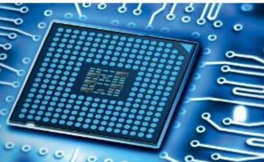
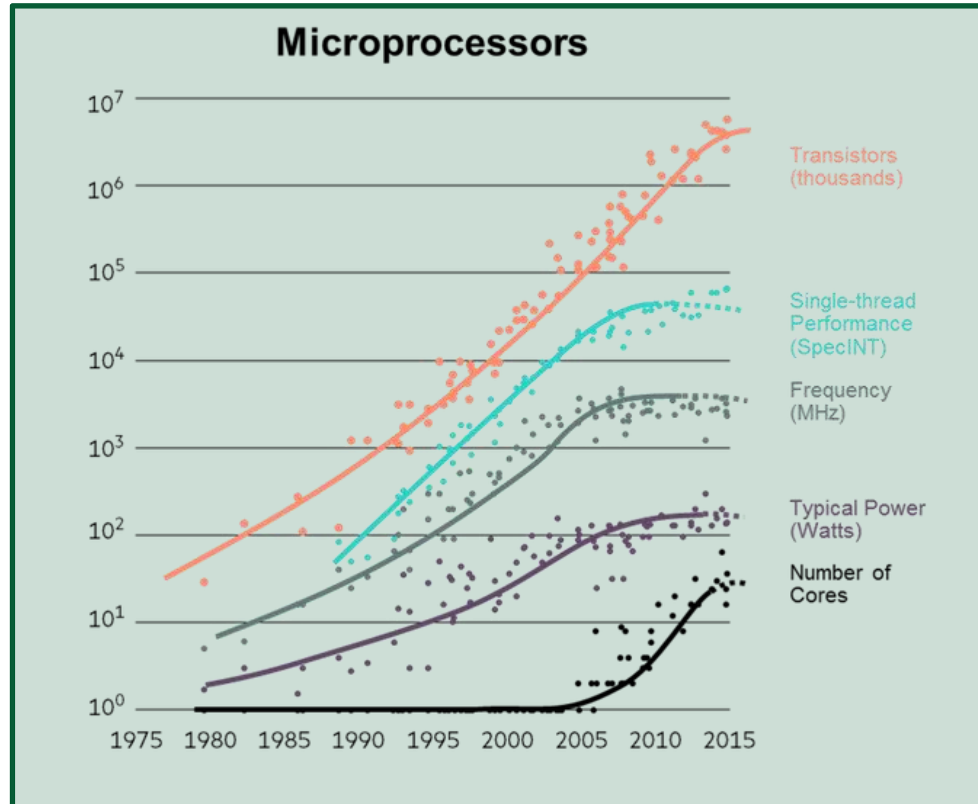
Quantum sensing: Accelerating ramp up and reducing scrap rates of next-gen semi devices

Bayerisches Staatsministerium für
Wirtschaft, Landesentwicklung und Energie

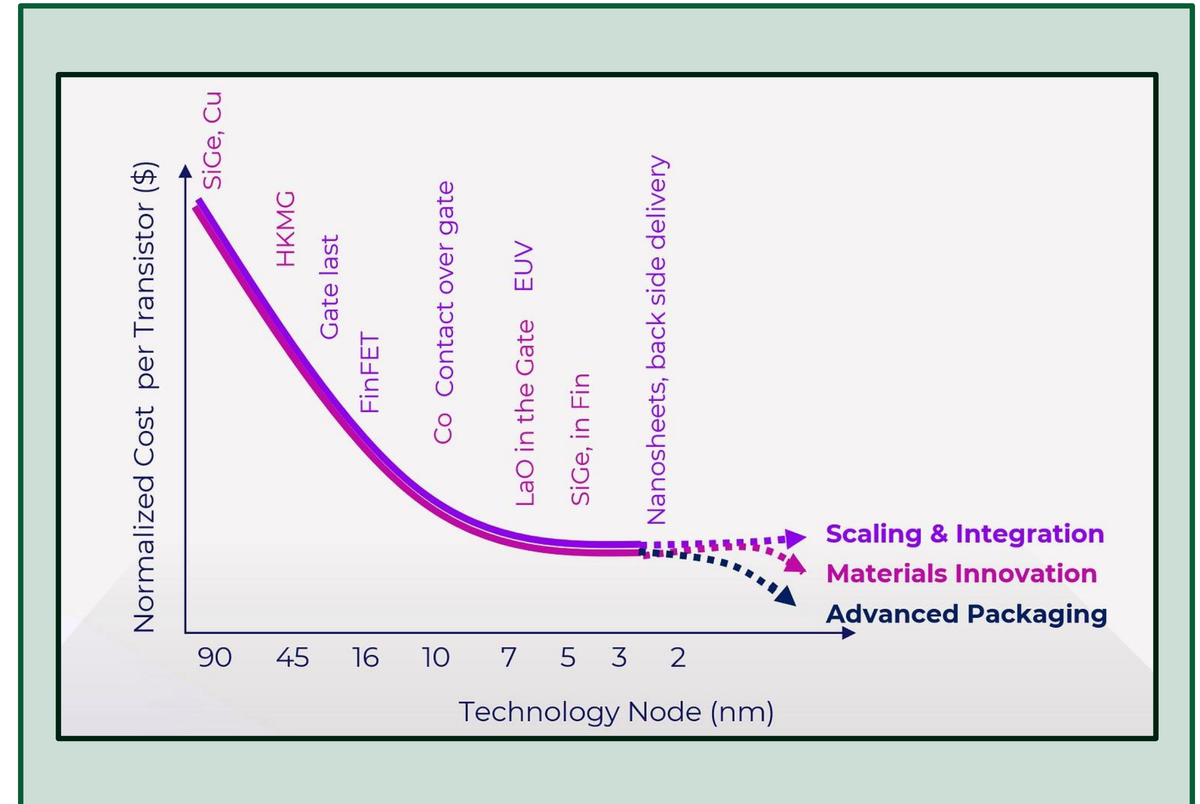
BAYERISCHER
HALBLEITER-KONGRESS
2024



Shrinking transistors and increasing planar density do not necessarily translate into performance improvements anymore!

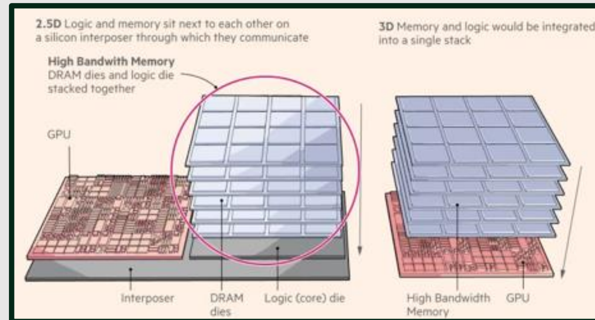


Due to physical limits, smaller transistors do not necessarily result in overall performance gains



Materials innovation and advanced packaging is needed to stay economically viable below the current node size

Heterogenous integration trends pose new challenges for traditional electrical failure analysis



Trend 1

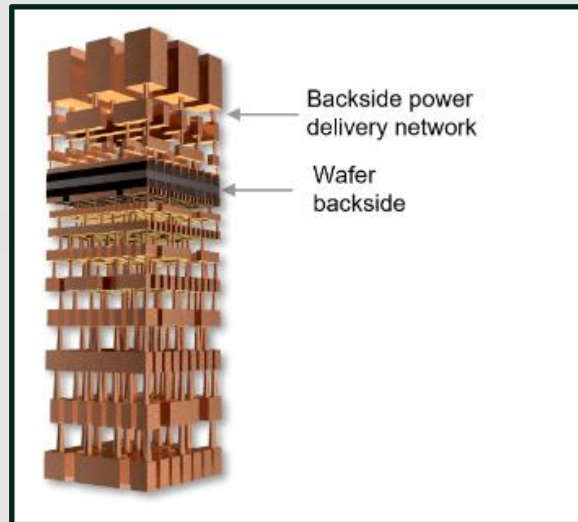
Advanced Packaging

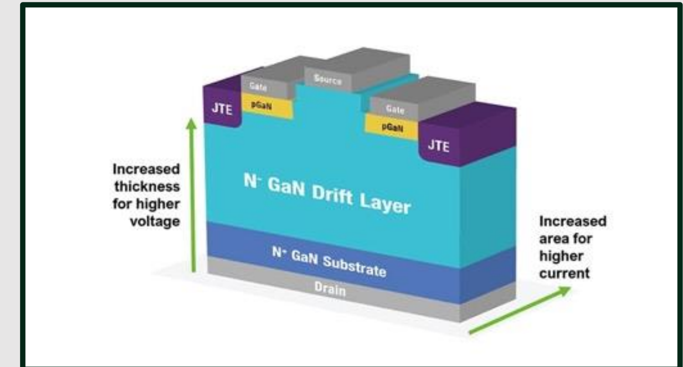
Advanced packaging solutions such as 2.5/3D integration and chiplets, are becoming essential. However, they complicate access and introduce new failure modes including verticals.

Trend 2

Backside Power Delivery

Backside power delivery is also a rising trend. However, metallization on both sides is complicated.



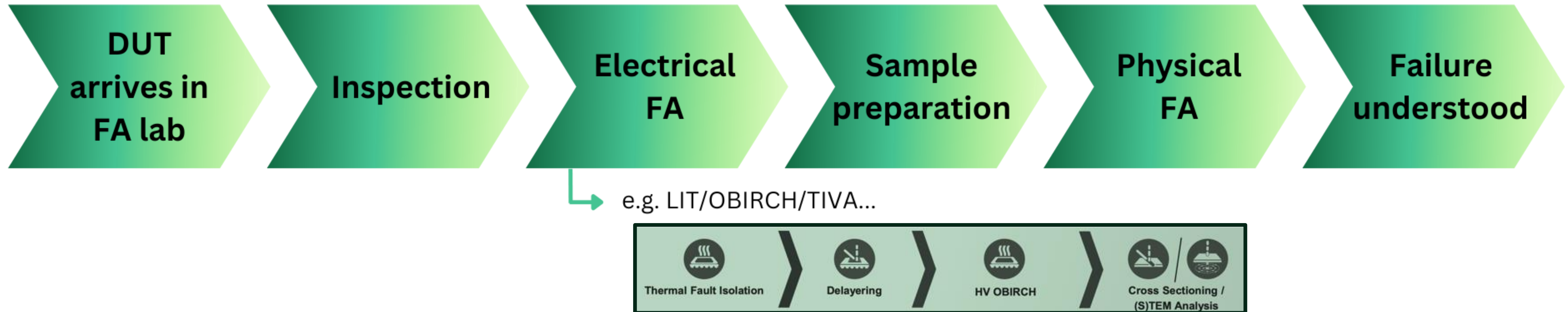


Trend 3

Wide Band-Gap Materials

Wide band-gap materials are being adopted, but they introduce novel failure modes. The vertical HEMTs are especially difficult to probe due to the opposite placement of drain and source.

Current EFA techniques are multi-step and cumbersome for new trends. They also can’t supply electrical information directly.



Source: ThermoFisher

Standard optical techniques like OBIRCH and TIVA work well for 2D planar chips for coarse fault localization

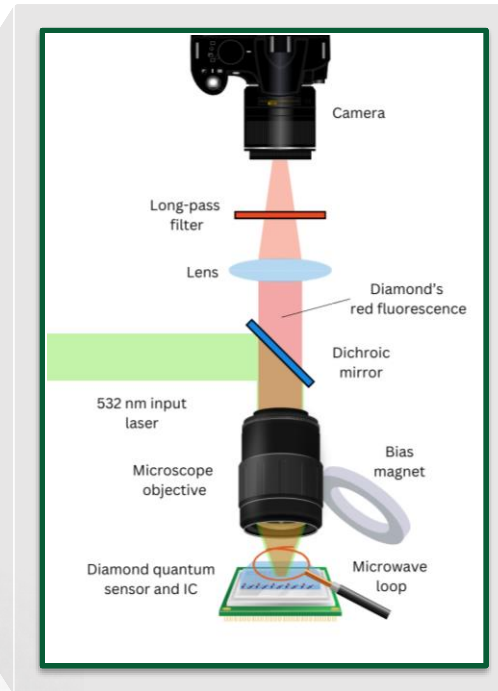
However, they simply don’t work directly for the new trends without cumbersome sample prep

They rely on coarse lateral and depth localization by **Lock-in Thermography (LIT)** first, introducing an additional step

Furthermore, LIT only supplies thermal information and usually has an **uncertainty of ± 40 µm** for deep defects

Hence, despite being very useful in identifying layer-level, it cannot resolve at the die-level

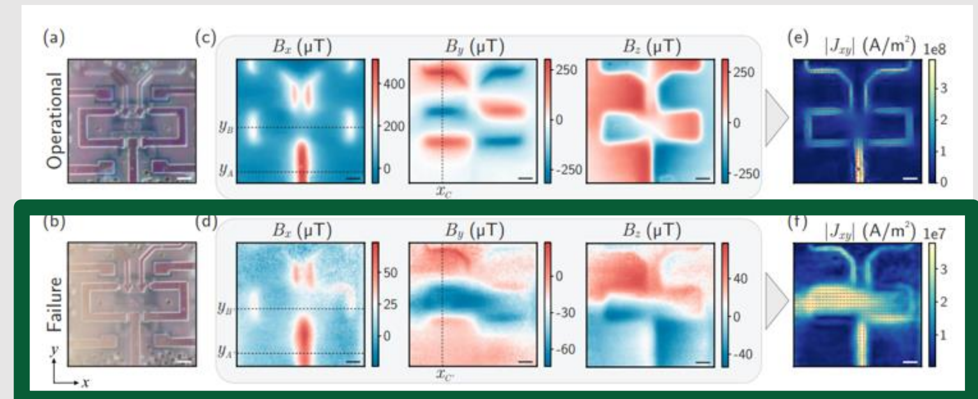
Diamond-based quantum sensing can image currents from multiple layers, capable of resolving defects in 3D and give current flow information



01 **Direct information of 3D magnetic fields, and current density**

02 **High precision lateral and depth localization of electrical failures in a matter of minutes**

03 **Non-destructive electrical analysis of multiple layers when high resolution is not necessary**



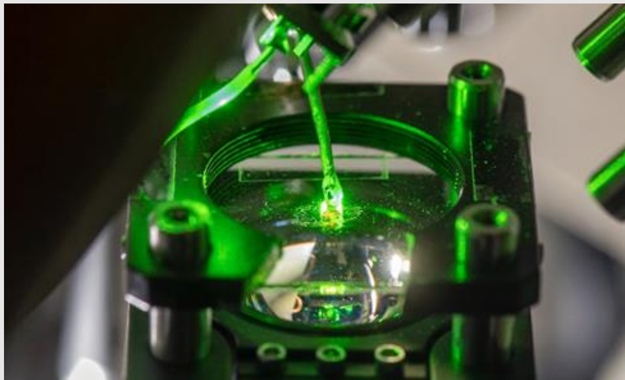
Non-invasive imaging of three-dimensional integrated circuit activity using quantum defects in diamond [Garsi et al.]

What we offer

Testing as a Service

We offer direct testing in-house. We combine quantum sensing expertise with operational efficiency of our in-house systems.

A generic EFA sheet containing device and testing information is necessary.



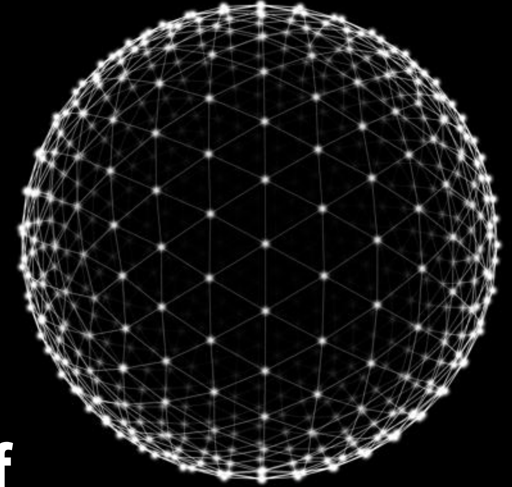
EFA Device Sales

Our prototype device QD-0 is available for on-site integration starting Q4 2024. The system comes with our integrated analysis software.

Integration and Maintenance

Our experts are ready to assist you all the way from device installation to data processing. We make your transition to quantum-sensing EFA as smooth as possible.

QUANTUM DIAMONDS
SENSOR TECHNOLOGY



More than Moore: enabling the next generation of advanced semiconductor devices

Dr. Fleming Bruckmaier

CTO

sales@quantumdiamonds.de

+49 151 730 710 26