Compression testing results

UBS n°13 – 12/11/16

Objectives

- To observe if there is an improvement by using vacuum impregnation.
- To compare the Young's modulus of plain ½ hard copper, production conductor and conductor consolidated at 2.95mm combined with fiber glass vacuum impregnation without kapton.

Summary of test results

- A stack of ten layers of plain ½ hard copper combined with fiber glass vacuum impregnation without kapton exhibits a Young's modulus at ≈**28** GPa and elastic behavior above 110 MPa. This modulus value is in reasonable agreement with the mixture law calculation at 40 GPa.
- A stack of ten layers of production conductor as delivered combined with vacuum impregnation without kapton exhibits a modulus at **≈4** GPa and strong plastic behavior with a large remanent strain at ≈2%. The production conductor is too soft and starts to yields above 20 MPa.
- A stack of ten layers of conductor consolidated at 2,95 mm combined with vacuum impregnation without kapton exhibits a Young's modulus at ≈**20** GPa and elastic behavior up to ≈ 60 MPa. Above 60 MPa the conductor starts to yield again and the stack modulus drops at ≈ 4 GPa.

Next steps

These tests show that conductor consolidating at 2,95 mm combined with fiber glass vacuum impregnation, without kapton, might provide a coil pack modulus at ≈20 GPa up to 60 MPa. Further work is still required to demonstrate this solution could be acceptable to fix the conductor quality issue. Especially short samples critical current measurement and microphotography shall check that consolidating process at 2,95 mm does not damage the SC wires and the soldering. FEA coil calculation shall also demonstrate that 20 GPa modulus and elastic behavior up to 60 MPa are enough to guarantee the coil reliability.

Samples

- 13-11: plain ½ hard copper combined with vacuum impregnation
- 13-31: production conductor (Dipole E002) combined with vacuum impregnation
- 13-41: conductor consolidated at 2.95mm combined with vacuum impregnation.

All samples are vacuum impregnated according to the following procedure:

Layer insulation: fiber glass, thickness 0,20 mm half overlap (total thickness 0,40 mm per side)

Resin impregnation: epoxy Araldite F / Hardenner HY905 / Flexibilisator DY040 / Accelerator DY061

Curing cycle: 5h at 80°C then 7h at 120°C

Results

The following graph provides the compression curves for each sample.