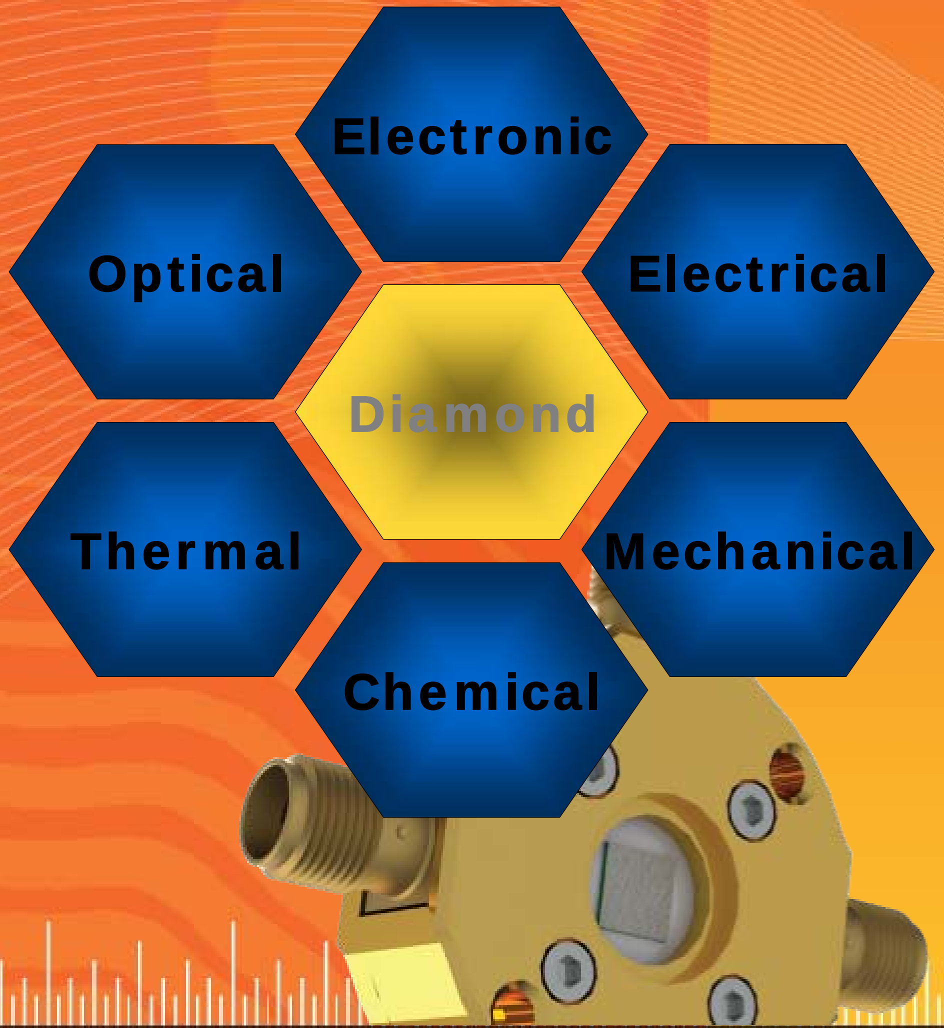
Properties of Diamond

Diamond Detectors Ltd

- Broad transmission spectrum
- Highest thermal conductivity
- Highest resistance to thermal shock
- Low thermal expansion coefficient
- High chemical (bio) inertness
- Highest Young’s modulus
- Highest Knoop hardness
- High tensile strength
- Good electrical insulator
- Good electrical conductor (doped)
- Low dielectric constant
- Low dielectric loss
- Wide electronic band gap
- High electronic mobility



Properties of Diamond

Diamond radiation detectors are able to detect deep UV photons, X-rays, gamma rays, electrons, alpha particles, charged ions and neutrons, with a dynamic range in energies spanning from 5.5 eV up to GeV of cosmic rays.

Since the bandgap of diamond is 5.5 eV this leads into a negligible dark current noise at room temperature with no need for cooling.

Metal diamond interfaces play a key role in the performance of the detectors as different metallization techniques lead to either "ohmic" or Schottky electrical contacts.

Intrinsic Properties

- Radiation Hardness
- Wide band gap 5.5eV (no thermally generated noise)
- Low Z (tissue equivalent)
- Low energy absorption
- High thermal conductivity
- High Hole and Electron Mobility

Detector Properties

- High sensitivity
- Good spatial and temporal resolution achievable
- Low leakage currents and stable *(< 0.01pA / pixel)*
- Low capacitance

Device Advantages

- Intrinsically simple device (no pn junction required)
- can fabricate robust, compact devices
- High temperature operation (no need for cooling)

Applications Include:

- High Energy Physics
- Civil Nuclear
- Medical Therapy / Dosimetry (X-ray & Particle Therapies)
- Synchrotrons and Cyclotrons
- Radiation Monitoring (nuclear, medical and oil & gas)
- Deep UV (< 240nm)

Properties of Diamond

Intrinsic Material Properties

	Si	4H-SiC	GaN	Natural Diamond	CVD Diamond	Potential device application benefit
Bandgap (eV)	1.1	3.2	3.44	5.47	5.47	High temperature
Breakdown field ($MVcm^{-1}$)	0.3	3	5	10	10	High voltage
Electron saturation velocity ($x10^7$ cm s^{-1})	0.86	3	2.5	2	2	High frequency
Hole saturation velocity ($x10^7$ cm s^{-1})	n/a	n/a	n/a	0.8	0.8	
Electron mobility (cm^2 V^{-1} s^{-1})	1450	900	440	200–2800	4500	
Hole mobility (cm^2 V^{-1} s^{-1})	480	120	200	1800–2100	3800	
Thermal conductivity (Wcm^{-1} K^{-1})	1.5	5	1.3	22	24	High power
Johnson's figure of merit	1	410	280	8200	8200	Power-frequency product
Keyes' figure of merit	1	5.1	1.8	32	32	Transistor behavior thermal limit
Baliga's figure of merit	1	290	910	882	17200	Unipolar HF device performance

Isberg, J., *et al.*, *Science* (2002) 297, 1670

Chris J. H. Wort* and Richard S. Balmer

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