Partial Discharge (PD) is the localized electrical breakdown of a small portion of insulation between two electrodes, but not the complete electrical breakdown of the insulating material. The discharge phenomena is repeated every cycle and the electrical stress can cause PD activity in air bubble inside transformer oil, PD activity at insulation material interface, and PD current spikes.

**CAUSE OF PARTIAL DISCHARGE:**
Concentrated electric field lines (relatively higher electrical stress) in voids where the electrical permittivity is much higher than that of the surrounding area may lead to PD. The void/gap may be air bubbles, and the insulating material may be solid or liquid. The discharge phenomena is repeated every cycle and the voids may grow bigger due to charge bombardment during discharge, and high current leading to high temperatures that alter the chemistry of the material in that region.

E-fields can also concentrate in a region due to local charge densities that are relatively higher than the surrounding material. Example: At sharp corners and asperities in a conductor.

The theoretical model for E-field and charge accumulation near a corner, where $\theta$ is the angle of opening between connecting conductors and $\alpha$ is the distance from the corner.

**EFFECT OF PARTIAL DISCHARGE:**
PD within an insulator degrades the material, leading to reduced lifetime of the insulation. This makes power modules less reliable. This effect is exacerbated when operating at higher frequency, power, temperature, and altitude.

Ultimately, PD can cause complete electrical breakdown which may be catastrophic. This electrical stress can be relieved by chamfering or filleting which showed at least 2x improvement.

**Corner Correction:**

There is significant impact in filleting a sharp corner, but the impact reduces with increase in fill size.

**Observations from Experiments:**
Subjecting samples with sharp corners and no sharp corners to increasingly higher voltages confirmed that filleting indeed helps. Samples with no sharp corners could sustain higher voltages compared to those with sharp corners.

**Fabrication and Test Setup:**
The test coupons were fabricated on single sided copper clad FR4 substrate using a milling machine with minimum tool tip size of 127 μm (5 mils). The Valhalla Scientific hi-milling machine with minimum tool tip size of 127 μm was used to apply voltage between 100 V and 3 kV. The test coupons were fabricated on single sided copper clad FR4 substrate using a milling machine with minimum tool tip size of 127 μm (5 mils). The Valhalla Scientific hi-milling machine with minimum tool tip size of 127 μm was used to apply voltage between 100 V and 3 kV.

**Corner Correction at the Design Stage:**

Post Layout Optimization in PowerSynth

**Device & Layer Information:**
- Model
- Multi-Objective Optimization
- Layout Solution Set
- Expert Solution

Impact of filleting on adjacent components and total footprint → Future work.