Final Webinar of the GRIDABLE Project

14th June 2021

PLASTIC NANOCOMPOSITE INSULATION MATERIAL ENABLING RELIABLE INTEGRATION OF RENEWABLES AND DC STORAGE TECHNOLOGIES IN THE AC ENERGY GRID

Fundamental properties of dielectrics for extruded cables

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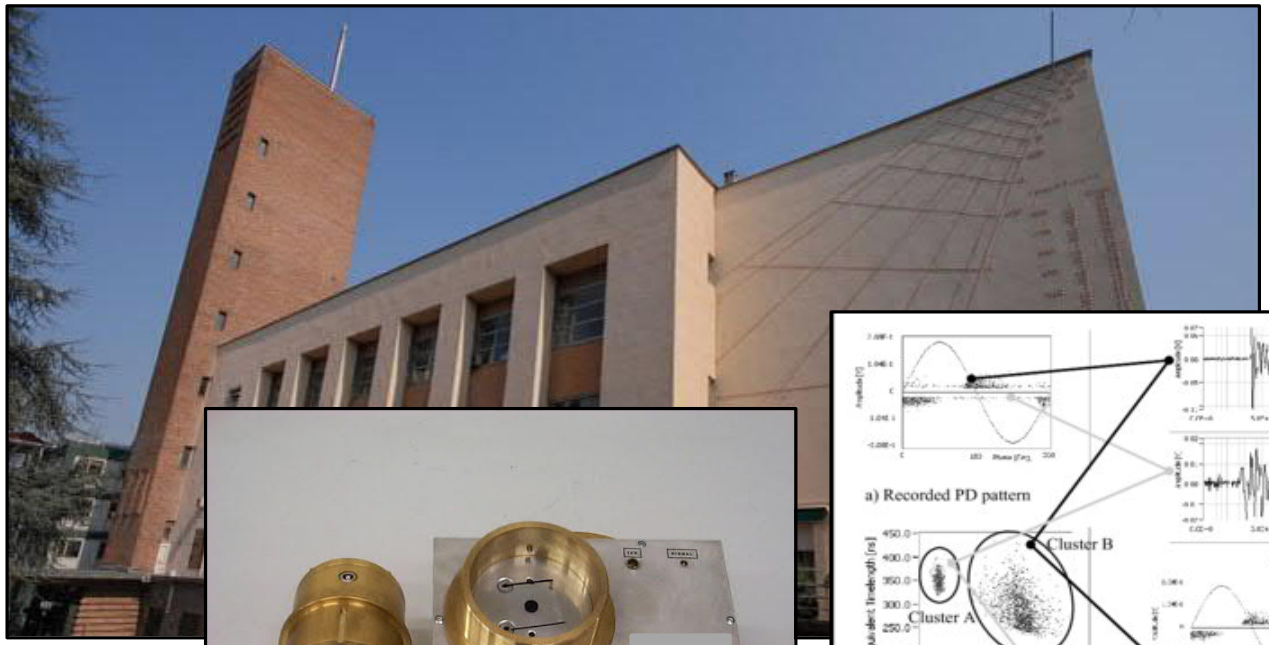
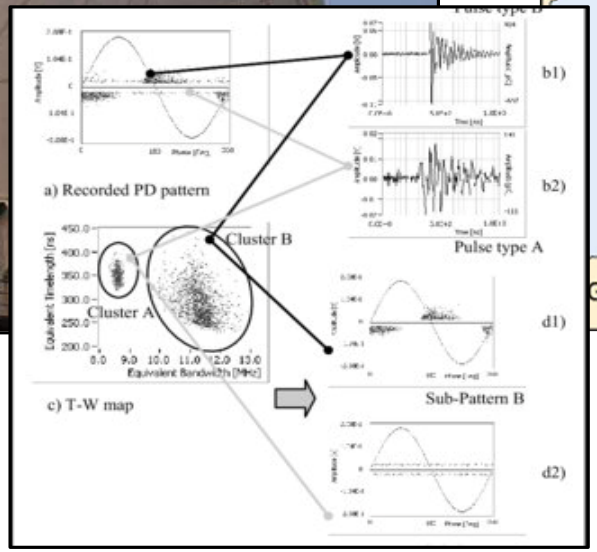
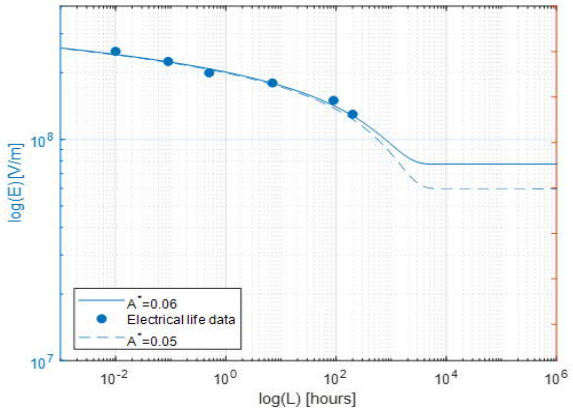
LIMES in a nutshell

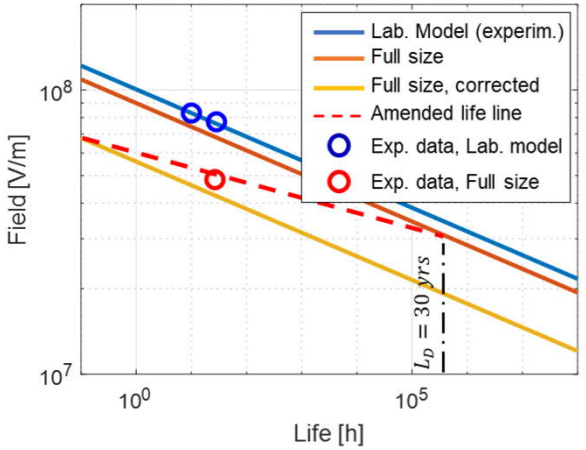




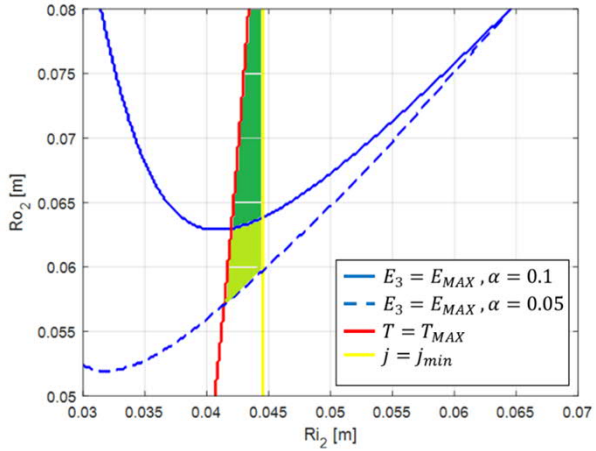
Our activities

- Life modelling
  - Electromechanical modelling
  - Dimensional effects
  - Cumulative damage based design





- Characterization of dielectrics for HVDC applications
  - Cables
  - Capacitors
  - Optimization algorithms
  - Tailoring of dielectric properties



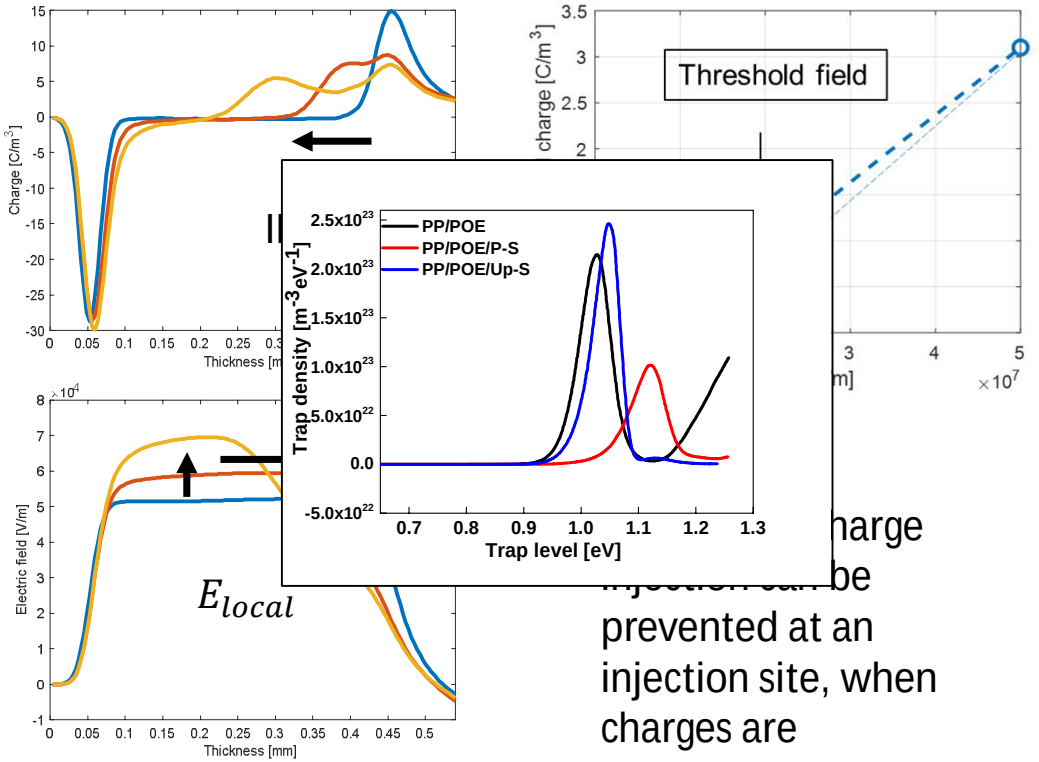
Space charge and aging

Space charge can be a source of local field intensification.

This is a key property to evaluate in the development of a new material.

When voltage is constant and field is locally intensified, there must be a region where field is reduced to values below the threshold field.

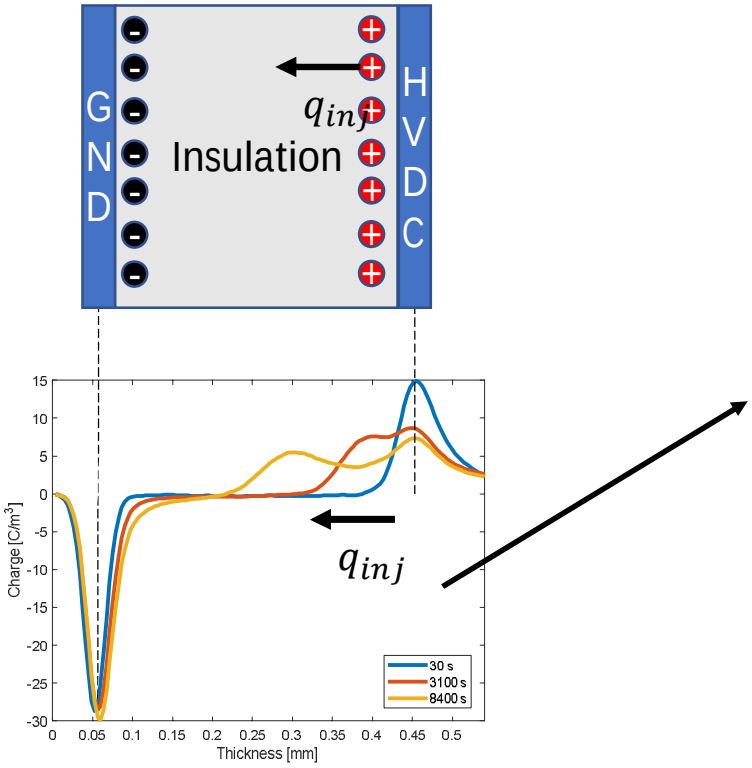
This can be exploited to prevent further charge injection.

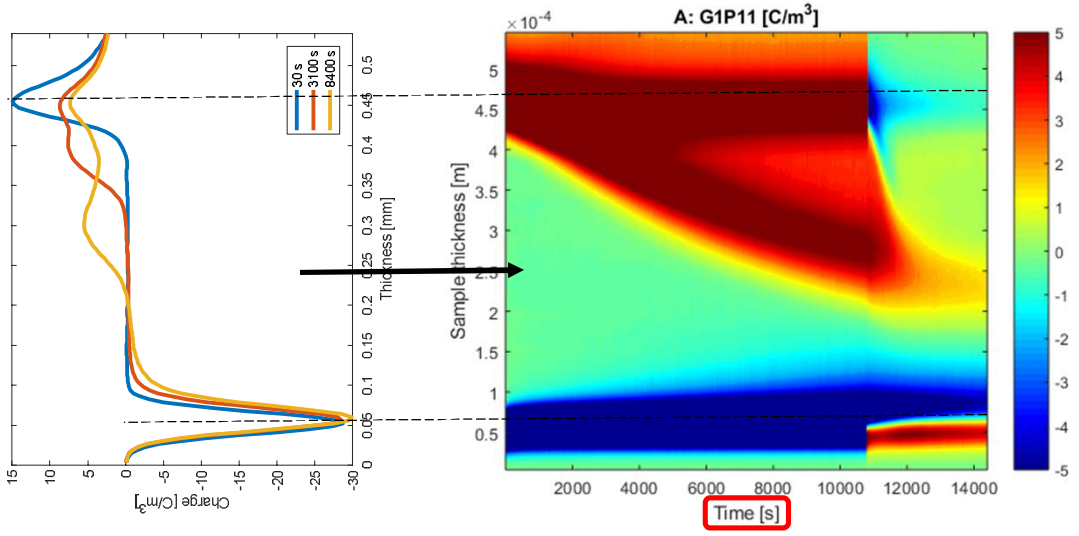


harge
be
prevented at an injection site, when charges are immediately trapped!

PEA patterns

- From signals to patterns



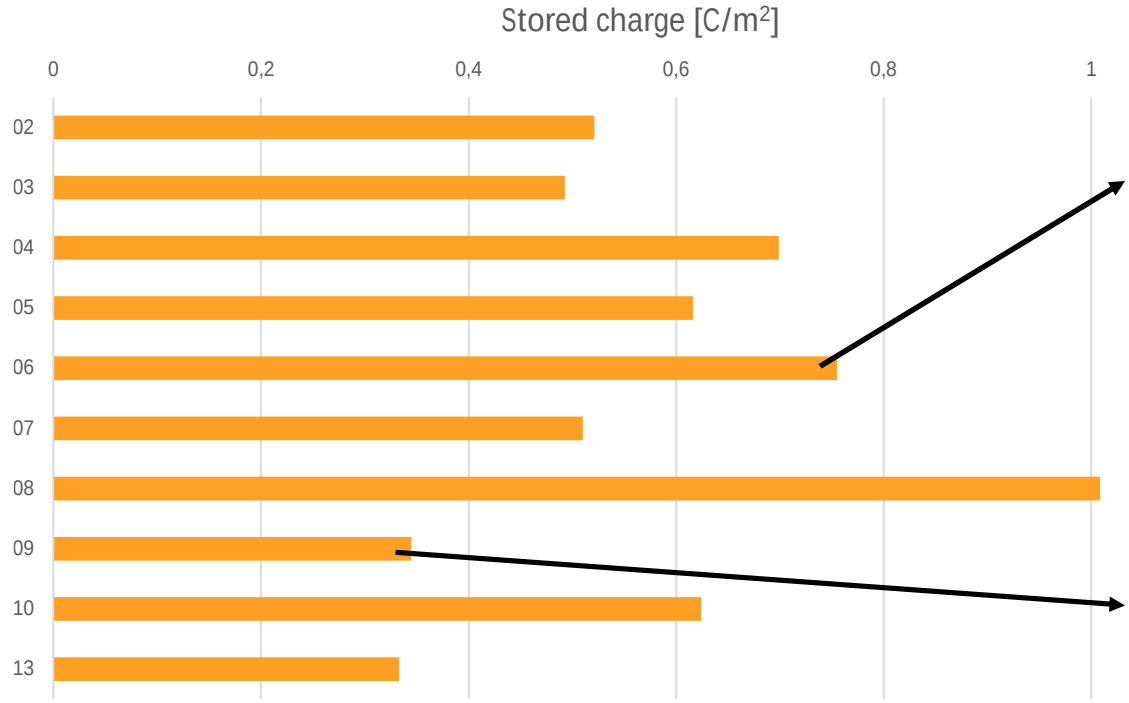


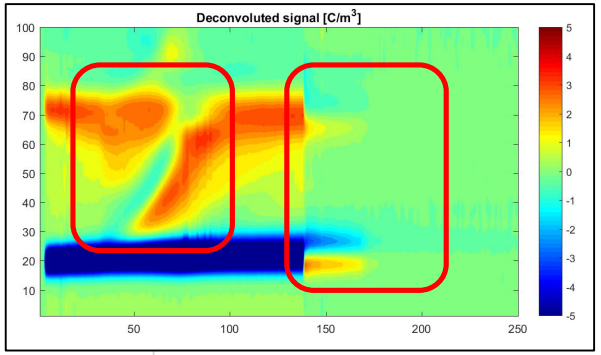
x-axis = time
y-axis = space
Color = Charge density

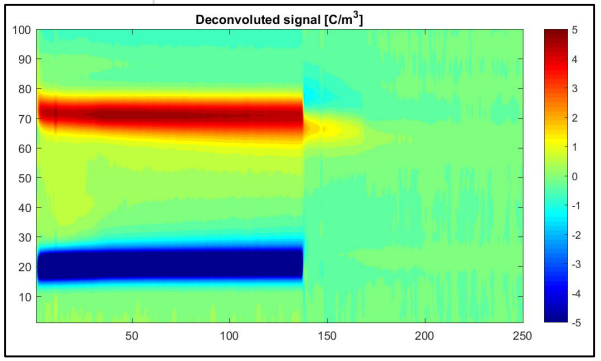
1 signal per second, during a polarization period.

Characterization of dielectrics: preliminary results

- Neat resins





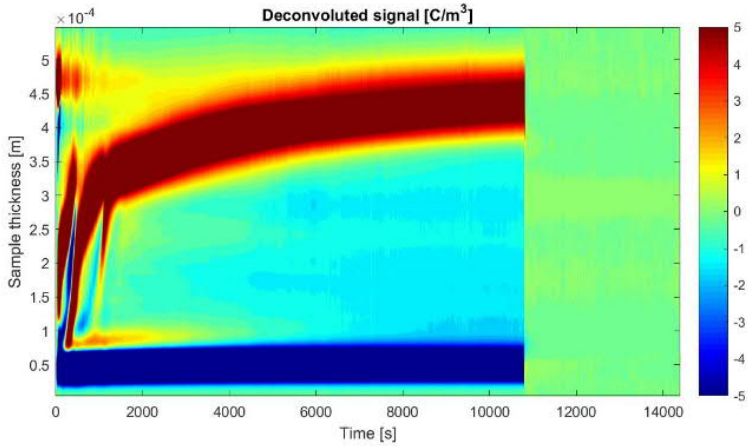


... > 200 recipes in total at the end of the project

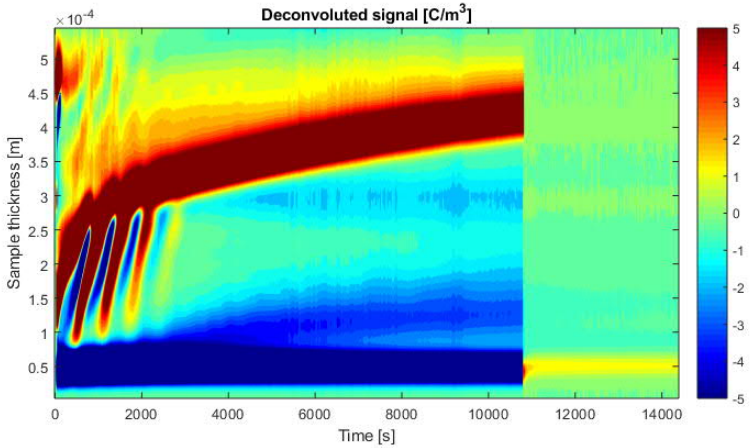
Characterization of dielectrics

- Space charge accumulation (better or on par with XLPE)
- Conductivity (mild increase)
- Loss tangent (on par)
- Dielectric strength (increase)

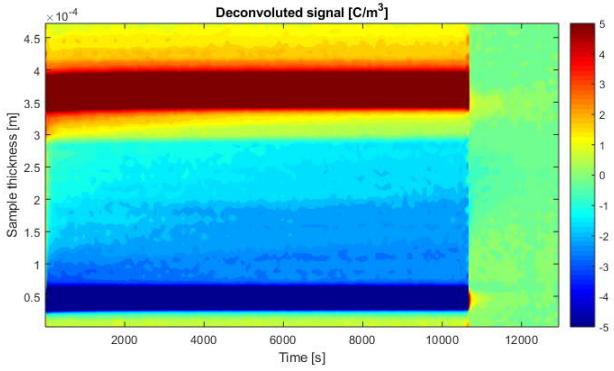
Neat



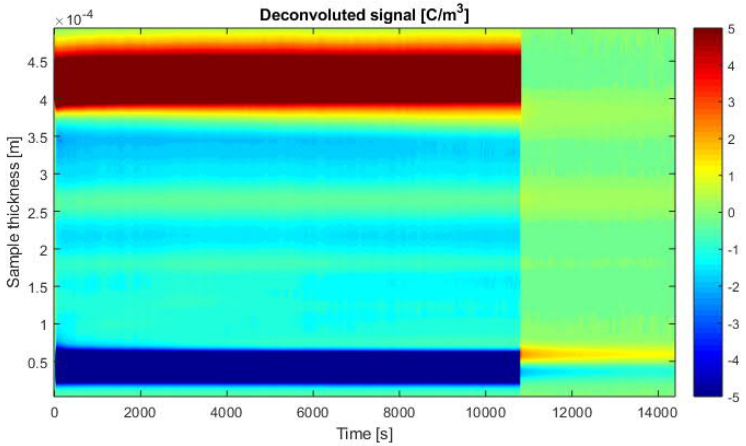
Neat + SiO2



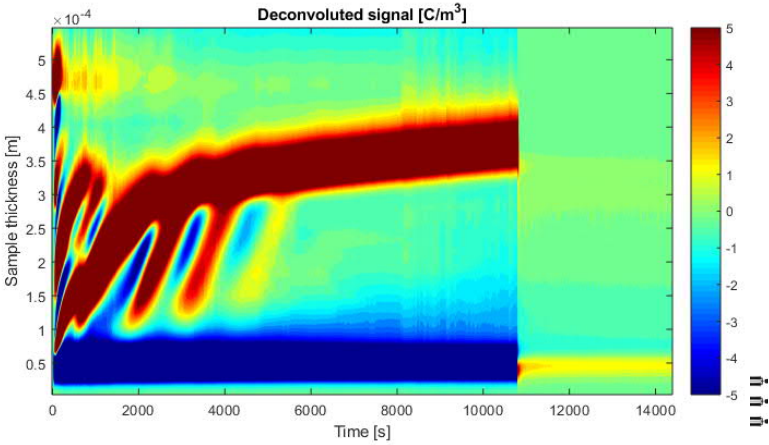
XLPE (fully de-gassed)



Neat + SiO2 + Functionalization A



Neat + SiO2 + Functionalization B

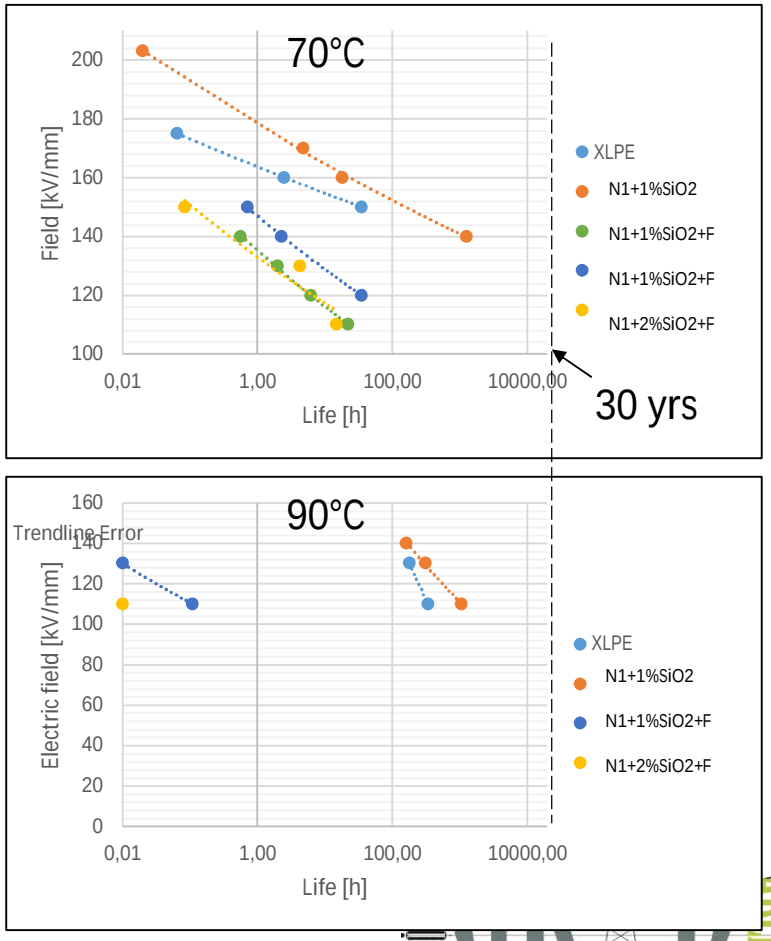


Characterization of dielectrics: life modelling

$$L = C \cdot E^{-n}$$

- The performance of the neat material seems to be better overall, with life exceeding results of XLPE of roughly one order of magnitude.
- However, extrapolation results in similar values for those two alternatives, due to a higher VEC value of XLPE.
- No nanostructured blend is capable to replicate or improve the results of neat, or XLPE.
- Design field is reduced at 70°C, but clear advantages at 90°C.

Temperature	70°C		90°C	
Material	VEC [-]	Design field [kV/mm] ($L = 30\ yr$)	VEC [-]	Design field [kV/mm] ($L = 30\ yr$)
XLPE	41.6	121.2	3.8	N/A
Neat 1	29.4	116.4	7.7	60.1
Neat 1 + 1% SiO2 + F	15.1	59.4	14.2	9.2
Neat 1 + 1% SiO2 + F	17.5	72.1	-	-
Neat 1 + 2% SiO2	18.5	67.7	-	-



Characterization of dielectrics: conclusions

- A new blend capable of competing with XLPE, with improved high temperature performance, was produced in this project
- Nanofilling helped in reducing space charge accumulation, hence electric field distortion
- A mild increase of conductivity was observed, in particular due to a high electric field dependancy
- No clear advantages were observed in long term life tests after introducing fillers in the polymeric matrix developed here

Thanks for your attention

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