

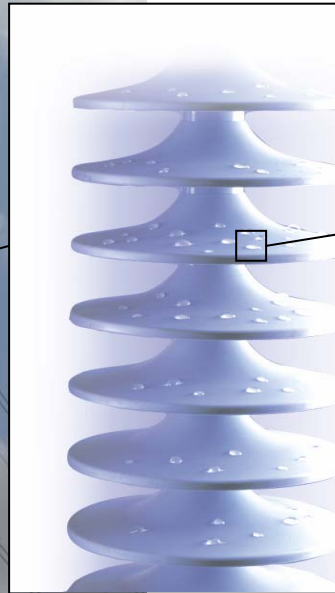
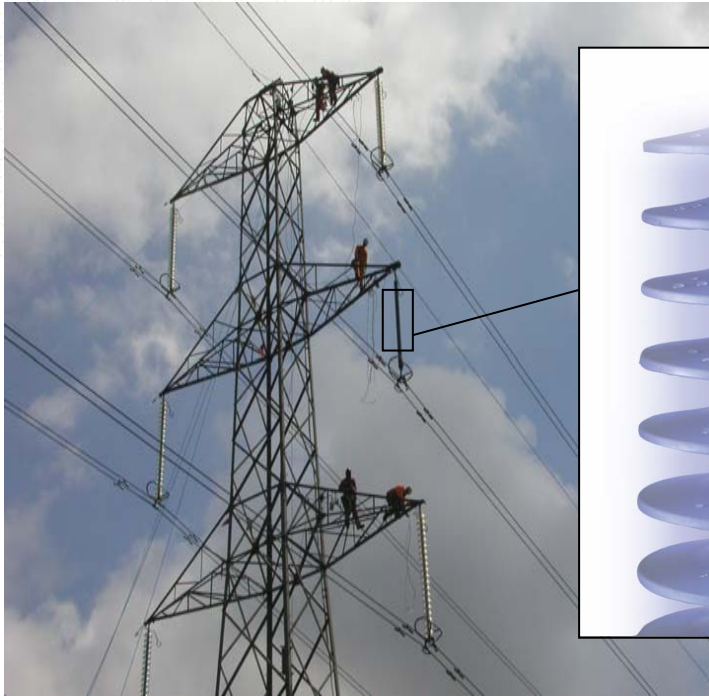
# Outdoor HV polymeric insulation

## Progressive ageing or event driven ageing?

Simon Rowland

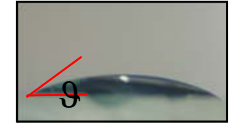
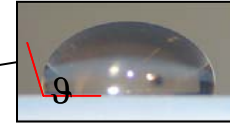
The University of Manchester

# Ageing of insulators

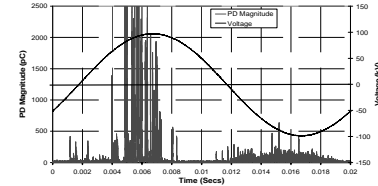
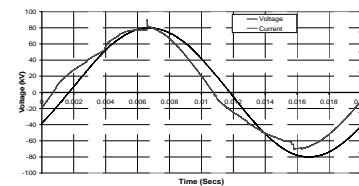


Indicators show gradual change:

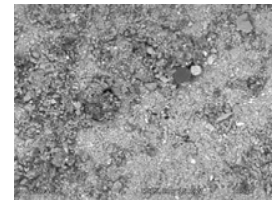
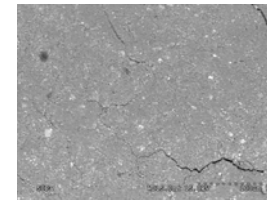
Hydrophobicity:



Partial discharge and leakage currents:



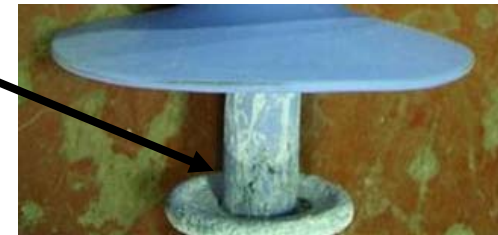
Microscopy:



Chemical analysis: FTIR, EDX

The gradual ageing provides the situation to develop whereby significant activity can then result in aggressive short term damage of a different nature:

Does the high temperature arcing damage result from continuous processes, or from adventitious circumstances?

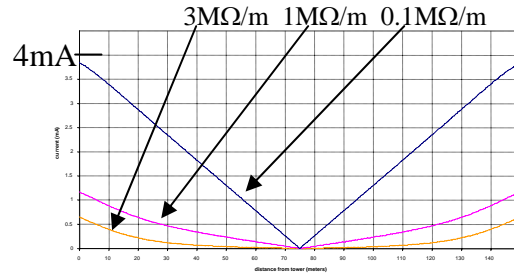
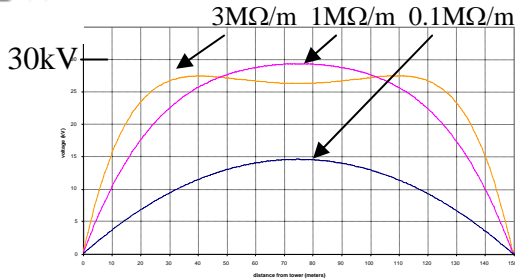
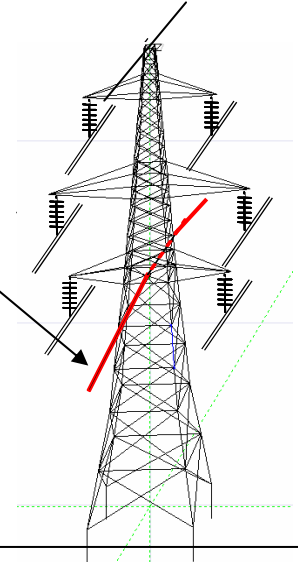


# Ageing of ADSS cables

**Compared to standard insulators:**

- High source impedance
- Low maximum current (5 mA)
- Low typical current (0.01 mA)

All dielectric self-supporting optical cable



**Indicators show initial gradual change:**

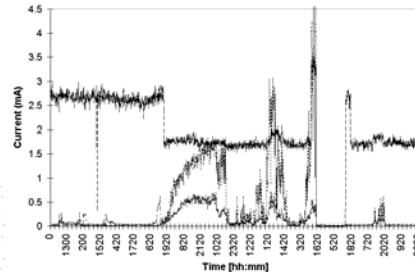
- Hydrophobicity:
- Partial discharge and leakage currents:
- Microscopy:
- Chemical analysis: FTIR, EDX

**Gradual ageing changes the situation so aggressive damage of a different nature occurs:**

- gradual ageing leads to possibility of dry-band arcs
- abnormal weather leads to leads to dry-band arc compression
- we require wind and high pollution

After years of ageing, rare circumstances lead to:

- > mobile moisture
- > high currents



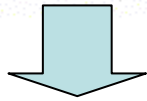
Severe damage in minutes



# The common thread

## Insulators (e.g.)

- surface degradation
- increased currents
- dry-band arcing



- severe ageing and erosion
- failure

**Anomalous environment key?**

## Gradual ageing

- average conditions key
- process measurable
- condition measurable

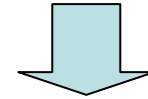


## Key changes of state

- anomalous condition key
- process fast?
- conditions transient?

## Cables (e.g.)

- bulk degradation
- water tree growth



- electrical tree initiation
- electrical tree growth
- failure

**Voltage impulses key?**

## Issues for management of assets

- what is gradual ageing? what can I measure?
- when does ageing cause a change of state?
- how do I measure this?
- which conditions create critical ageing conditions?
- **what are the prospects for identifying key changes in practical insulation?**