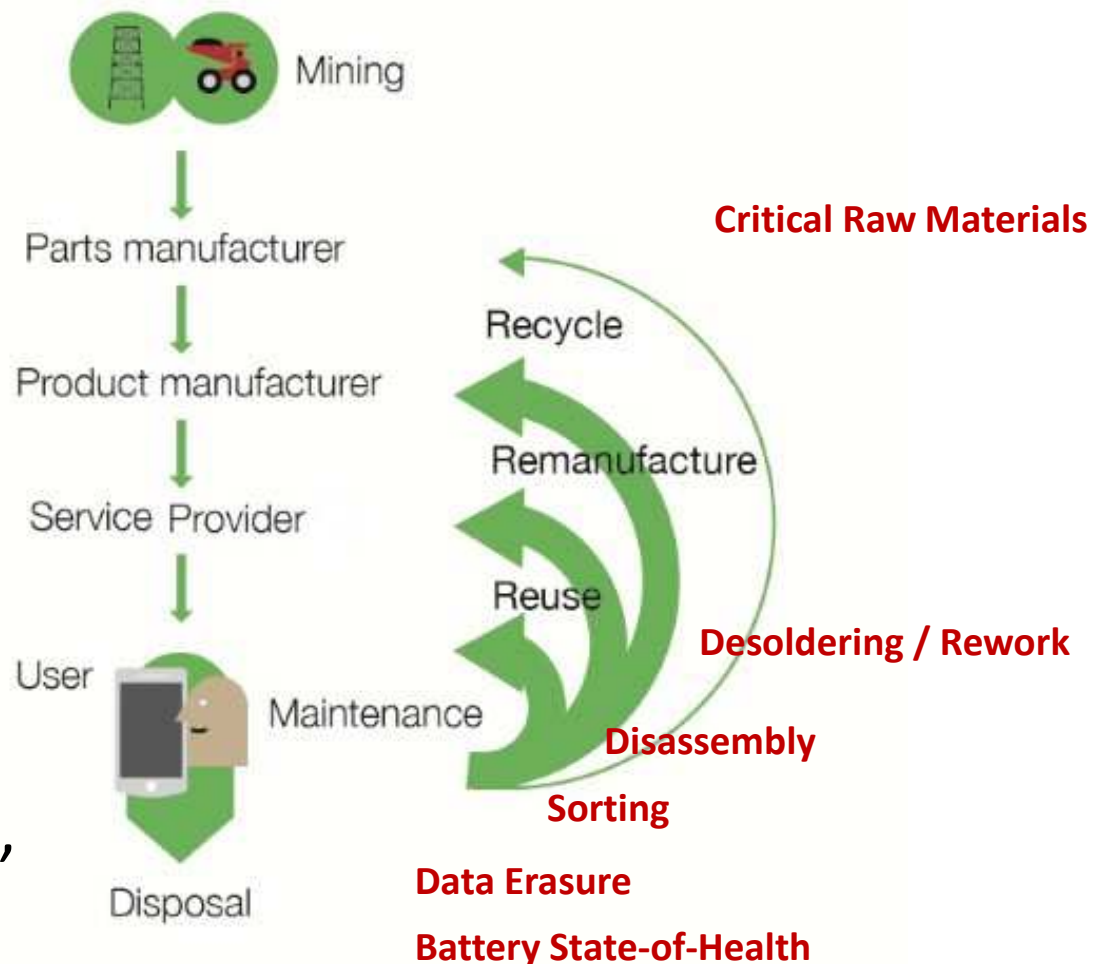


“Sustainable Smart Mobile Devices Lifecycles”

PCB Modularization (Embedding)

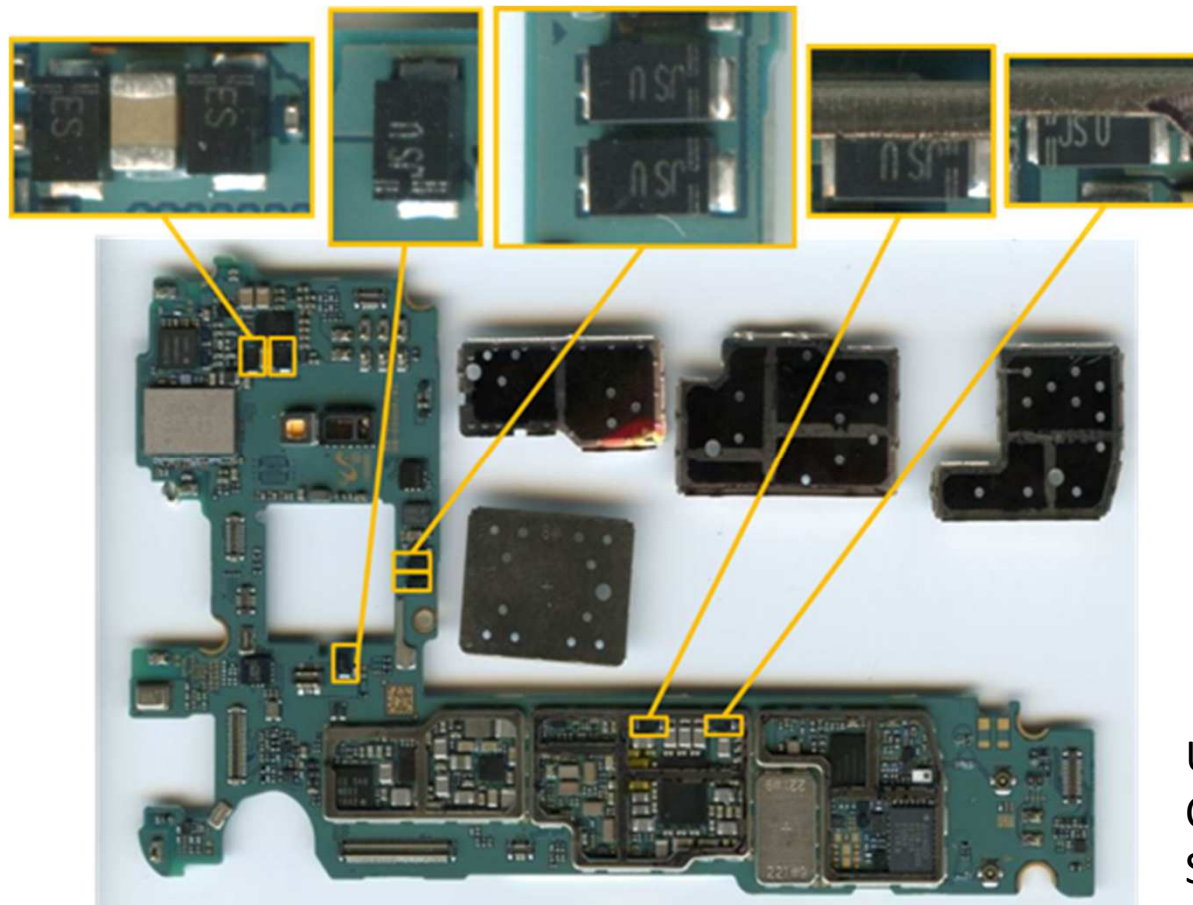
**Design for a Circular Economy:
Smartphones, Tablet, Digital
Voice Recorder**

- sustainablySMART:
11 technological actions,
cross-fertilisation



Recovery of Critical Raw Materials

Recovery of Tantalum

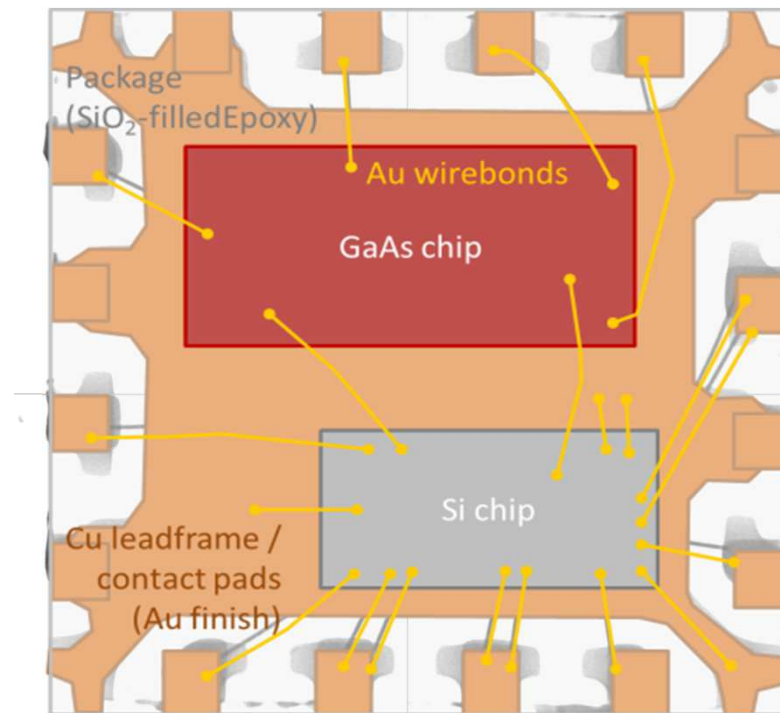


Use of Tantalum Capacitors in the Samsung Galaxy S7

Recovery of Critical Raw Materials



Recovery of Gallium



WLAN module
with GaAs and
silicon chips in one
package

Recovery of Critical Raw Materials



Recovery of Tungsten



Recovery of Critical Raw Materials



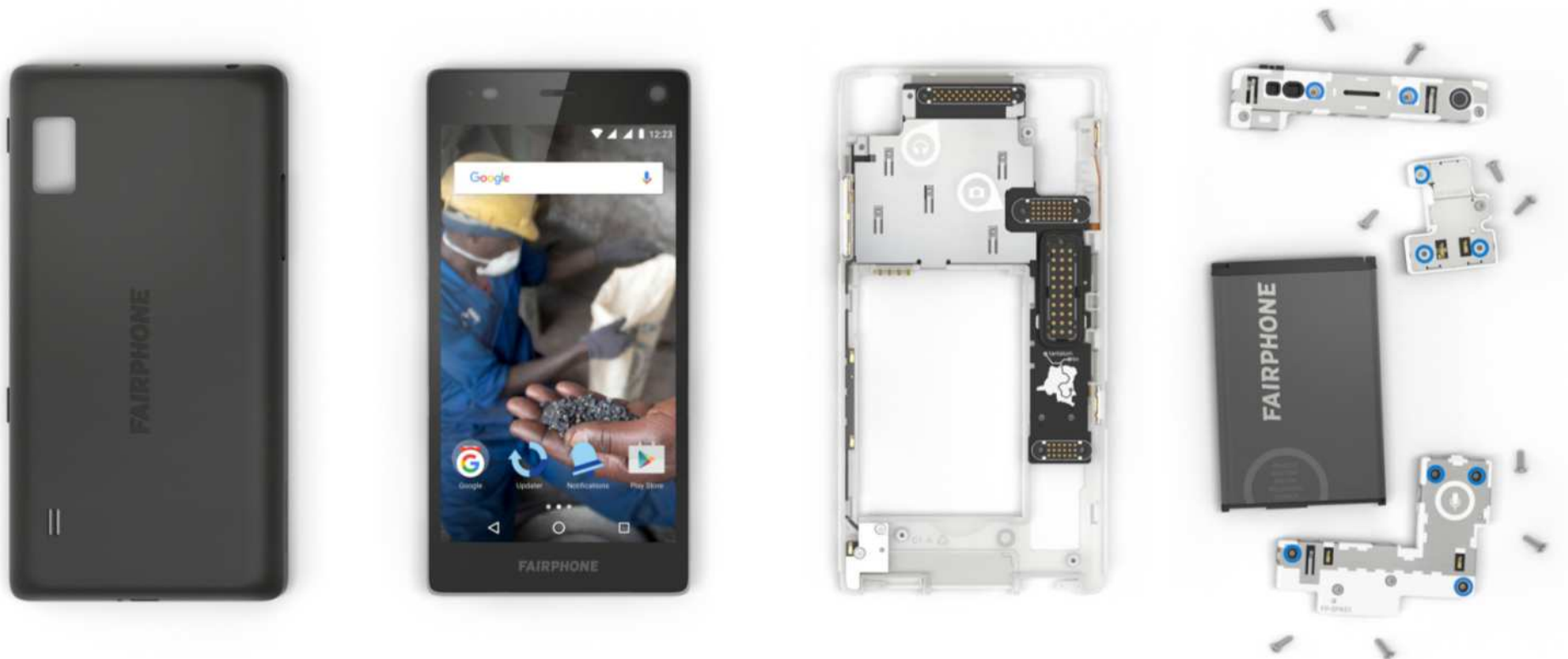
Recycling Potential

	Ta	Ga	W
Target component	Tantalum capacitors	GaAs modules	Vibration motors
Existing recycling process for post-consumer scrap	yes	no	no
Recycling of post-consumer scrap potentially feasible	yes, large scale processes for post-industrial scrap in place	no (Ga content too low)	requires pre-processing of vibration motors to separate the heavy metal from motor parts
Recovery of contained precious metals feasible	yes (Ag)	no	not clear yet
Material value per phone	< 0,2 €-cents	< 0,03 €-cents	max. 1,8 €-cents
Economically viable	no	no	depends on overall disassembly process
High environmental impact of primary material	no	no	no
Conflict minerals	yes	no	yes

Product Design

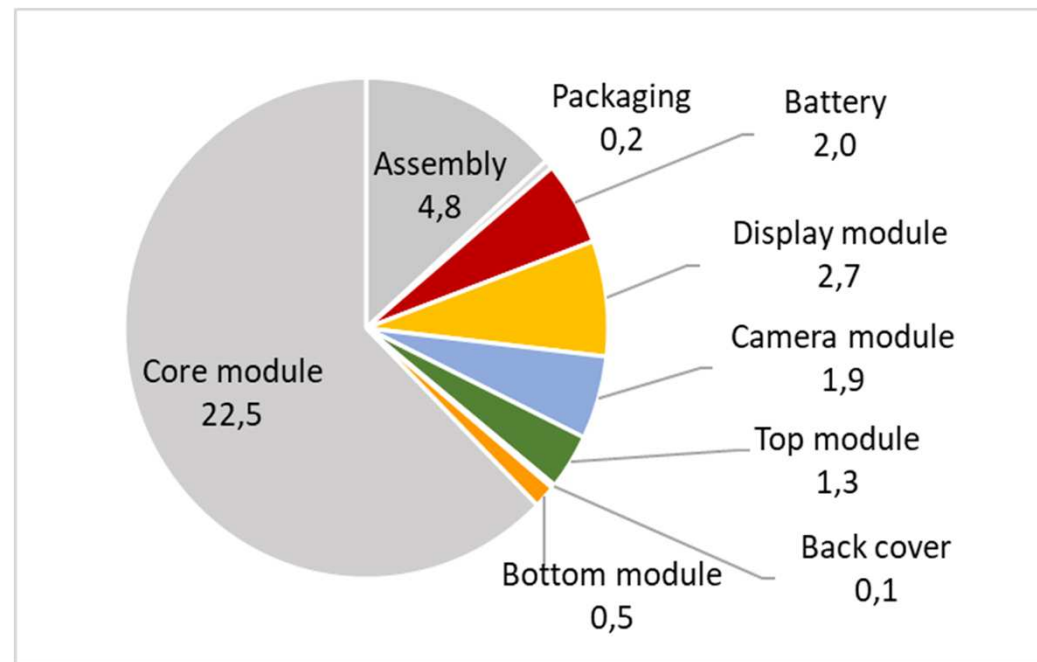


Fairphone 2



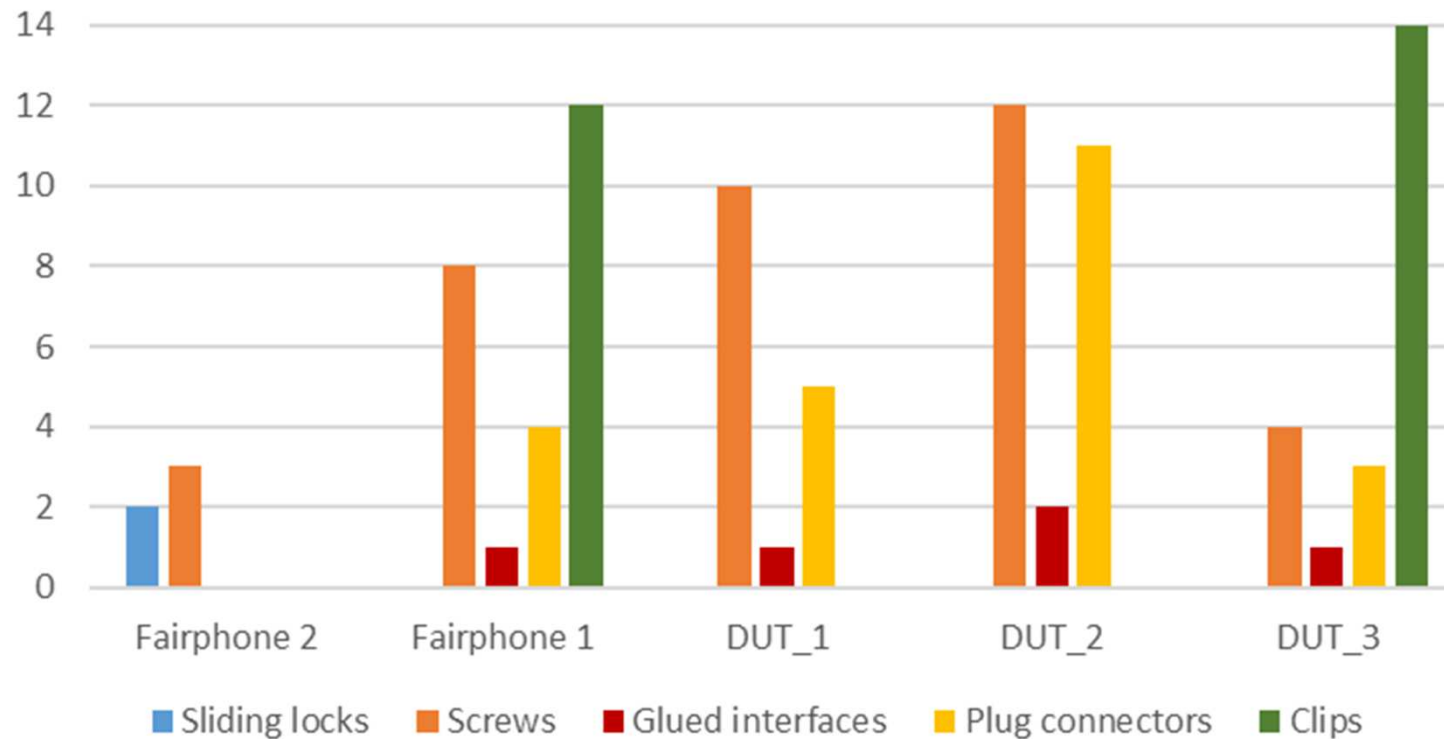
Fairphone 2

Global Warming Potential of Module Production, Assembly and Packaging



Fairphone 2

Fasteners to Disassemble the Rear Camera



Product Design



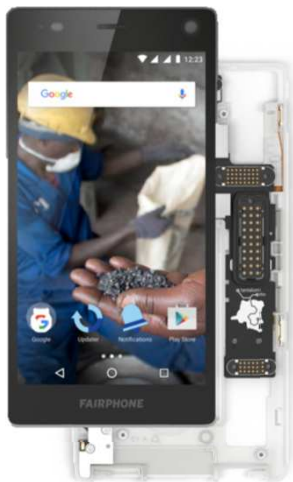
Fairphone 2 Repair instructions by iFixit



Product Design



Fairphone 2:
Modularity for
reparability



PuzzlePhone:
Open-standard
modularity



**Digital Voice
Recorder:**
B2B product



iameco tablet:
“low-tech” FabLab
compatibility



Product Design



#1 Attachment & Trust



#6 Dis- & Reassembly



#2 Durability



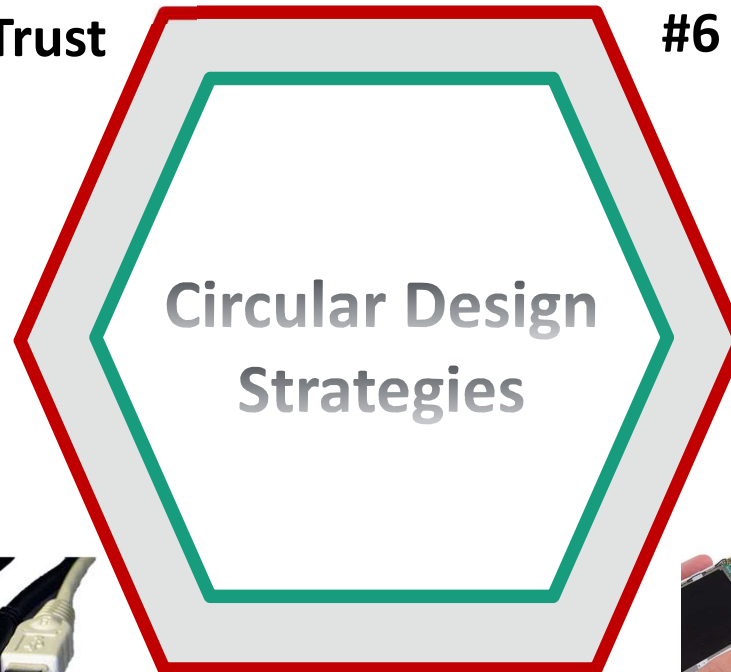
#5 Upgradability & Adaptability



#3 Standardization & Compatibility



#4 Ease of Maintenance & Repair



Recommended reading: C. Bakker, M. den Hollander: Products that Last

Product Design



Fairphone 2:
Modularity for
reparability

PuzzlePhone:
Open-standard
modularity

DVR:
B2B product

iameco tablet:
“low-tech” FabLab
compatibility

Table 1: Circular Design Strategies – Self Assessment (ABC-Analysis)

Circular Design Strategy	Fairphone 2	Puzzlephone	Digital Voice Recorder	iameco D4R tablet
Attachment & Trust	C	A	A	C
Durability	A	A	A	B
Standardization and Compatibility	B	A	B	B
Ease of Maintenance & Repair	A	B	C	A
Upgradability & Adaptability	B	A	B	A
Dis- & Reassembly	B	C	C	A

A: most important; B: moderately important; C: less important than other design strategies

Initial judgement as of March 2016, design priorities have changed since then and initial judgement might not have been accurate

Key message:
Even for similar products a Circular Design approach might look very different

Presentations



Session 3.3

PCB Modularization (Embedding)

Design for a Circular Economy:
Smartphones, Tablet, Digital
Voice Recorder

Product trends

Session 3.9
iFixit Repairability Assessment



Session 1.6

M. Regenfelder, R. Pamminger: New
Business Models for Circular Economy

(Critical Raw Materials)



Session 3.6

Desoldering / Rework

+ Technical Tour!

Data Erasure
Battery State-of-Health