SINGLE CRYSTAL DIAMOND

Diamond can be doped using boron (p-type) and phosphorus (n-type) during synthesis. Thus it is feasible to build diamond electronic devices, which is an emerging research field.

Single crystalline diamond and its doped variations can be produced using chemical vapor deposition technology. As shown in the center picture above it is possible to simultaneously produce many crystals in a single synthesis run. Similar to the development of silicon carbide and gallium nitride wafers it is expected that ever-larger diamond plates will become available and thus further reduce the costs of the material for electronic device and other application development.

SINGLE CRYSTAL DIAMOND

Single crystalline diamond (SCD) has extraordinary physical properties, which makes diamond the material of choice for many challenging applications. Diamond is not only the hardest material. It also offers a unique combination of properties relevant to high power and high frequency electronic applications:

- Highest thermal conductivity of 2200 W·m⁻¹·K⁻¹
- Widest band gap of 5.45 eV
- Largest electric breakdown field of 106 V·cm⁻¹
- Highest saturation electron drift velocity of 2.7·10⁷ cm·s⁻¹

The graph shown on this page compares several wide bandgap semiconductor materials in terms of a “Figure of Merit” indicating the excellent potential of diamond as a power semiconductor material.
OUR OFFER

CCD offers the development of single crystalline diamond material tailored to customer specifications. Examples are freestanding SCD plates of up to 8×8 mm² in size and crystals shaped for specific applications. Our in-house fabrication capabilities enable material development and prototype production of complex SCD products.

SCD GROWTH

Single crystal diamond is grown by in-house developed state-of-the-art microwave plasma assisted chemical vapor deposition technology. High process pressure synthesis at 380 Torr (0.5 atm) achieves more than 1 mm of homoepitaxial diamond growth per day. When using 8×8 mm² seed crystals this rate produces more than 1 carat of diamond per day per seed. Post-processing includes laser cutting and mechanical polishing to obtain freestanding plates and shaped crystals.

A diamond synthesis process was developed to produce optical grade type Iia SCD material. The nitrogen content in the fabricate crystals is less than 500 ppb and there is little optical absorption for photon energies below the bandgap (wavelengths greater than 225 nm).

SCD PROCESSING

In-house post diamond growth fabrication capabilities include wet chemical etching, plasma dry etching, mechanical polishing and laser cutting.

Grown SCD material is sliced off its seed crystal via laser cutting. After mechanical polishing freestanding high quality crystals are obtained as a semi-finished product. These crystals can then be sliced to produce diamond plates for wafer based applications or they can be shaped into specific geometries as requested by the customer (see for example the attenuated total reflection spectroscopy crystals shown in the photo on top of this page).

SCD DEVICES

CCD has capabilities of manufacturing electronic SCD devices such as pn- and Schottky-barrier diodes. Device fabrication and characterization is carried out in our cleanroom facility.

SCD PRODUCTS

Optical grade intrinsic SCD diamond can be used for:

- Attenuated Total Reflection (ATR) crystals
- Raman laser crystals
- Raman probes
- Heat spreaders
- X-ray optical components
- Freestanding SCD plates (diamond wafers)
- Gemstones

Electronic grade intrinsic and doped single crystalline diamond can be used for:

- Radiation detectors
- Spin electronic devices
- High power high frequency electronic devices