

03/10/18

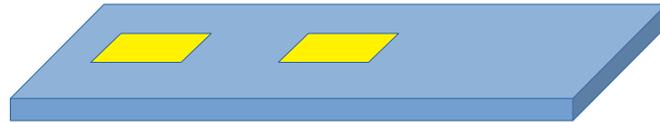
Hybrid or heterogeneous, and how



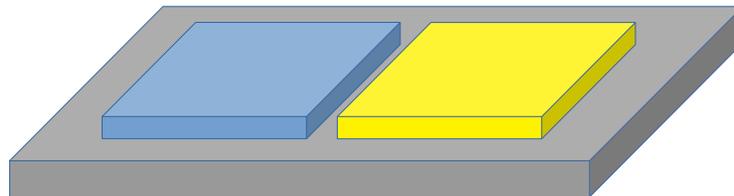
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Heterogeneous integration: Is the process that combine two or more material technologies into a single die. This process is performed at the fabrication stage (die bonding, wafer bonding, transfer printing, direct growth, etc.).



Hybrid integration: Is the process that connects two or more dies, usually from different material technologies, into one single package. This process is performed at the packaging stage after fabrication (butt coupling, flip-chip, etc).



- Silicon dioxide (SiO_2 , Silica / PLC)
- Silicon Nitride (Si_3N_4) / TriPleX™
- Silicon photonics (Si, SOI)
- III-V compounds (InP, GaAs)
- Lithium Niobate (LiNbO_3)
- Si CMOS / BiCMOS



Best Technology Features

- Low propagation loss
- Good coupling to fibers
- Good electro-optic effect
- Good thermo-optic effect
- Good electro-absorption effect
- Light generation / regeneration
- Small footprint
- Compatibility with electronics

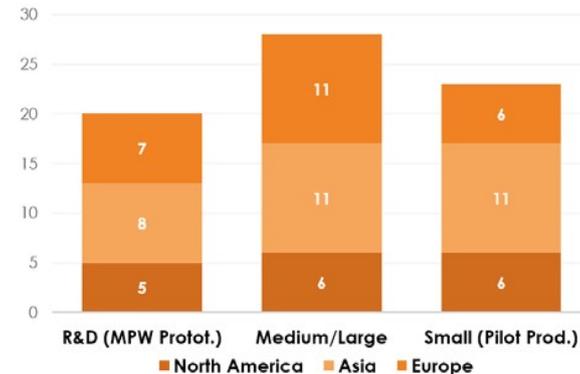
	SOI	SiO_2/Si	$\text{Si}_3\text{N}_4/\text{SiO}_2$	InP/GaAs	LiNbO_3
Low propagation loss		Orange	Orange		
Good coupling to fibers		Orange	Orange		Orange
Good electro-optic effect				Orange	Orange
Good thermo-optic effect	Orange	Orange	Orange	Orange	
Good electro-absorption effect				Orange	
Light generation / regeneration				Orange	
Small footprint	Orange		Orange	Orange	
Compatibility with electronics	Orange				

- Many Si foundries like Towerjazz or SUNY offer Si_3N_4 heterogeneous integration for low loss optical waveguide propagation and fiber coupling.
- Some Si foundries like CEA LETI or soon IMEC are starting to offer heterogeneous integration with InP in a generic process.
- Some Si foundries like IHP or GlobalFoundries are offering co-integration with electronics.
- A hybrid solution with TriPLeX and InP being offered through MPW runs.
- InP foundries providing wafers or dies (SOAs and lasers) for hybrid and heterogeneous integration with Si and Si_3N_4 platforms.
- Thin-film LiNbO_3 over Si starting to be commercially offered soon.

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FOUNDRIES VOLUME CAPABILITIES

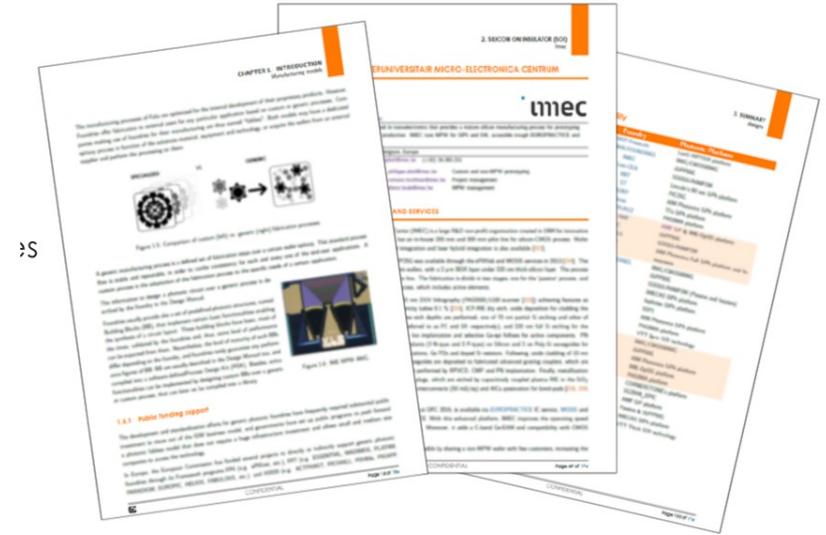
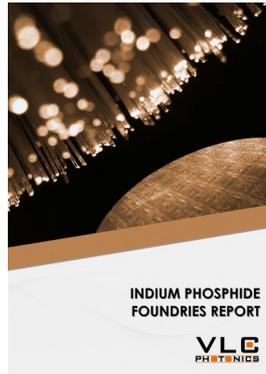


Silicon photonics foundries report

- 35 entries, 6 brokers, 180 pages

Indium Phosphide foundries report

- 20+ entries, 4 brokers, 150 pages



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