Fibers Desizing Updates

Javier Osuna

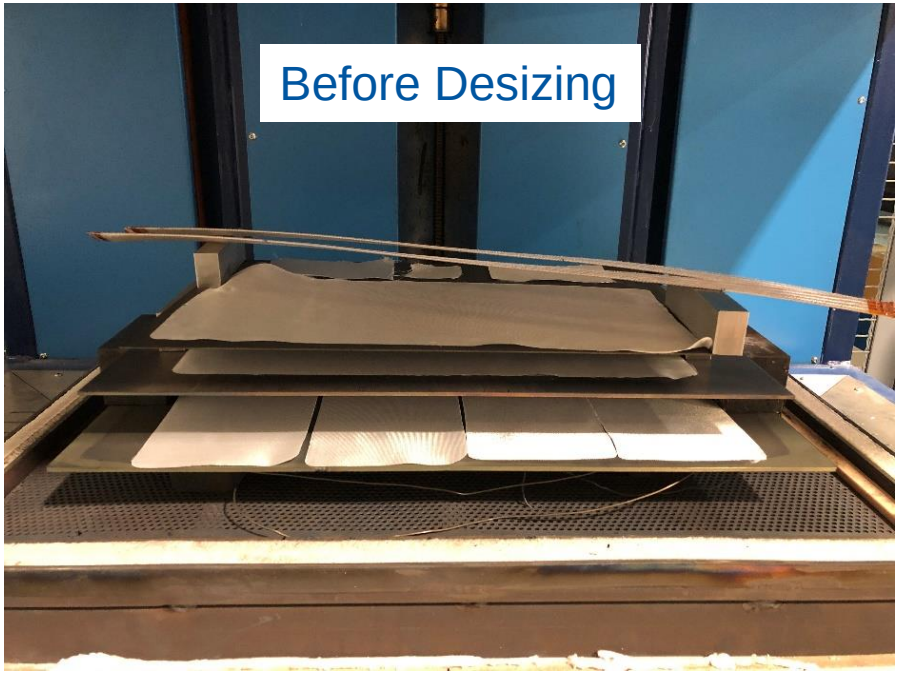
Summary of Experiments/Tests

1. Thermal Desizing + Reaction Cycle (48h at 650C in Ar)
   - Making plates for **electrical tests** (S2 Glass, Quartzel)
   - Study of cable **conductor oxidation** during thermal desizing

2. Plasma Desizing + Reaction Cycle (48h at 650C in Ar)
   - **Parameter** Study (Distance, time, intensity)
   - Plates for **electrical tests**

Thermal Desizing Process

400C for 4h in air, 50C per hour ramp rate.



Starting from top:

Layer 1:

- 2 Insulated MQXF Cables S2 Glass 933

Layer 2:

- 1 200mmx400mm tissue S2 Glass 636 11 Tex
- 2 tissues of S2 Glass 636 11 Tex for TGA
- 1 tissues of S2 Glass 493 66 Tex for TGA

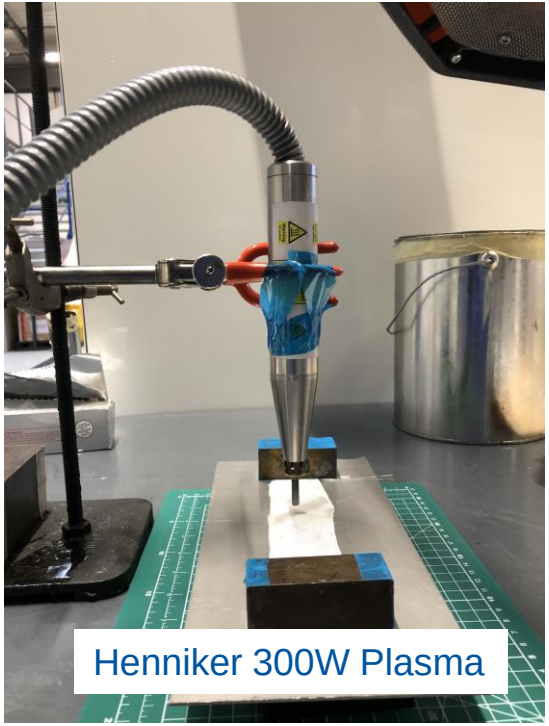
Layer 3:

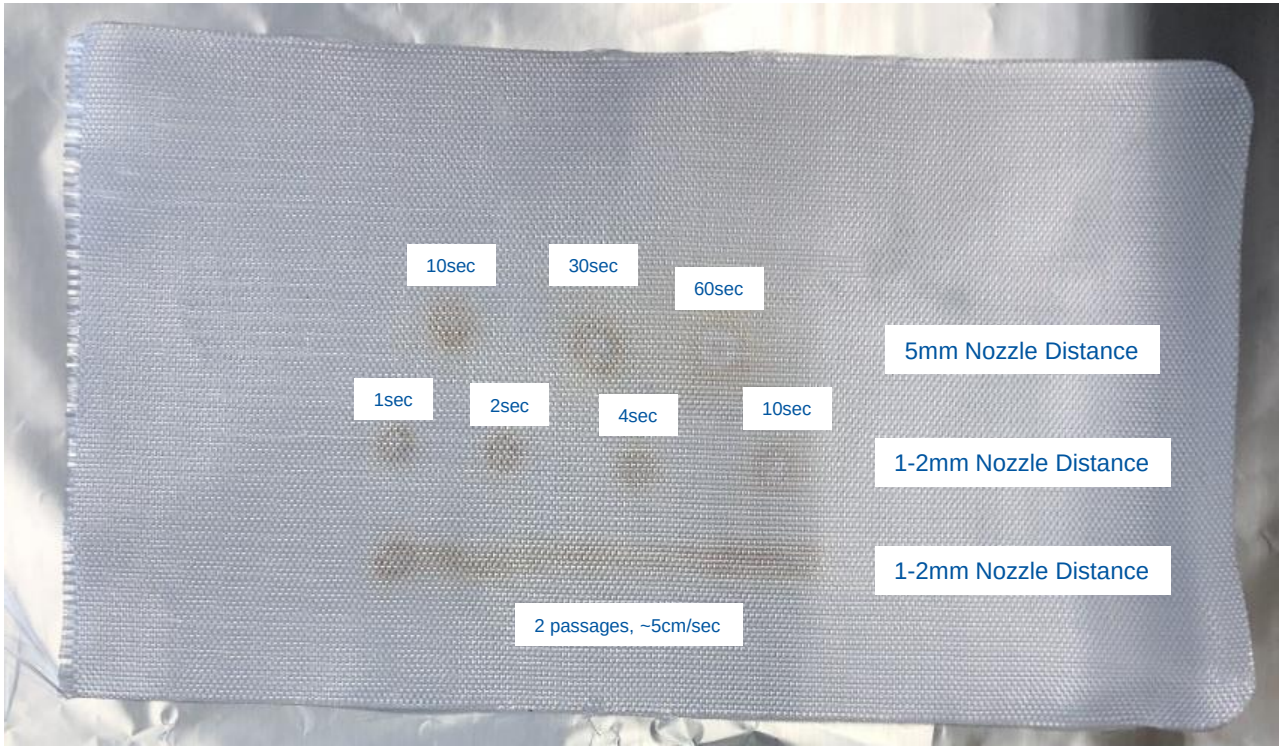
- 1 200mmx400mm tissue S2 Glass 493 66 Tex

Layer 4:

- Left: 2 tissues 120mmx300mm S2 Glass 493 66 Tex
- Right: 2 tissues 120mmx300mm Quartzel QS1318 Sizing 33 Tex

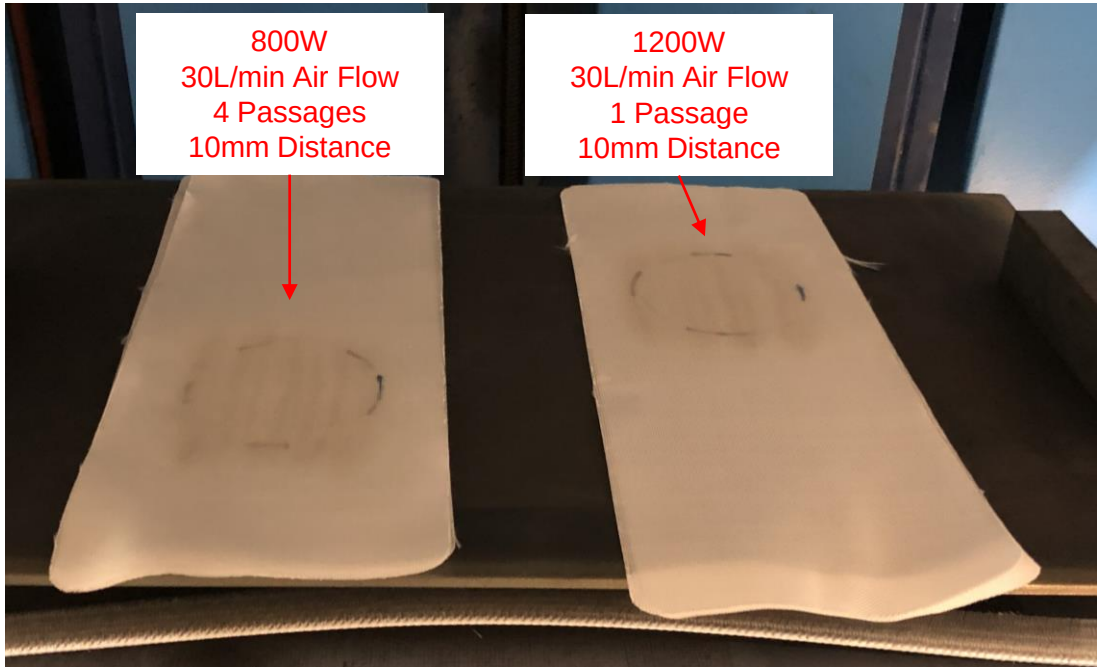
Plasma Desizing Parameter Study



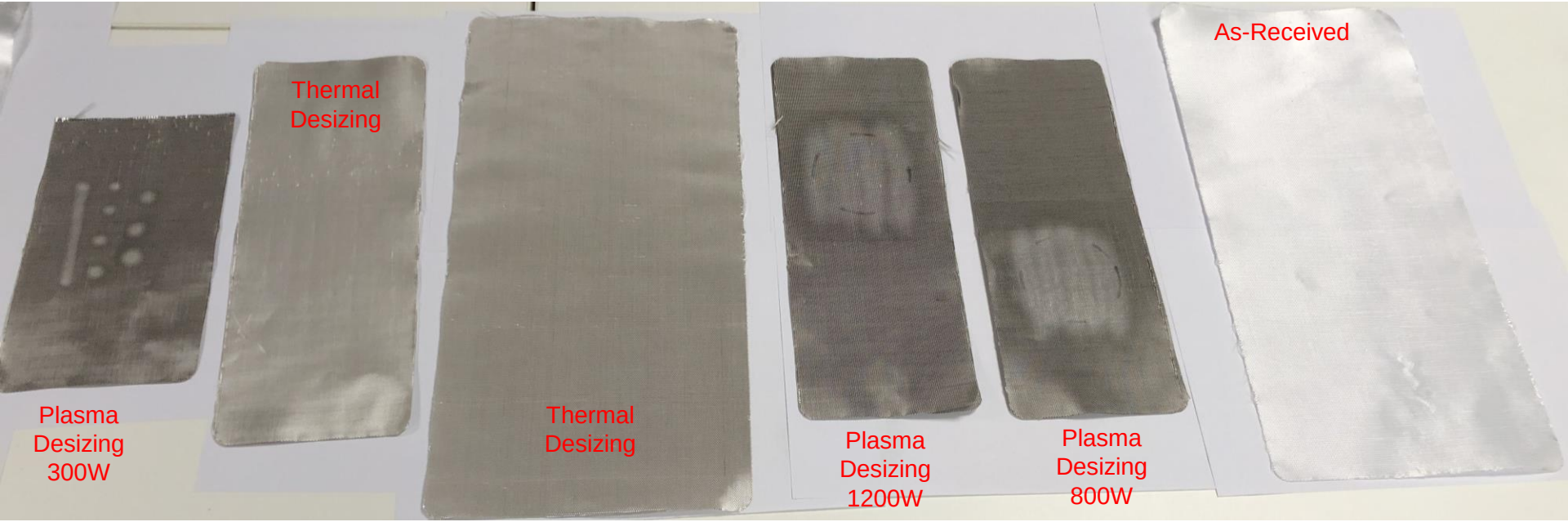


Plasma Desizing Parameter Study

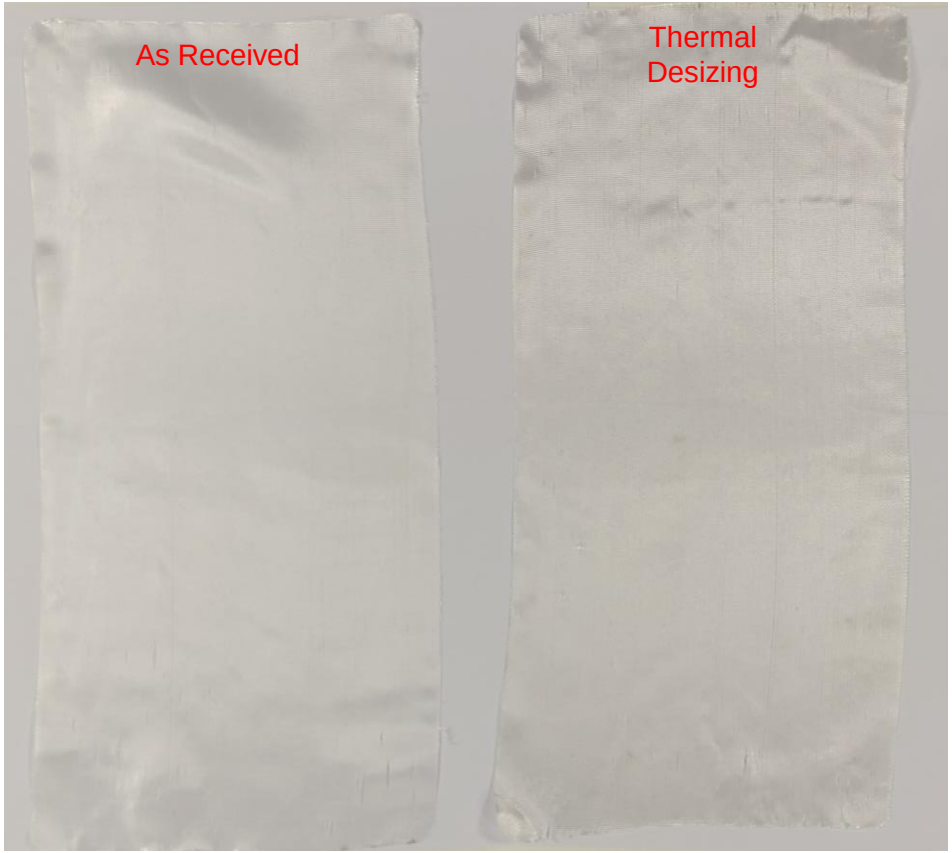
AcXys ULS Nano 1200W Plasma



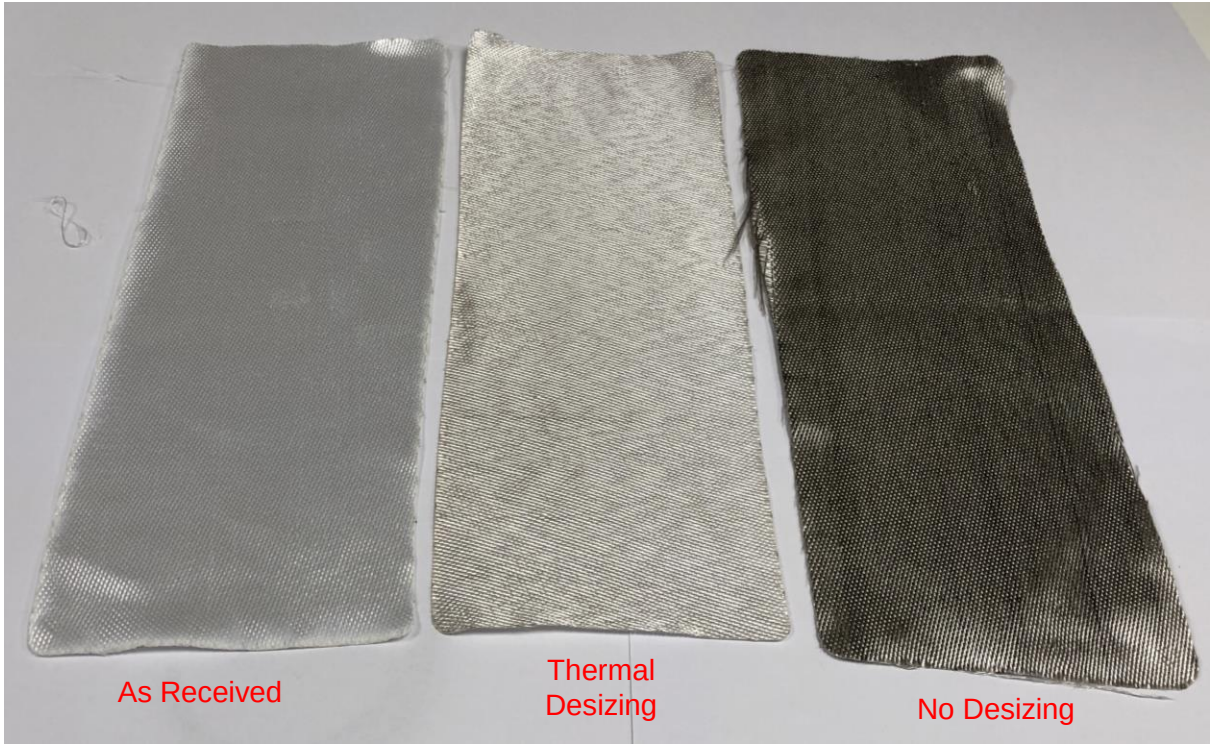
S2 Glass 493 Sizing 66 Tex



S2 Glass 636 Sizing 11 Tex



Quartzel QS1318 sizing 33 Tex



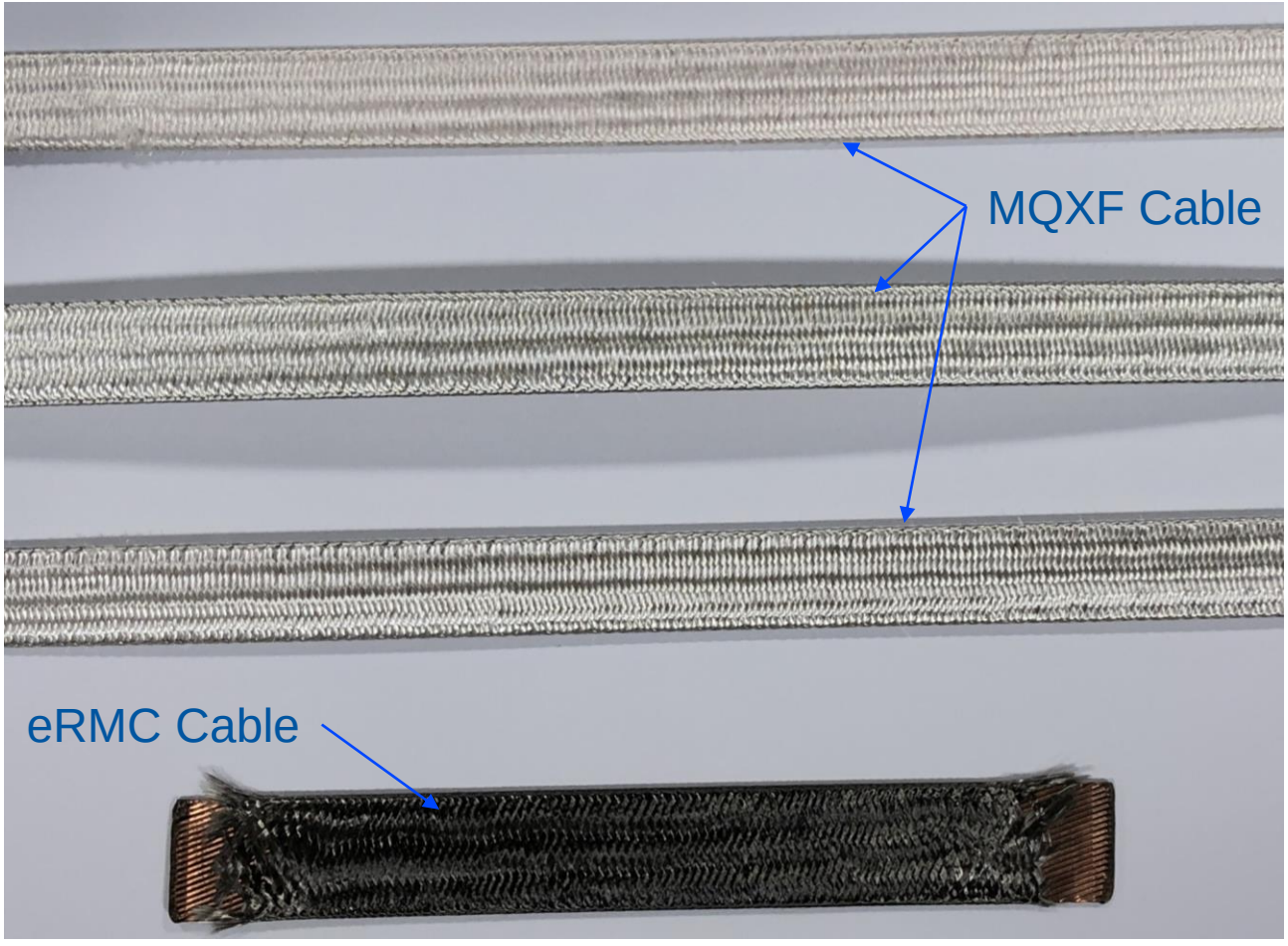
S2 Glass Braid 933 Sizing 33 Tex

As-Received

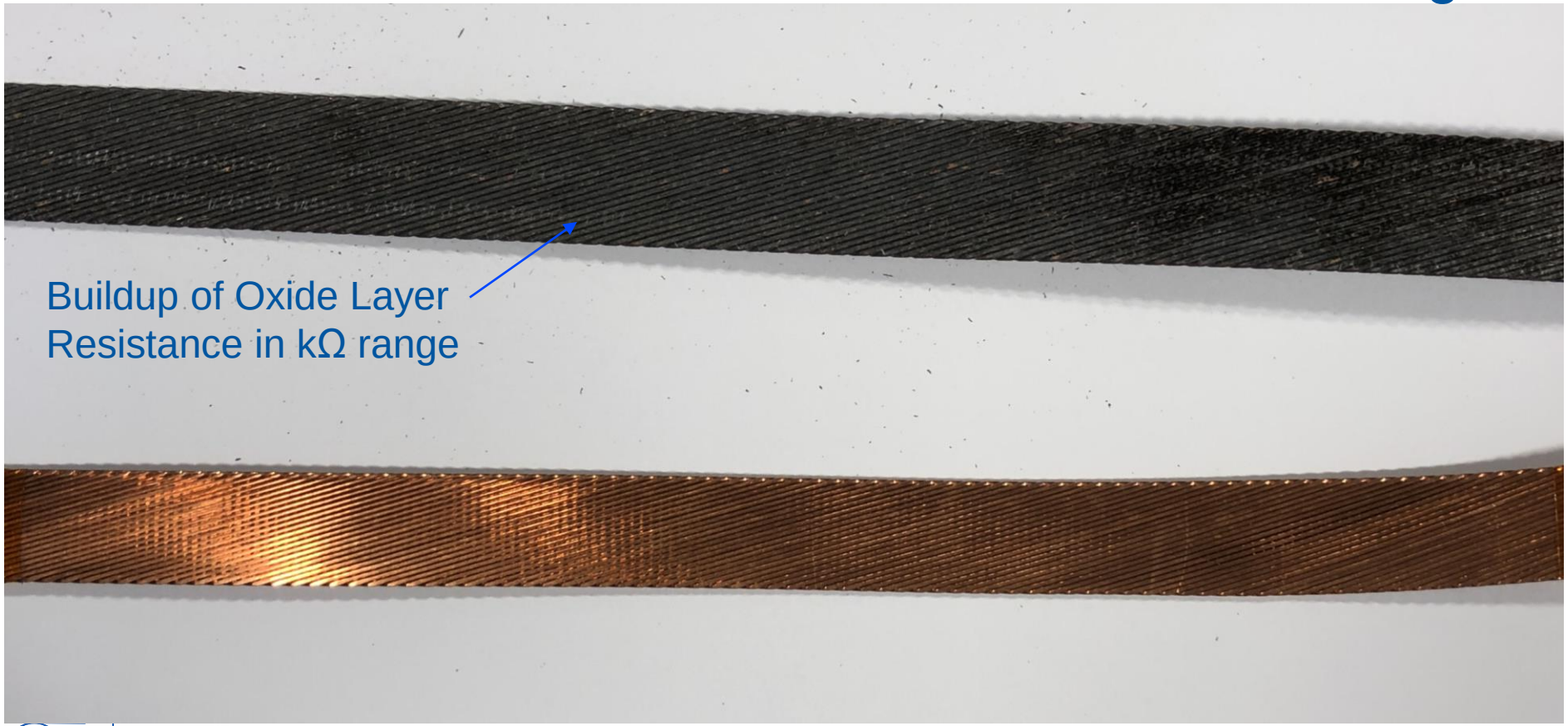
After Thermal Desizing

After Thermal Desizing + Reaction Cycle

No Desizing, After Reaction

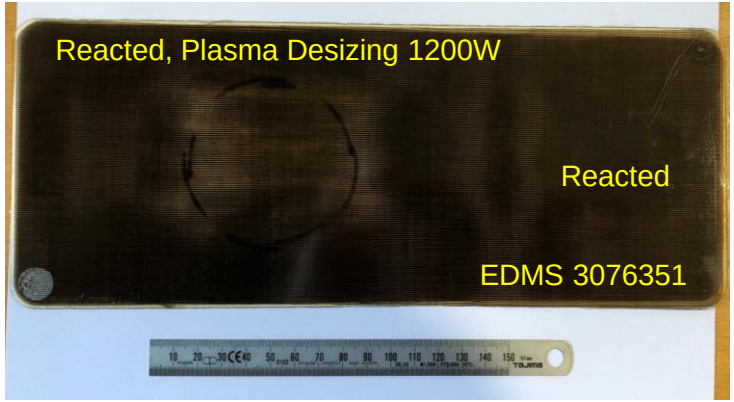


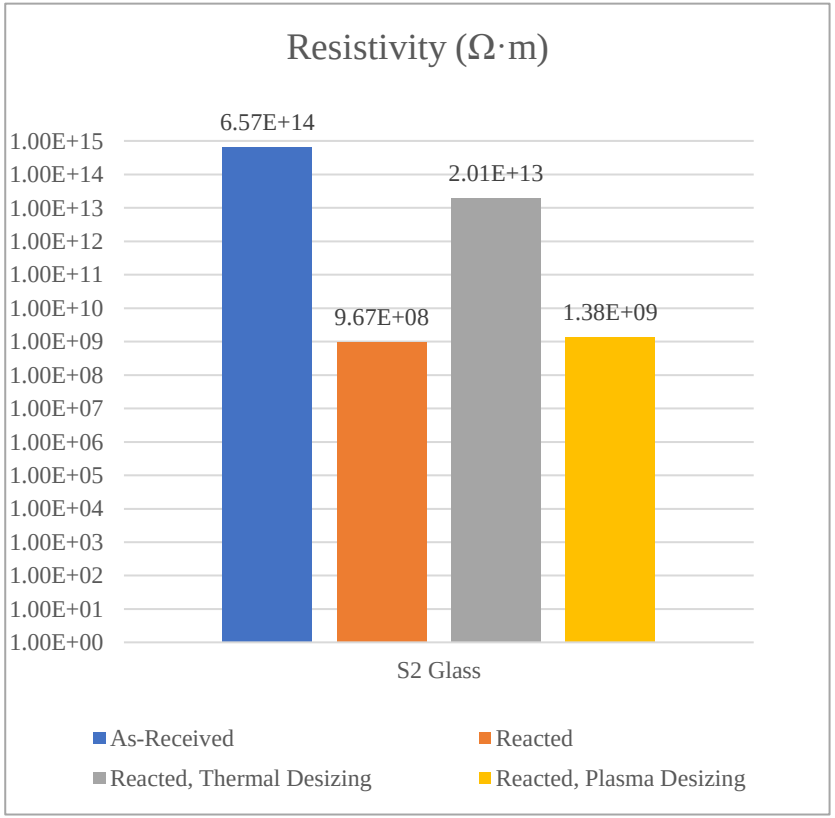
Nb3Sn Precursor Cable – After Thermal Desizing



Nb3Sn Precursor Cable – After Thermal Desizing

Resistivity Tests (Reports Pending)





Conclusions and Future Work

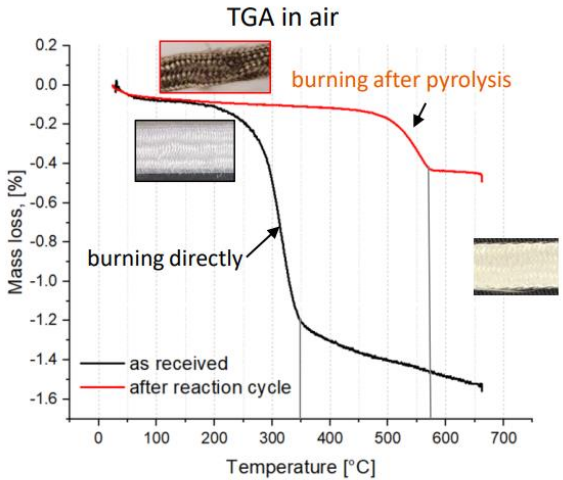
- Thermal desizing also appears to work on quartzel (QS1318 sizing).
- Thermal desizing appears more effective on 636 sizing than 493 sizing. Thickness of the fabric may have an influence
- On S2 glass (493), a small amount of conductive residue is present after the reaction cycle, even with thermal desizing.
- This small amount of conductive residue lowers resistivity, but it remains very high (in the order of $10^{13}\,\Omega\cdot m$.).
- The 1200W plasma desizing does not appear to be effective at preventing carbon residue formation.
- Future Work:
  - Validation of results with dielectric strength tests.
  - Impregnation and testing of S2 glass fibres with 800W plasma desizing.
  - Impregnation and testing of quartzel fibres with thermal desizing.
  - Optimization of plasma treatment parameters and preparation of plates for electrical tests (sizing 636 and 493).

Thank You

Additional Slides

A.Brem *et al.* 'Progress in materials and processes at PSI' (2023)

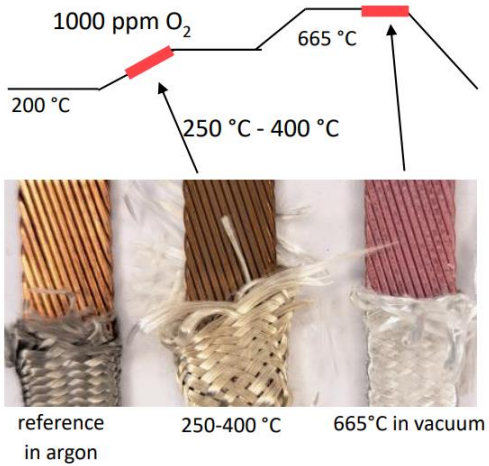
https://indico.cern.ch/event/1302031/contributions/5587828/

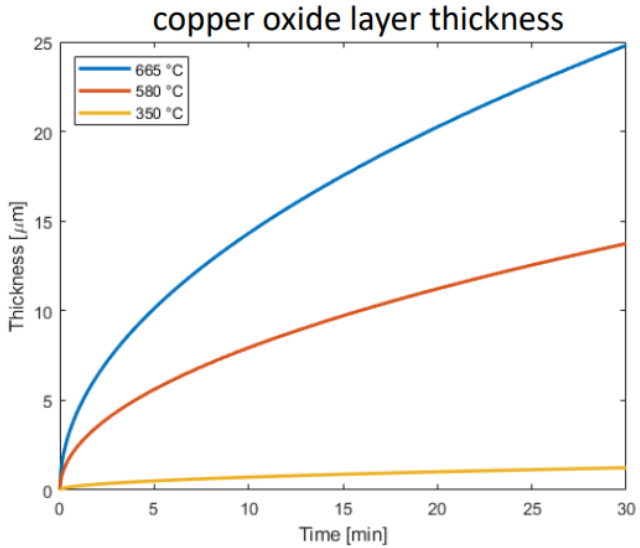


TGA measurements of glass fiber braids in atmosphere at 1 °C/min.
As received: braid as received on the cable – no cleaning
After reaction cycle: braid as received after a complete reaction cycle

	$RRR_{292/18}$	RRR reduction
Reference	532	-
250-400 °C	521	2%
665°C **in vacuum**	443	16%*

** in line with the reduction in cross-section due to the oxide layer*

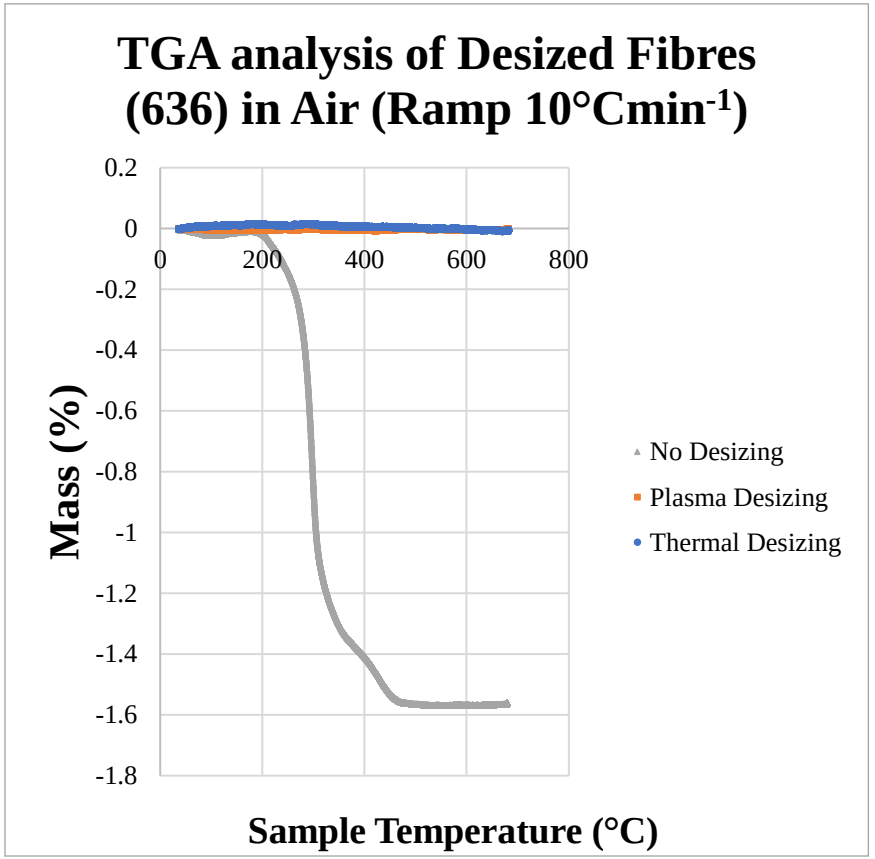




Build up of CuO layer at various temperatures in atmosphere, calculated with a parabolic rate law, Ea = 92.5 kJ/mol.

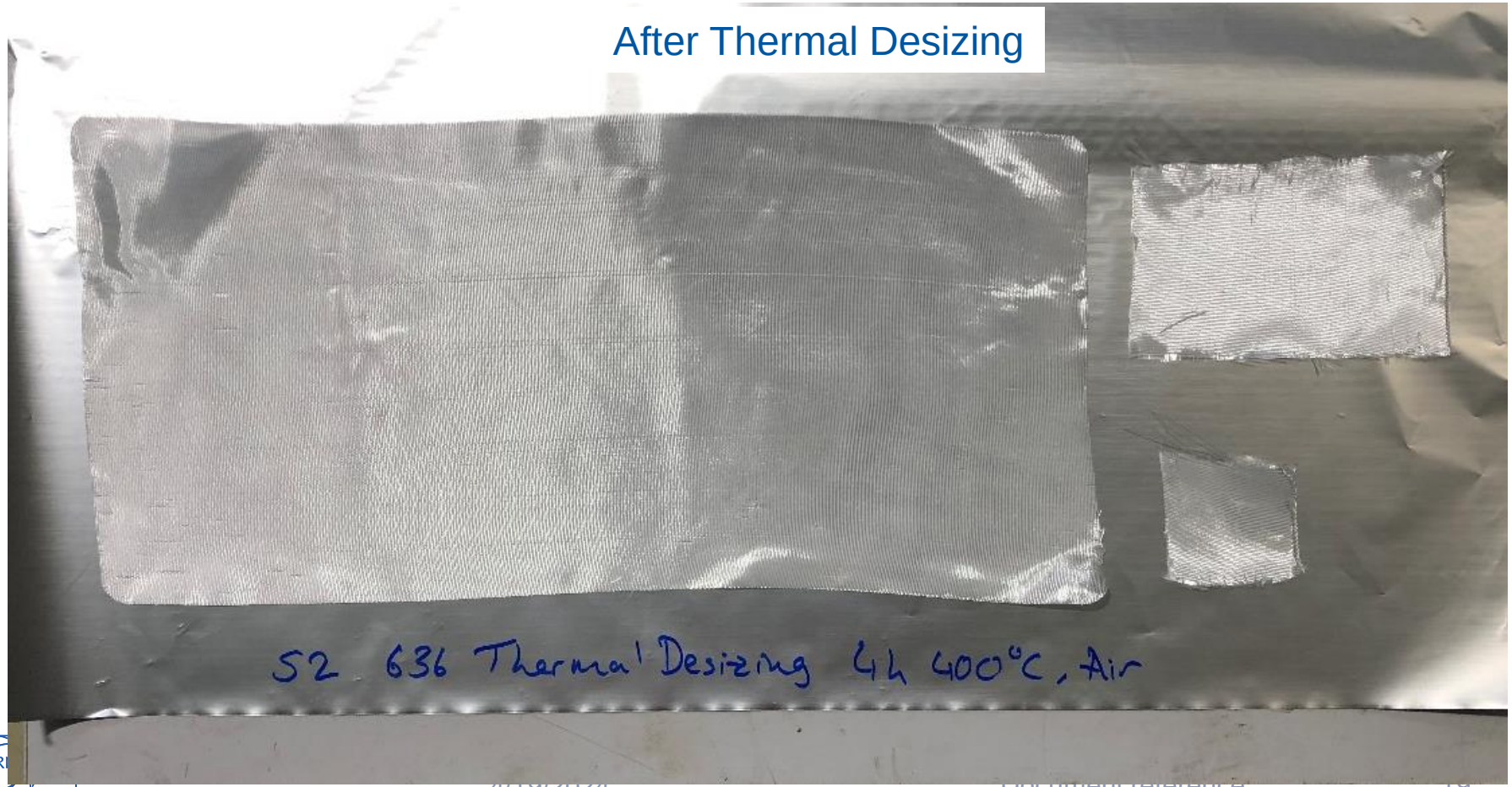
Thermogravimmetric Analysis (TGA)

- The effectiveness of a desizing process can be studied using thermogravimmetric analysis (TGA).
- A known mass of sample is heated with a fixed ramp rate in a controlled atmosphere and the loss of mass is measured.
- The presence of sizing is associated with a loss in mass.
- These results indicate that both the thermal desizing and plasma desizings are adequate methods.

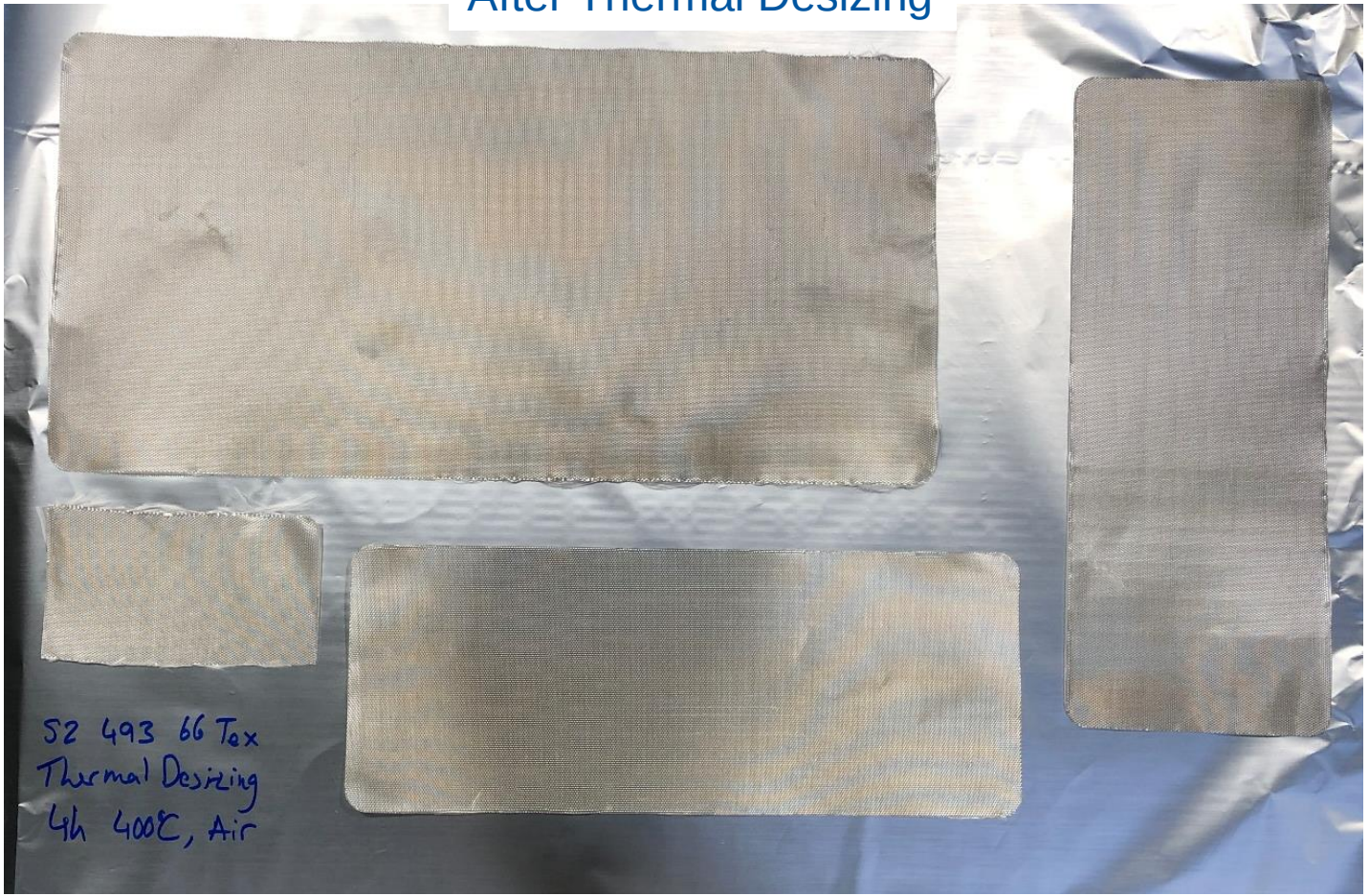


After Thermal Desizing

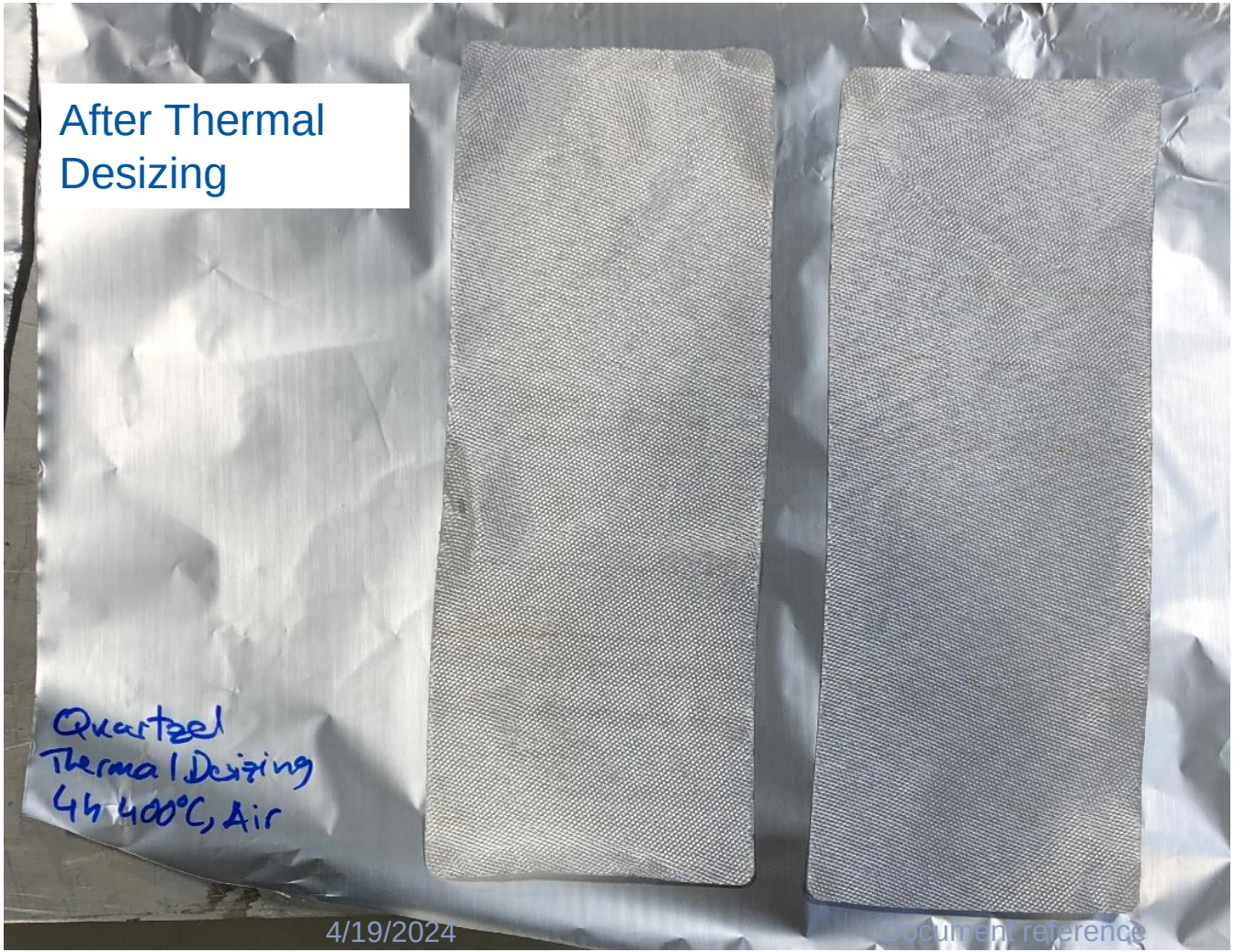
After Thermal Desizing



After Thermal Desizing



After Thermal Desizing



After Nb3Sn Reaction Cycle