The Tony Davies High Voltage Laboratory

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UNIVERSITY OF Southampton

Surface Fluorinated Epoxy Resin for High Voltage DC Application

Dielectric 2013

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- Fluorination Treatment
- Experiment procedure
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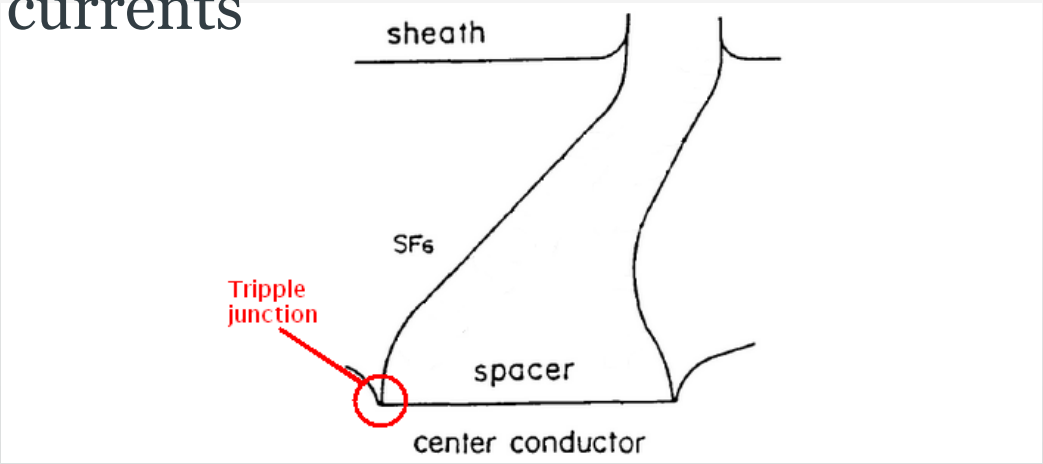
Project Aim

- To study how various fluorinating conditions enhance dielectric properties of epoxy resin where the prepared samples will be experimentally investigated as well as electrically characterised and tested

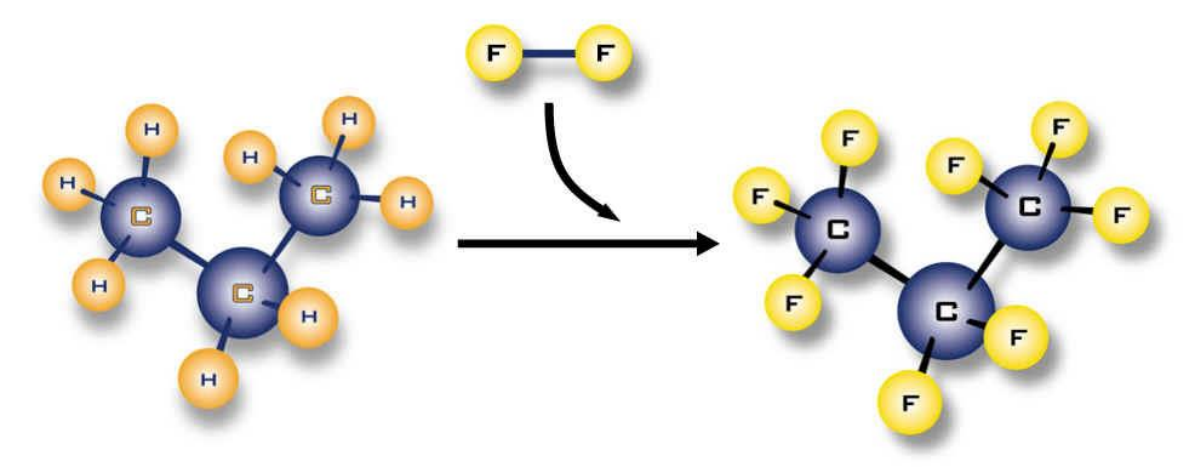
Background Problem

- Prolonged use of HV DC GIS shows an unforeseen behaviour concerning the electric stresses at triple junction
- The static surface charges distort local field and cause significant drop in spacer DC flashover
- These charges are generated by various ionization mechanisms in the adjacent gas and both surface and bulk ohmic conduction currents



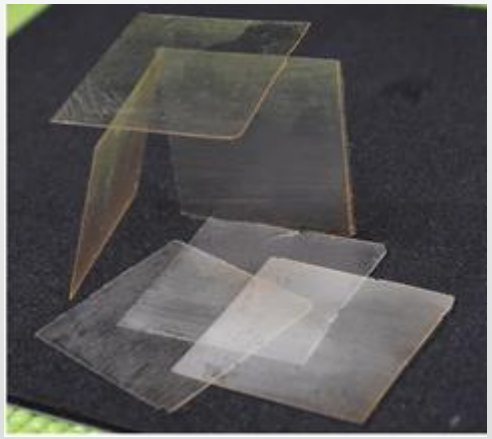
Fluorination Treatment

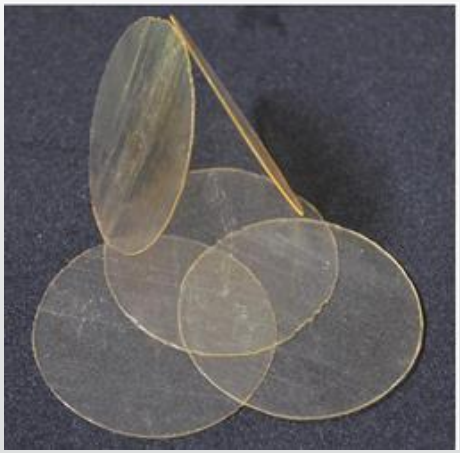
- Treatment of polymeric materials with fluorine or fluorine-inert gas (nitrogen, helium etc.) mixtures
- Improves wettability, adhesion, chemical stability, barrier properties, biocompatibility, and grafting
- Hydrogen atoms are substituted by while double and conjugated bonds are saturated with fluorine



Sample Preparation

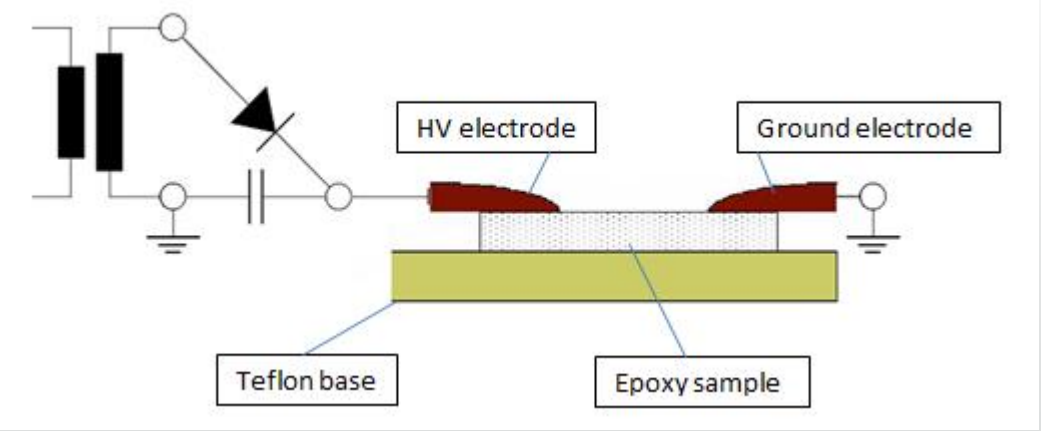
- Bisphenol-A type epoxy resin (Araldite LY556) together with anhydride hardener (Aradur 917) and imidazole accelerator (DY070) are used to make epoxy samples
- The cured samples are sent to Tongji University, China for fluorination treatment
- Three different fluorination times are done; 10min, 30min and 60min





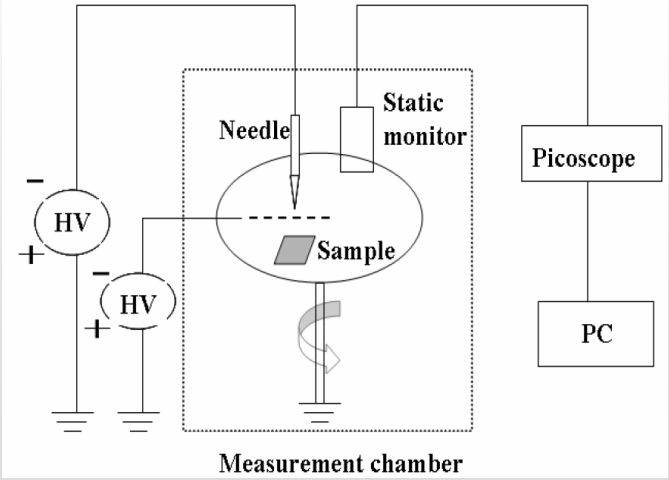
DC Flashover Test

- The flashover kit consist of 2 finger electrodes with 8mm gap
- The HV DC is generated by Haefely Trench high voltage construction kit
- The samples are subjected to a linearly increased voltage until they underwent flashover



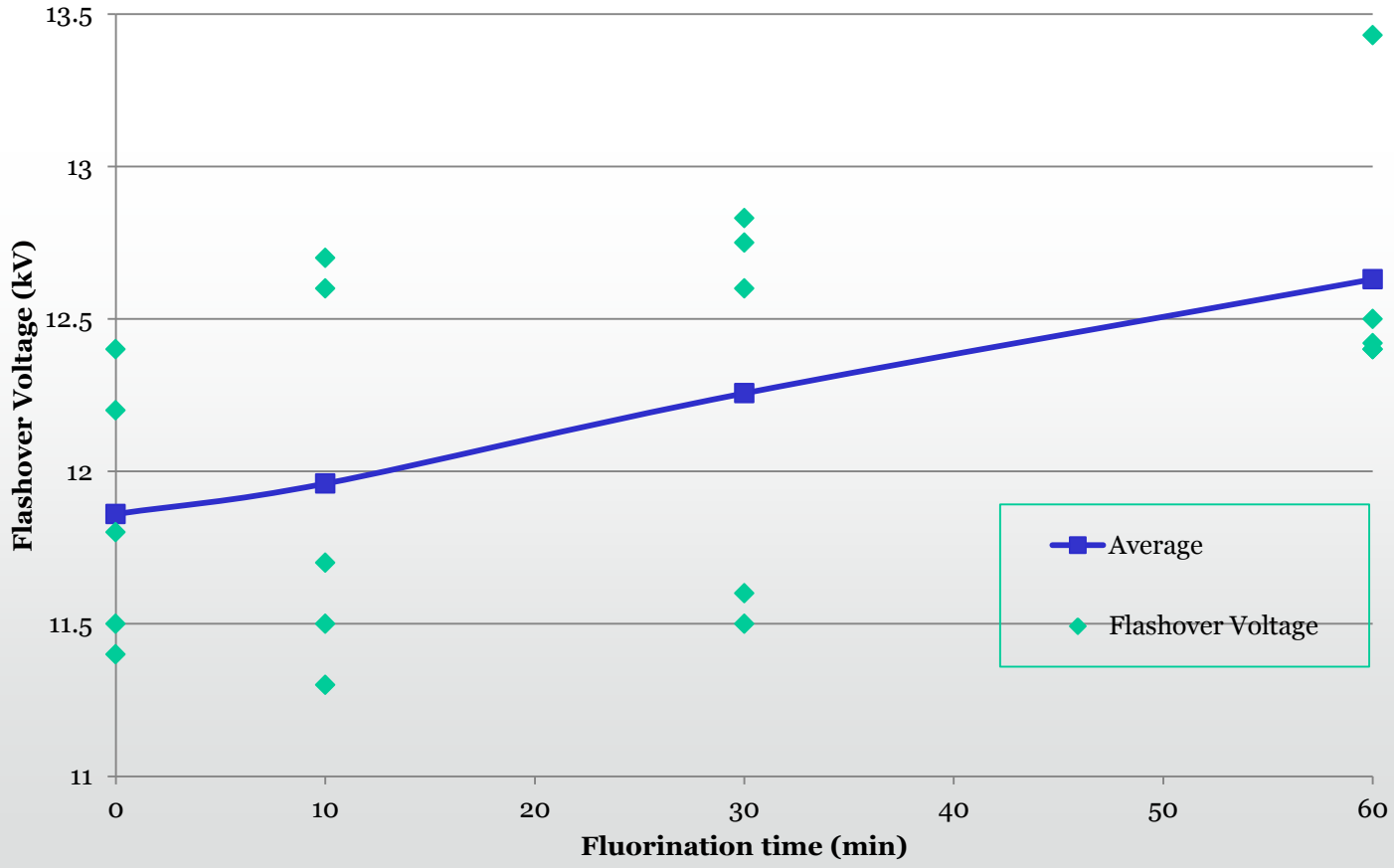
Surface Potential Decay

- Measurement tool to characterize charge carrier mobility and trap parameters for each fluorination conditions
- The epoxy samples are negatively charged by corona effect on their free surface for 1 minute
- The sample is quickly moved with the rotating system towards a compact JCI 140 static monitor to measure the surface potential decay



DC Flashover results

- There is a clear trend of increasing surface breakdown strength as the fluorination time increases



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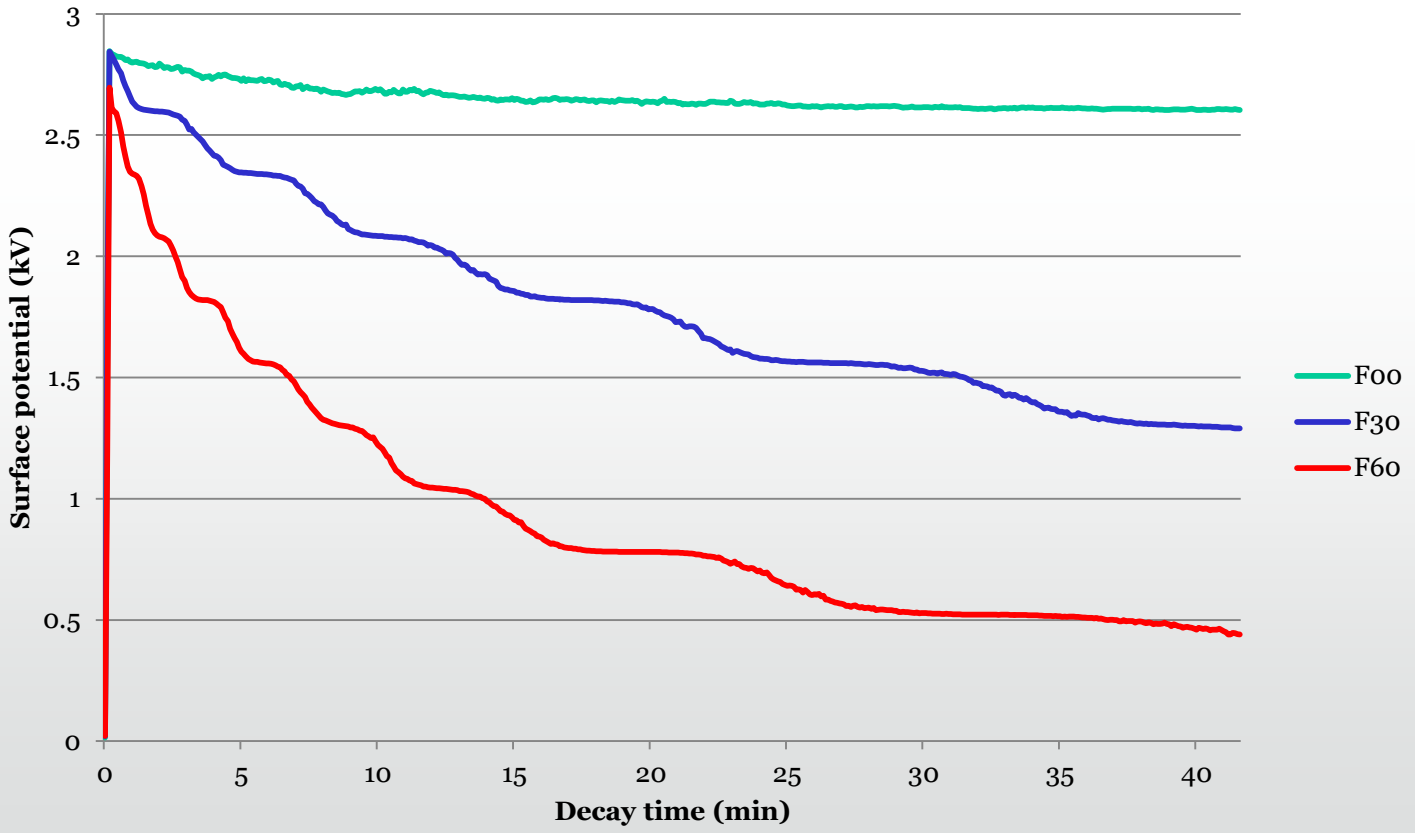
- With the introduction of fluorinated substituent onto the surface of epoxy resin sample, the resistivity along the dielectric surface is relatively decreased
- Decrease in surface resistivity enables any trapped charges on the surface to leak away faster and this reduces their effect in enhancing the local electric field of epoxy resin

Surface Potential Decay results

- There is a clear trend of increasing surface potential decay rate as the fluorination time increases



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- The movement of charge into the bulk or along the surface will lower the surface potential
- As the conductivity of surface increase (fluorination time increases), charges move faster into the bulk or along the surface
- PEA method need to be utilised in order to determine the responsible mechanism behind the decay

Conclusion

- The results of this study indicate that the introduction of fluorinated layer on epoxy resin appears to play a significant role in improving the dielectric properties of epoxy resin as seen from DC flashover tests and surface potential decay measurements

Future work

- A study similar to this one should be carried out inside fully encapsulated high pressure SF6 gas insulated system
- Test using PEA method on the samples is necessary to accurately determine the possible mechanism of potential decay which contribute towards this trend, be it surface or bulk ohmic conduction
- To assess the effects of other type of chemical treatment such as plasma onto the surface of epoxy resin and its influence on the dielectric properties


Thank you for your attention