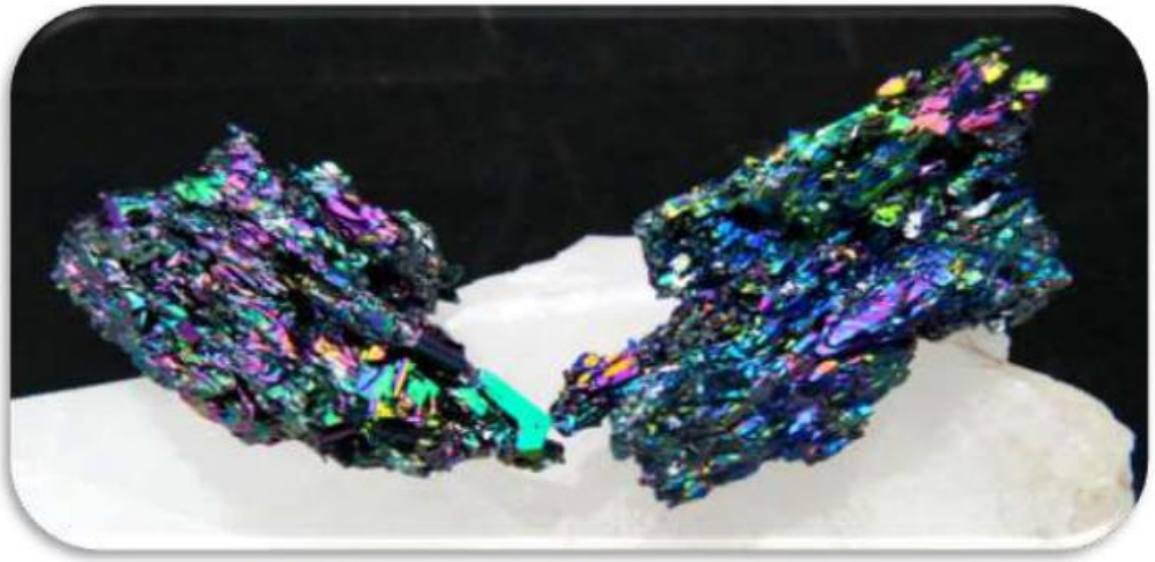
Evolving Frontiers

WBG
India Options
(Carried forward to Future Workshop)

Wide Band Semiconductors



Silicon Carbide

Gallium Nitride

Diamond

Semiconductor Materials		
Material	Chemical Symbol	Bandgap Energy (eV)
Germanium	Ge	0.7
Silicon	Si	1.1
Gallium Arsenide	GaAs	1.4
Silicon Carbide	SiC	3.3
Zinc Oxide	ZnO	3.4
Gallium Nitride	GaN	3.4
Diamond	C	5.5

APPLIED MATERIALS

What is Band Gap- and why does it matter…

- Band Gap is the energy required to excite an electron from the valence band to the conduction band.
- If band gap is large then a higher critical electric field is required to initiate impact ionization, thus causing avalanche breakdown.
- So the device will have high reverse voltage withstanding capability.
  Breakdown Voltage ∝ 1/2 * (Drift Width) * (Critical Electric Field)
- For same breakdown voltage, WBG device will be smaller.
- Due to large band energy high temperature is required to cause ionization, so high temperature operation possible

Parameter	Units	Silicon	GaN	SiC
Band Gap, Eg	eV	1.12	3.39	3.26
Critical Field, E_{Crit}	MV/cm	0.23	3.3	2.2
Electron Mobility, μ_n	$cm^2/V.s$	1400	1500	950
Permittivity, ε_r	_	11.8	9	9.7
Thermal Conductivity, λ	W/cm.K	1.5	1.3	3.8

APPLIED MATERIALS

Why WBG Semiconductors

- Lower on-resistance
- Faster switching speeds and lower switching losses
- Higher operating temperatures
- Better thermal conductivity
- Smaller size
- Lower cost
- Highly reliable and durable
- High voltage blocking capability

APPLIED MATERIALS®

Energy Saving and Carbon Foot Print

1. The impact of Wide Band Gap Semiconductor based power electronics on energy savings can be simply predicted by the energy saving record of IGBT Technology in America till date which is 15 Trillion Dollars which is equivalent to 15 lakh crore rupees.

2. The cumulative impact of IGBT technology in 20 years has reduced CO2 emissions by 2 Trillion Pounds which is the total CO2 emission by the world in 2 years.

APPLIED MATERIALS®

Wide Band Semiconductors impact on power-electronics, RF, Industrial Drives, Lighting, Chargers … profound and growing…

Applications & Impact

APPLIED
MATERIALS®
make possible