CoCaSCOPE approach for High definition 3D finite element analysis of low temperature Rutherford cable

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In the perspective of simulating and managing the mechanical stresses within strain-sensitive superconductors such as Nb₃Sn, we are proposing a multiscale numerical approach for 3D simulation of Rutherford cables, up to the filament scale, presented in [1],[2]. This poster summarizes recently developed features and results.

Preprocessor: impregnated cable model generation [3]

- Fully scripted pre- and post-treatment
- Strand dimensions
- Number of strands
- Mass fractions
- Compression
- Gap between strands

Bi-material strand model based on homogenization [2]

CONCLUSIONS

New features have been added to the CoCaSCOPE approach:
- Generation of the conformal mesh of the cable impregnation matrix in 3D
- Introduction of copper hardening at the microstructure level, taken into account in the homogenized bi-material strand model
- Automated script-based post-treatment of the experimental σ(ε) plots
- First identification of the microstructure parameters at cryogenic temperature (77K)

Numerical identification of the microstructure parameters [4]

Nanoidentation of strands at room temperature (RT)

Identification of the microstructure parameters is performed using ILCO routine [4] by iteration on an analytical strand model based on volume fraction. Identification results are injected in 2 FEM strand models (detailed model / bi-material model) for comparison with experimental plots.

Microstructure parameters (given at RT / 77K for PIT strand) can be used for predictive simulations, even for load cases significantly different from the ones used during the identification process.