

Study Committee D1
Materials and Emerging Test Techniques
Paper D1-PS2-11161

A test setup to find the relation between interfacial pressure and tangential breakdown voltage of epoxy/silicone rubber interface

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Motivation

- Advent of standardized plug-in cable – GIS interfaces (CIGRE B1 – B3.49 JWG)
- Detailed study and testing of the epoxy/silicone rubber interface
- To determine a relation between the interfacial pressure and the tangential electric breakdown field strength.
- To develop the newly standardized inner-cone cable accessories

Requirements for interface testing

The CIGRE WG 15-10, in 1996 developed the following requirements for interface testing test cells. The test cells should:

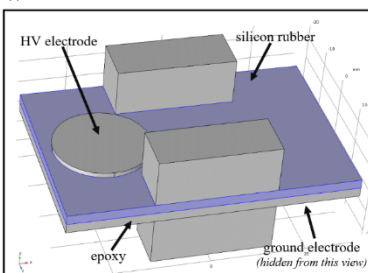
- Have a **simple configuration** that is **easy to reproduce**
- Have **no metal electrode** at the interface
- Allow various **defects** to be introduced
- Enable study of **mechanical pressure effects**
- Enable study of **surface roughness effects**
- Enable study of effect of **silicone oil** and other **lubricants**

Existing test setups/ literature

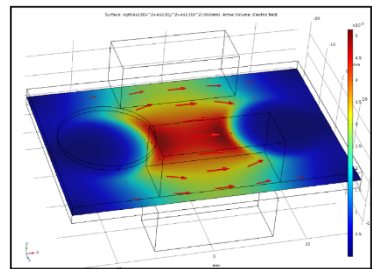
- not easy to recreate
- require to be immersed in oil or insulating gel
- non-uniform electric field distribution
- presence of metal electrodes at the interface

Possible test setups

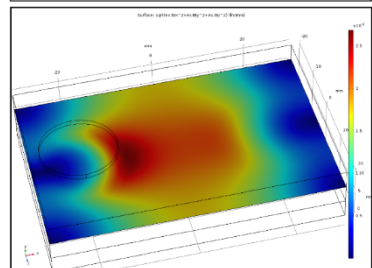
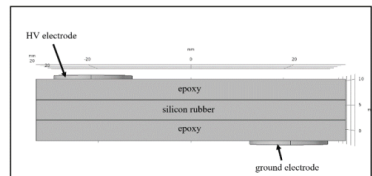
- Type 1



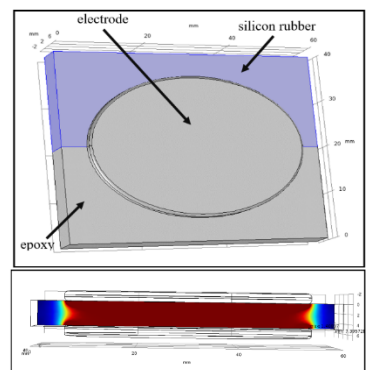
Possible test setups (contd..)



- Type 2



- Type 3



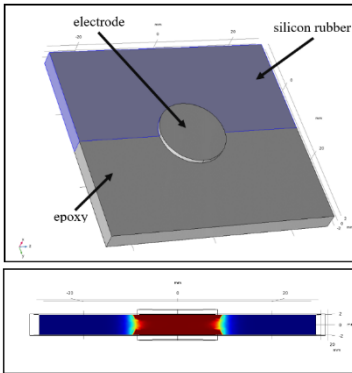
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Possible test setups (contd..)

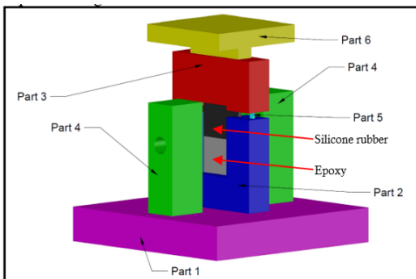
- Type 4



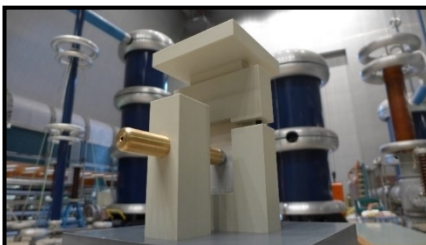
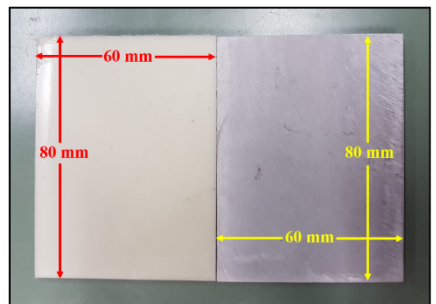
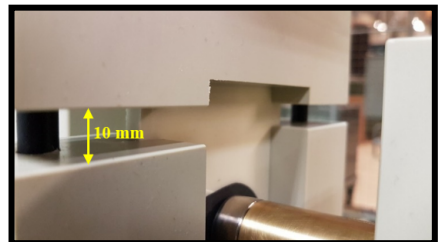
Salient features

- Have a **simple configuration** that is **easy to reproduce**
 - Modular test equipment
 - Can be 3D printed
- Have **no metal electrode** at the interface
 - Semiconductive tape is applied between electrode and interface
- Allow various **defects** to be introduced
 - Can be introduced. Has been tested.
- Enable study of **mechanical pressure effects**
 - Can be done. Has been tested.
 - Modularity of test setup helps to scale up/ down.
- Enable study of **surface roughness effects**
 - Can be introduced. Has been tested.
- Enable study of effect of **silicone oil** and other **lubricants**
 - Can be done. Has been tested.

Proposed test setup



- Part 1- base plate
- Part 2- Sample holder (bottom)
- Part 3- Sample holder (top)
- Part 4- Electrode holder
- Part 5- Guiding rod
- Part 6- Weight carrying plate



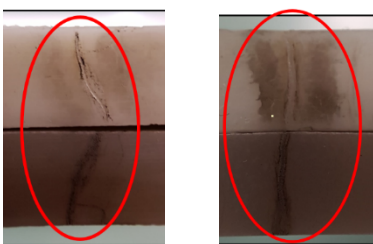
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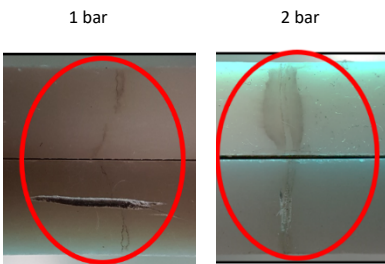
AC breakdown test

- With interfacial pressure



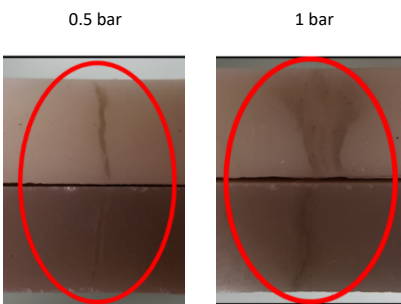
AC breakdown test with defect

- With interfacial pressure



AC breakdown test with heated samples

- With interfacial pressure

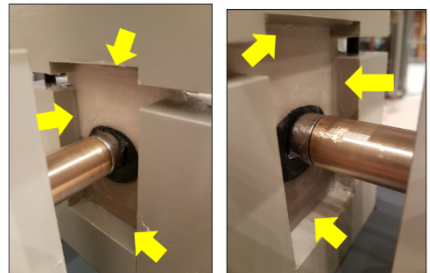


AC breakdown test with oil at interface

- Flashover at 50 kV through the inner slit
- Considered as the limit of the test setup

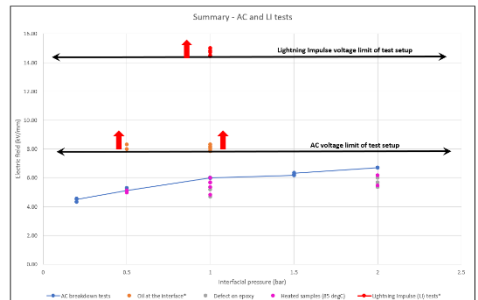
Lightning impulse tests

- Silicon grease applied to inner corners and sides



Conclusion

- Summary of test results



- As interfacial pressure increases, breakdown voltage increases
- AC voltage limit of test setup: 50 kV
- LI voltage limit of test setup: 90 kV
- Test setup can be put in vacuum/ SF6
- Future recommendations:
 - DC and low frequency AC conditions
 - Larger sample size