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Compression testing results

UBS n°11 – 12/10/29

Objectives

- To know the mechanical properties of a stack of plain copper without kapton.
- To observe the influence of the consolidation process on the stiffness of a stack of conductor without kapton.
- To recover testing results of June on consolidating of prototype conductor.

Summary of test results

- Remove the Kapton and apply only a B stage insulation improves significantly the stiffness of a stack of plain copper.
- There is no improvement of the mechanical properties of a stack of conductor when kapton is removed, whatever the consolidating process applied on the conductor at 2,95 mm or up to 120 MPa. The conductor stiffness improvement achieved by the consolidating process might be cancelled by a lack of resin between the layers interfaces. More tests have to be performed with higher mechanical pressure during the B stage curing process or with vacuum impregnation instead of B stage curing Consolidating the conductor at 80 MPa has no effect on the production conductor and a small effect on the prototype conductor. The production conductor is quite different from the prototype conductor used for the consolidating test in June. Especially it seems now that the SC cable sticks out the copper up to 0,1 mm. This new default might make the testing done on the prototype conductor not relevant for the production. SC cable position default might generate some serious mechanical trouble during the consolidating process or the compression. Consolidating tests at higher value with soldering inspection must be performed again on bare production conductor to investigate what is feasible or not.

Future tests

The aim of next tests is to understand why mechanical properties are not improved on a stack of conductor when Kapton is removed. The two following tests will determine if the lack of stiffness comes from a low tightening of the screws during curing or from the conductor geometry defects and its mechanical properties.

- Material: **production conductor without Kapton without consolidating** / Curing assembly: 40N.m of screws tightening with use of Belleville rings / Curing process: 140°C during 6h, tightening of screws after one hour of curing / compression test at 80 MPa.

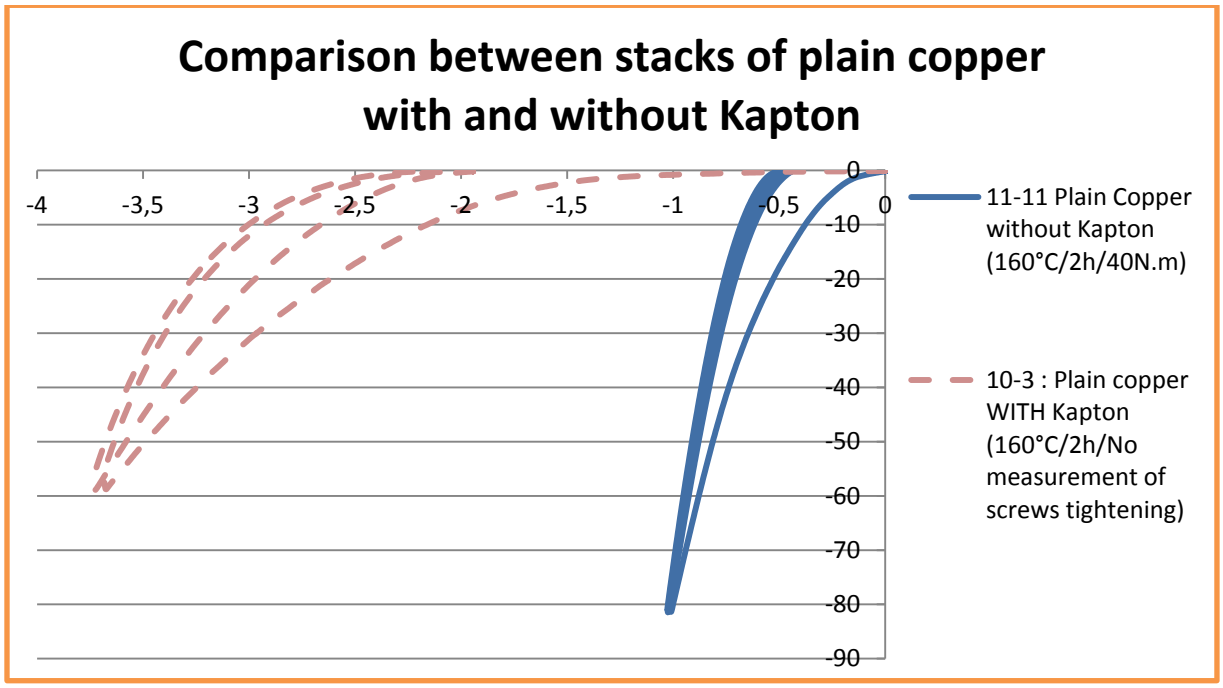
- Material: **production conductor without Kapton with consolidating at 120 MPa** / Curing assembly: 40N.m of screws tightening with use of Belleville rings / Curing process: 140°C during 6h, tightening of screws after one hour of curing / compression test at 80 MPa.

Materials and methods

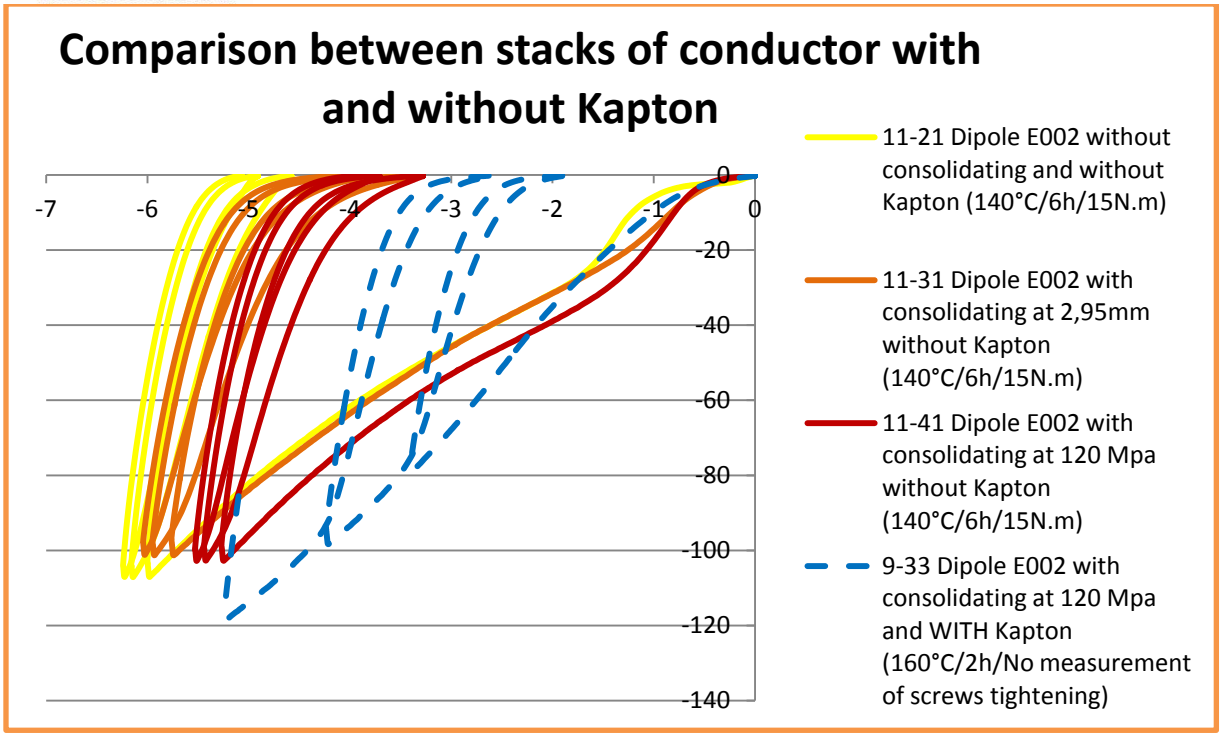
SAMPLE	MANUFACTURING PROCESS	TEST PERFORMED
Stacks 11-11 11-12 & 11-13	- Material : **plain copper** Cu-A1 (3x25) - Wrapping with BStage (without Kapton) at half covering - Screw tightening at 40 N.m = pressure of about 104 MPa - Using of **Belleville rings** in order to insure that pressure on the stack is preserved. - Curing at 160°C during 2h.	- Dimensions before and after test. - Measurement of compliance of the testing machine in this configuration : 3 x 80 kN. - Test on 3 stacks of plain copper without Kapton : 3 cycles at 80 Mpa (80kN)
Stack 11-21	- Material : **conductor Dipole E002 without consolidating** - Wrapping with BStage (without Kapton) at half covering - Screw tightening at 15 N.m = pressure of 65 MPa - Curing at 140°C during 6h / No Belleville ring	- Dimensions before and after test. - Test on 1 stack without Kapton : 3 cycles at 100 Mpa (80kN)
Stack 11-91	- Material : **conductor Dipole E002 without consolidating** - Wrapping with BStage (without Kapton) at half covering - Screw tightening at 15 N.m = pressure of 65 Mpa - Curing at **160°C during 2h** / No Belleville ring	- Dimensions before and after test. - Test on 1 stack without Kapton : 3 cycles at 100 Mpa (80kN)
Stack 11-31	- Material : **conductor Dipole E002 consolidated at 2,95 mm** - Wrapping with BStage (without Kapton) at half covering - Screw tightening at 15 N.m = pressure of 65 MPa - Curing at 140°C during 6h / No Belleville ring	- Dimensions before and after test. - Test on 1 stack without Kapton : 3 cycles at 100 Mpa (80kN)
Stack 11-41	- Material : **conductor Dipole E002 consolidated at 120 MPa** - Wrapping with BStage (without Kapton) at half covering - Screw tightening at 15 N.m = pressure of 65 MPa - Curing at 140°C during 6h / No Belleville Ring	- Dimensions before and after test. - Test on 1 stack without Kapton : 3 cycles at 100 Mpa (80kN)
Samples 11-5	- Material : **conductor Dipole E002** - Cutting of 3x 1 m for measurements of critical current	- Consolidating at 80MPa , 120 MPa and 2.95 for measurements of critical current.
Samples 11-6	- Material : **conductor Dipole E002** - Cutting of 4x 110 mm for micrography	- Consolidating at 80MPa , 100 Mpa, 120 MPa and 2.95mm for micrography.
Stack 11-7	- Material : **conductor Dipole E002** - Cutting of 10x 40mm for consolidating process	- Dimensions before and after consolidating process and after compression test. - Consolidating at 80 Mpa of each layer. - Compression test : 3 cycles at 80 MPa (60kN)
Stack 11-8	- Material : **Prototype conductor** - Cutting of 10x 40mm for consolidating process	- Dimensions before and after consolidating process and after compression test. - Consolidating at 80 Mpa of each layer. - Compression test : 3 cycles at 80 MPa (60kN)
Stack 11-0	- Material : **Prototype conductor** - Cutting of 10x 40mm for consolidating process	- Dimensions before and after test. - **No consolidating process.** - Compression test : 3 cycles at 80 MPa (60kN)

Results

- The following figure is a comparison between stacks of plain copper with and without Kapton. We observe that the stiffness of the stack is significantly higher when Kapton is removed.



- The following figure concerns stacks of conductor with and without Kapton, with and without consolidating. It shows that there is no stiffness improvement when Kapton is removed, whatever the consolidating process.



- The following figure is a comparison between production and prototype conductor. We observe that a consolidating process at 80MPa improves slightly the stiffness of the prototype conductor and has no effect on the the production conductor. (The initial low stiffness of the stacks of prototype conductor comes from friction between JLAB's fixture system and the stack: it length was slightly superior to 40mm).

Comparison between serial and prototype conductor (without insulation)