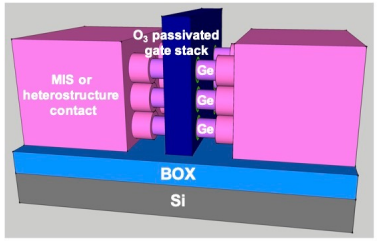
Saraswat Group Research

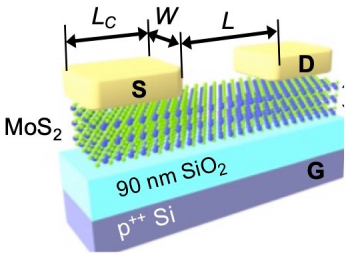
Objective
- Explore alternate materials and structures for nanoscale devices and interconnects for future ICs with scalability to beyond 10 nm node.
- Develop low-cost solar cell technology with efficiency to exceed what is possible with single junction silicon solar cell.

Nanoscale Electronic Device

Ge Nanowire MOSFET

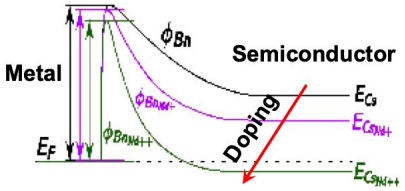


2D TMD MOSFET

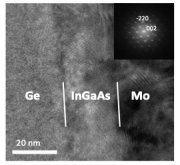


Low Resistance Nanoscale Contacts

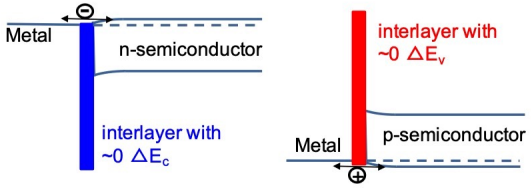
Decrease barrier thickness by increasing doping.
Best for n-Si, p-Ge, n-InAs



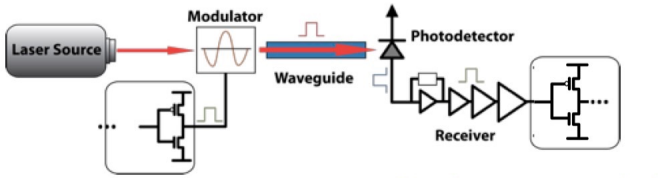
Heterostructures
e.g., p-Ge on p-Si
n-InGaAs on n-Ge
n-InGaAs on MoS_2



De-pinning Fermi level by metal - interlayer - semiconductor (MIS)
ZnO for n-contacts
NiO for p-contacts

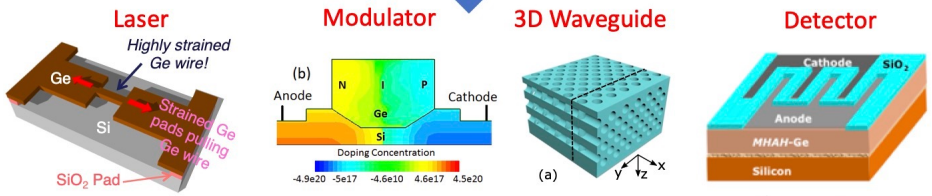


Ge Based Si CMOS Compatible Photonic Interconnects



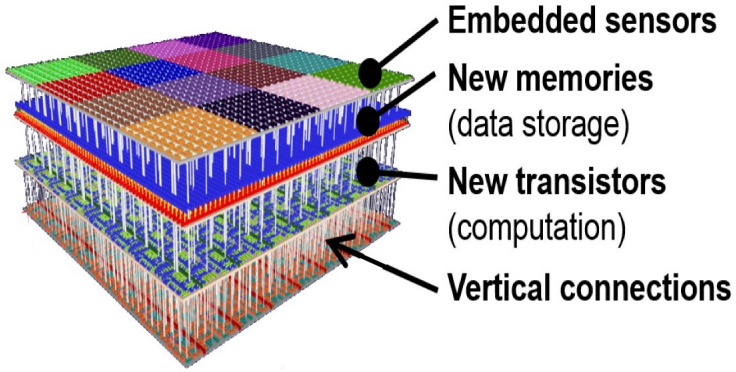
Laser/modulator converts electrical signal into optical signal

Photodector restores optical signal into electrical signal



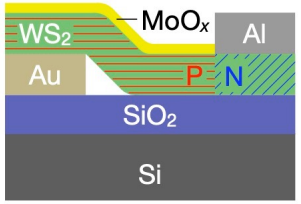
- **Ge based devices can be monolithically integrated on Si**
- **Laser is the only missing component to form optical interconnect**
- **Straining Ge and/or by adding Sn makes itdirect bandgap making lasing possible**

3D Integration

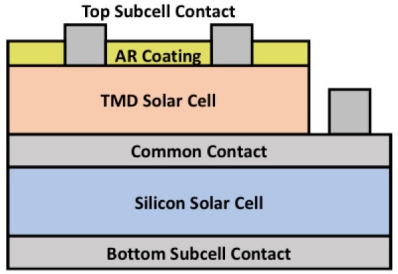


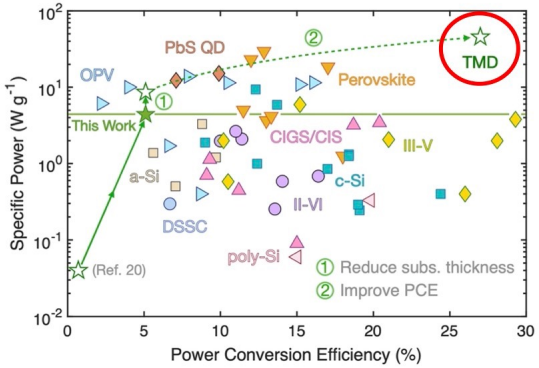
High Efficiency Solar Cells

TMD Solar Cell Using Junctionless MIS carrier selective contacts



TMD/Si MIS Tandem Solar Cell





- **Carrier selective contacts with wide band gap metal oxides suppress dark current by providing selectivity of both carriers**
- **TMDs like MoS_2, WSe_2, etc., on Si have the potential to develop a game-changing solar cell technology.**
- **Tandem solar cell with η >30% possible without requiring current or lattice matching**