Overview of Hybrid Integration approaches

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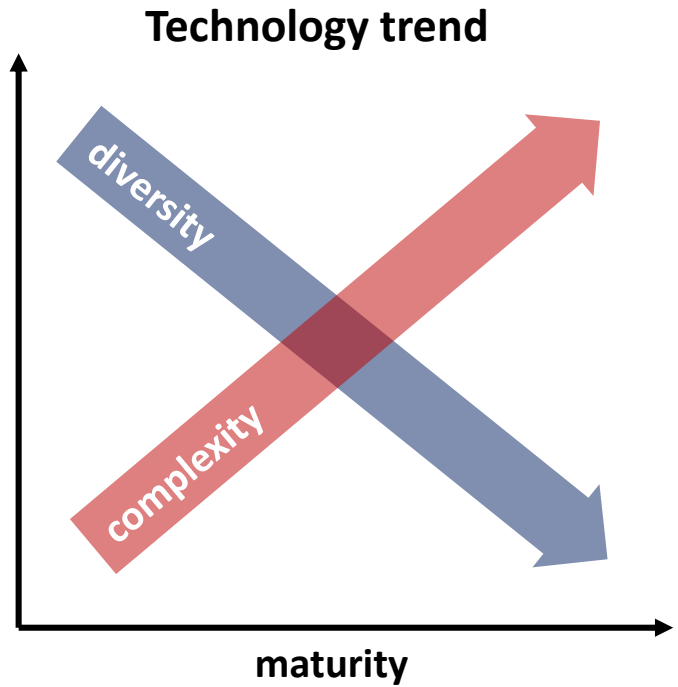
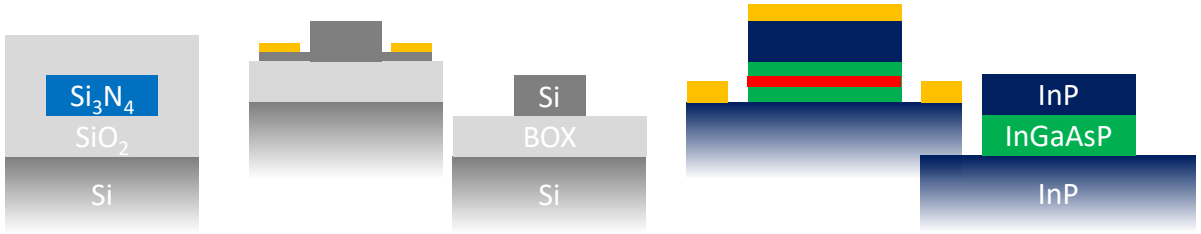
Semiconductors: exponential growth requires focus



Three major platforms in photonic integration



	silica / silicon nitride	silicon-on-insulator	indium phosphide
wavelength range	0.3 µm – 3 µm	1.1 µm – 4.5 µm	1.3 µm – 1.6 µm
lasers, amplifers	NA	NA	+++
photodetectors	NA	++	+++
modulators	NA	+	++
passive devices	+++	++	+
wafer level packaging	+++	+++	NA
electronic SoC and SiP integration	+++	+++	NA

The problem is well-known

- lack of laser in SiPh
- lack of actives in SiN
- need for low-loss passives in InP
- lack of large-scale integration in InP, …

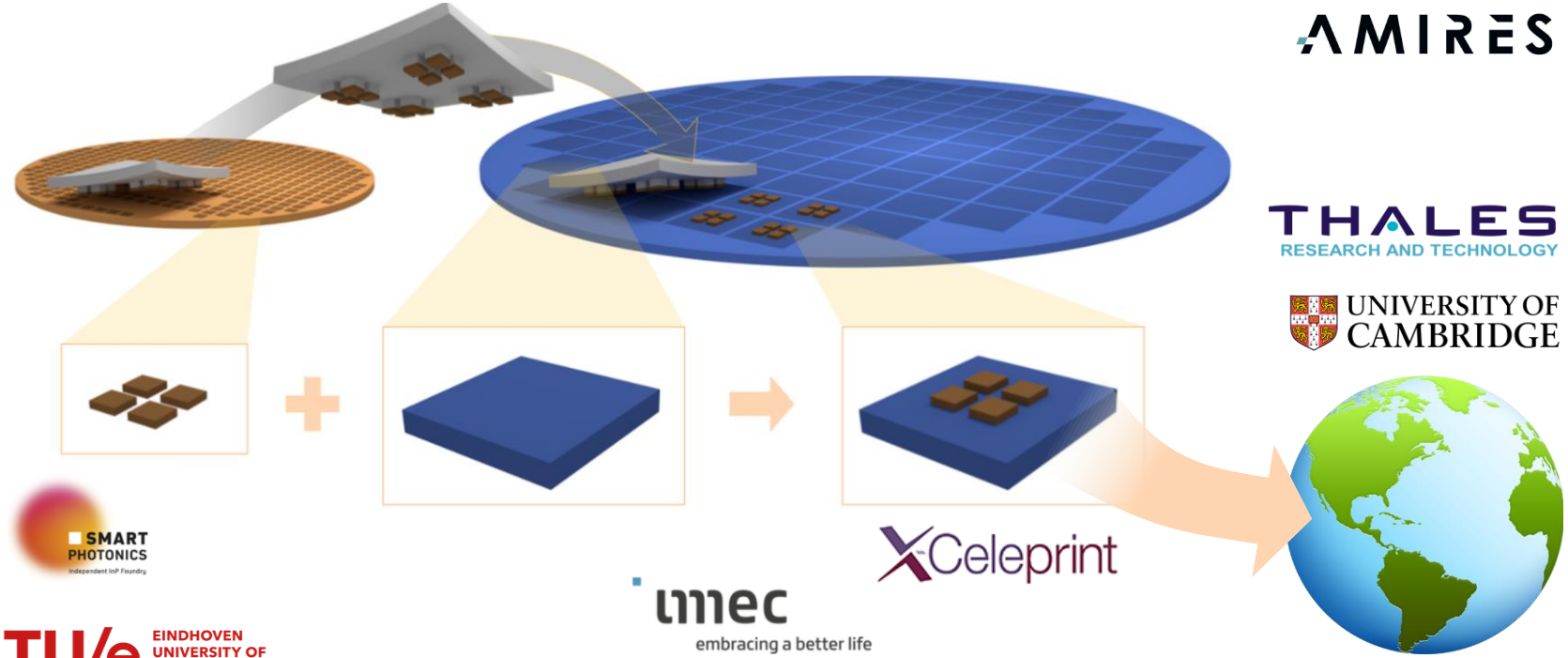
Technologies are complementary! We need to combine.

So, what are the options?

	Micro-package	Hybrid	Transfer-printing	Heterogeneous	Heteroepitaxy
integration density	-	- or +	+	+	N/A
SiPh compatibility	packaging	packaging	back-end	back-end	?
efficiency of III/V material use	+	+	+	-	++
alignment accuracy	-	--	-	+	+
throughput	--	---	+	++	+++
cost	high	highest	low	medium	potentially low
maturity	mature	maturing	academic	mature	no PICs yet

based on, a.o., Zhang, Roelkens, et al., https://doi.org/10.1063/1.5120004

INSPIRE – making micro-transfer printing market-ready



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Conclusion

- Combination of technologies is needed, as no platform is overall best-in-class;
- Target application is driver for selection of technologies (Si, SiN, InP)…
- … but manufacturing and cost requirements will determine the integration technique.

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