# A new roadmap for the analysis of power semiconductors

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# Outline

- Purpose of this roadmap?
- Basic concept
- Important analysis sequences
- Alloyed devices – what is still possible?
- From device to subsystem – an outlook towards future integrated failure analysis

# Purpose of the roadmap?

- Collection and systematization of lomg-term F/A experience in power electronics Ausbildung
- To find the right course in difficult cases
- To explain customers the complexity and time-scale of analysis requests – for instance in case of customer-return-8Ds

# Important analysis sequences (1)

X-ray imaging (planar radiography)

X-ray-tomography (XCT)

Electrical characterisation

Infrared-thermography (encapsulated)*

Scanning acoustic-microscopy (SAM)

Magnetic microscopy*

Decapsulation/ Extraction

Lichtmikroskopie/ REM/ EDX/ Auger

Infrared-thermography (decapsulated)

Emission microscopy

Magnetic microscopie

OBIRCH

FIB Cross sections

Metallographic cross sections

Chemical Delayering

Bond-pull/ shear tests

Hardness tests

Erosive material analysis

Transmission electron microscopy (TEM)

Non-destructive methods

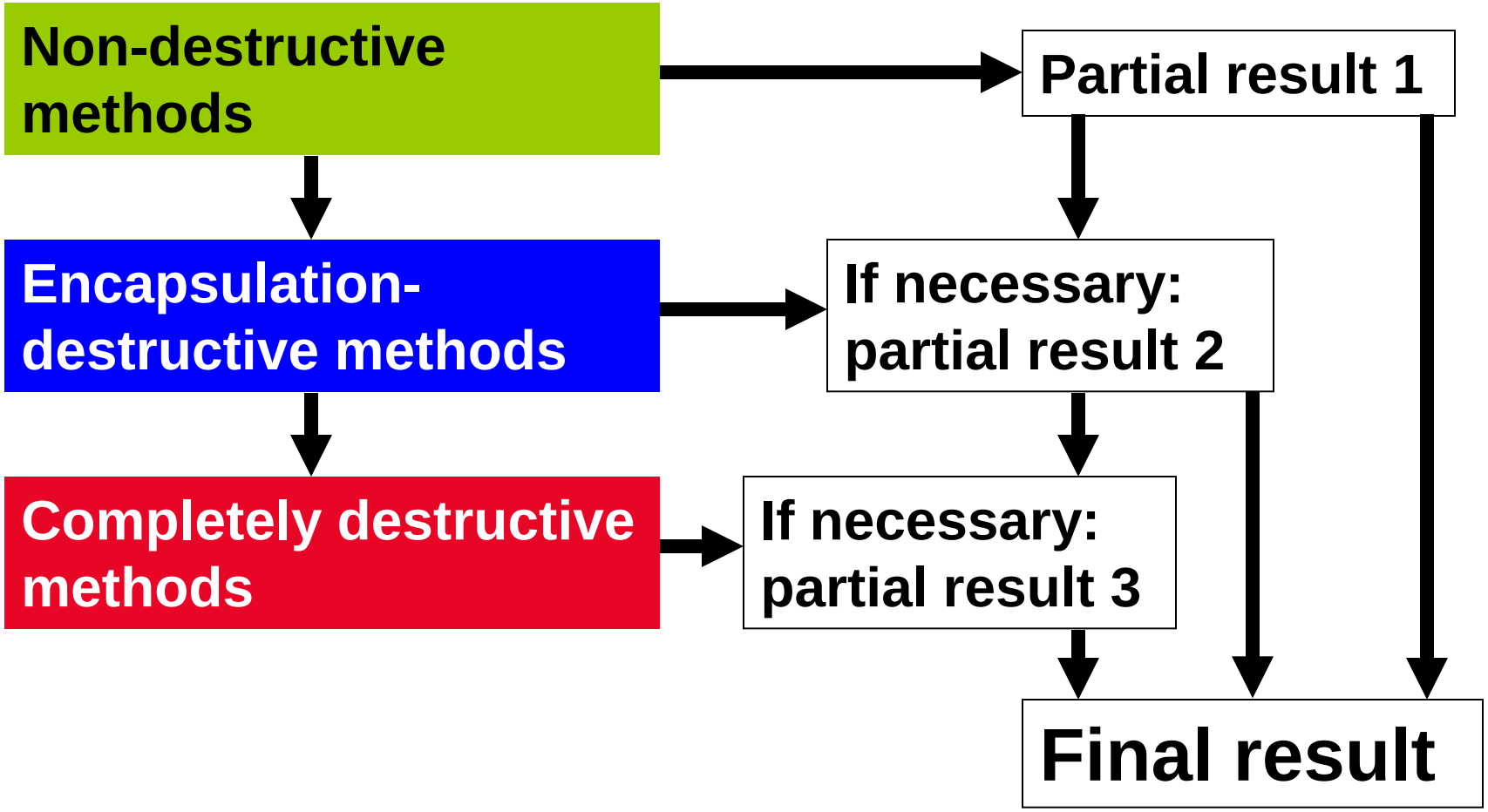
Encapsulation-destructive, power device remains functional

Destructive methods

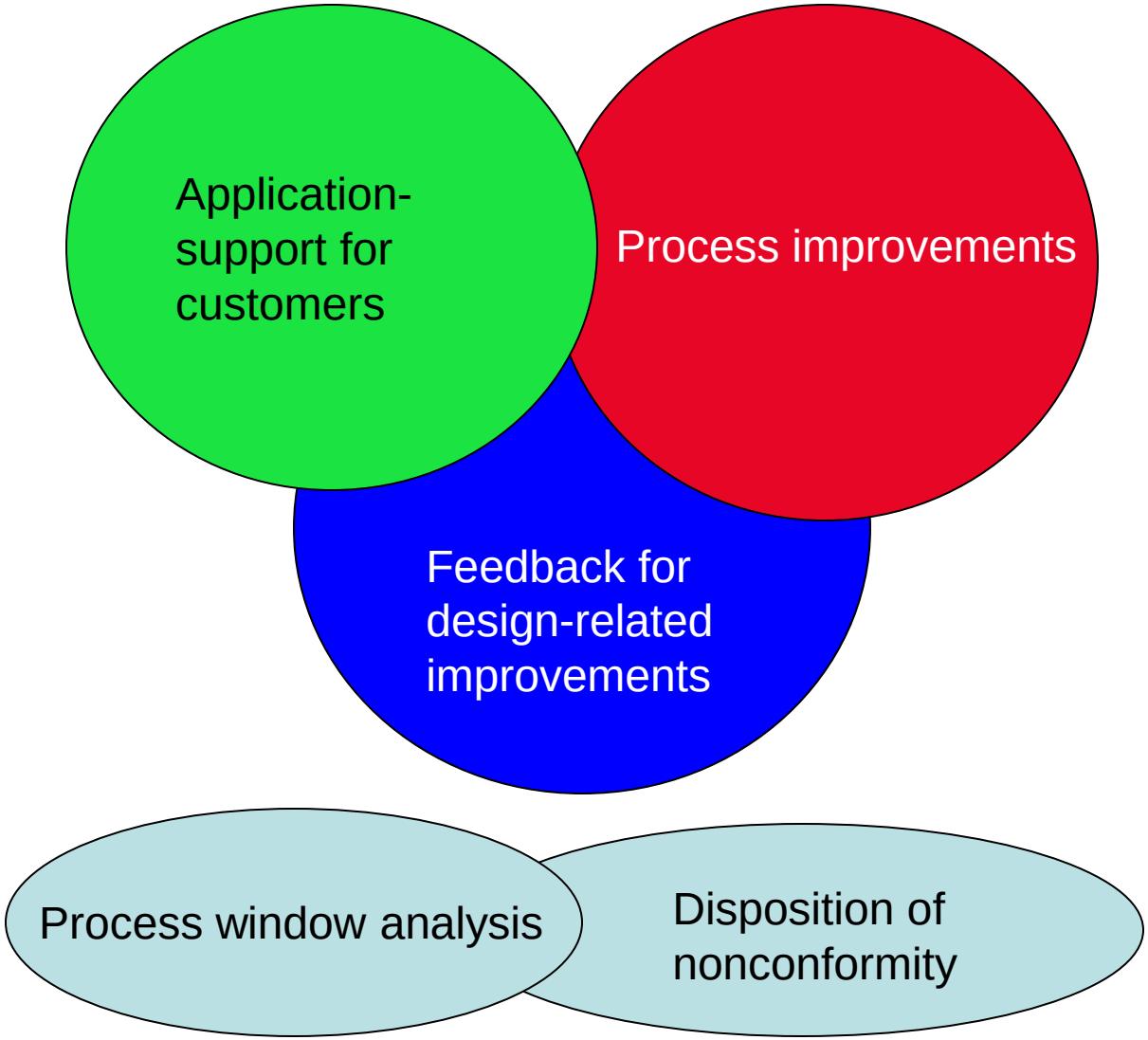
*) limited to small devices

# Important analysis sequences (2)

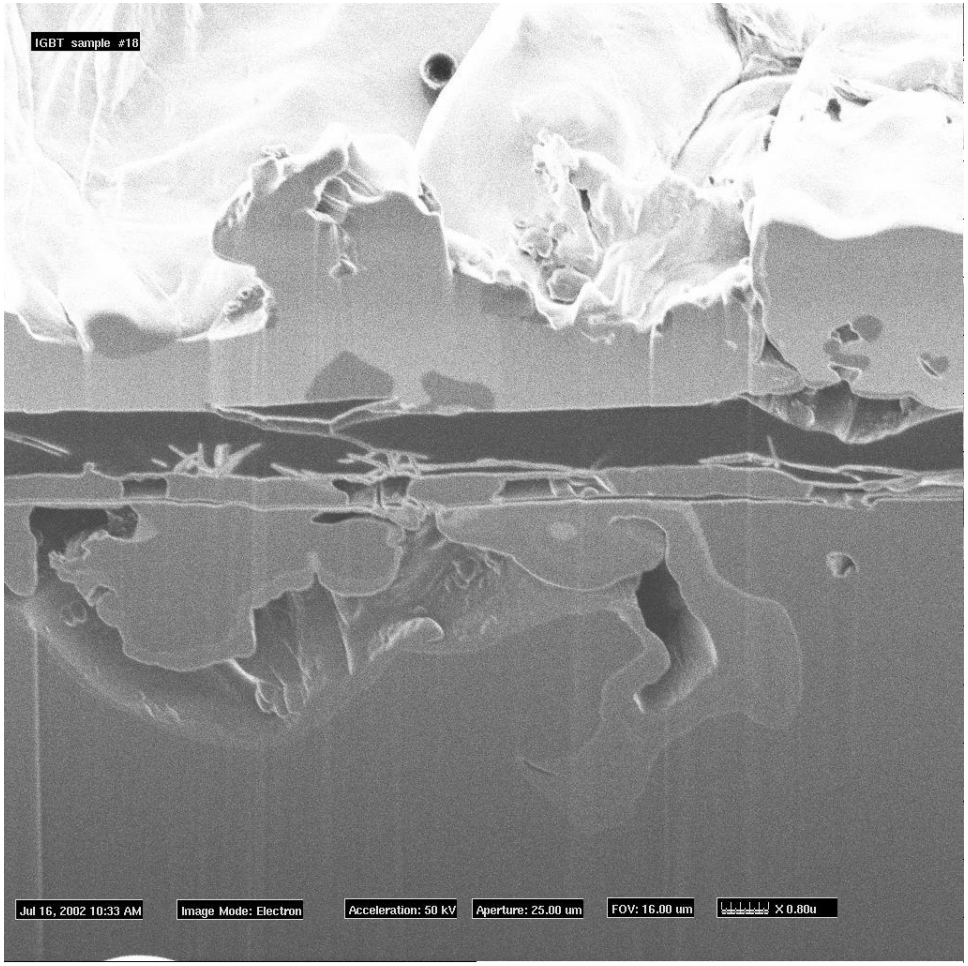
## Basic scheme



# Important analysis sequences (3) analysis goals



# Power module burned/ alloyed – what's still possible?




Such damage footprint allows to conclude towards a slowly growing failure mechanism. If such high temperatures would appear suddenly, a rapid mechanism would cause severe silicon cracks. As a best engineering assumption, continuous strong overload most probably initiated this failure.

# Failure analysis sequence

# Discussion of the roadmaps distributed

# From device to (sub)system – the future way towards integrated failure analysis

- Due to increased complexity of work-sharing supply chains and modular universal subsystem solutions, application-related failures significantly increased
- Most common examples in power electronics are high-level-inductive loads, cross-talk-effects into microelectronics part, adaption- and interface problems, floating/ moving potentials, ground loops, primary shorts by improperly placed ceramic capacitors and insufficient cooling concepts/ thermal budgets
- In contrast to 8D and 5-Why-approaches, EMPA prefers FMEA-based evaluation-/ solution-approaches

# Conclusion

- The new FA-roadmap supports the training of new failure analysts as well as customer trainings and advises experts, too
- Failure analysis must not focus exclusively onto the failed component – frequently, the root cause is hidden within the application environment.