

JLAB – UBS n°16 – test report

Objectives

- Determination of mechanical properties of each reel used for the dipole manufacturing after consolidation at 2,95mm: traction on bare conductors in axial direction & compression of stacks in azimuthal direction (with precompression at 10 MPa).
- Preparation of samples for tests in CEA Saclay at 77K and for micrography.

Summary of Test Results

- There is no significant difference between traction properties of the six reels. The Young's Modulus is superior to 100 GPa and the Yield Strength is between 120 and 145 MPa.
- It's the same conclusion for mechanical properties in azimuthal direction: The measured Young's Modulus is between 16 and 25 GPa and the Yield Strength is about 100 MPa.
- Consequently all reels are accepted for the dipole manufacturing.

Samples Preparation

- Consolidating of **5 meters** at 2.95mm with the temporary consolidation press for each reel used for the dipole manufacturing.
- Cutting of 190mm long samples of bare conductor for traction tests.
- Measurements of samples before traction test: there is no correlation of thickness & width between before and after consolidation.

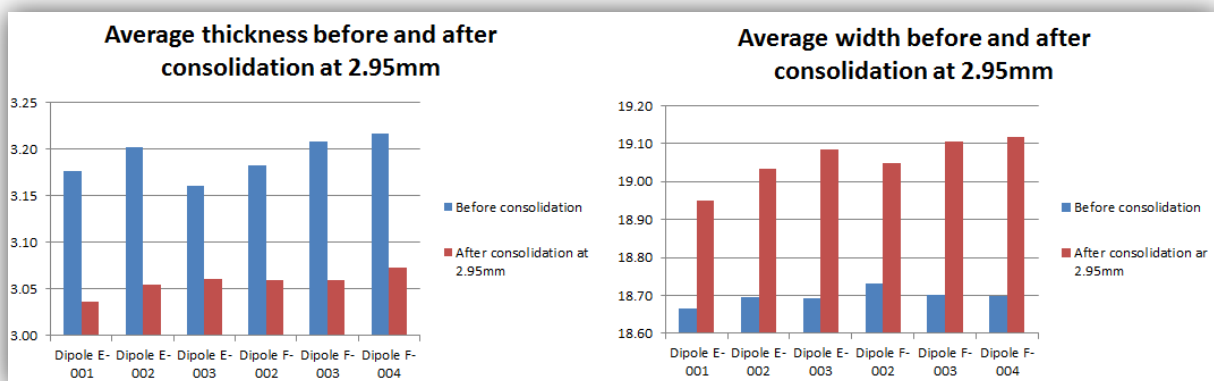


Figure 1: thickness & width of bare conductor before and after consolidation at 2,95mm

- Preparation of samples for compression tests:
 - Wrapping of 200mm bare conductors at half-covering (wrap thickness = **0.25mm**)
 - Precompression of the conductor thanks to screws at 10 MPa (15 N.m)
 - Etancheity & molding.
 - Cutting samples at 40mm.

- Measurements of samples before compression test: there is no correlation between bare conductor thickness after consolidation and stacks height after molding with a precompression at 10 MPa. The height of the stack varies between 37,81 and 38,18 mm.

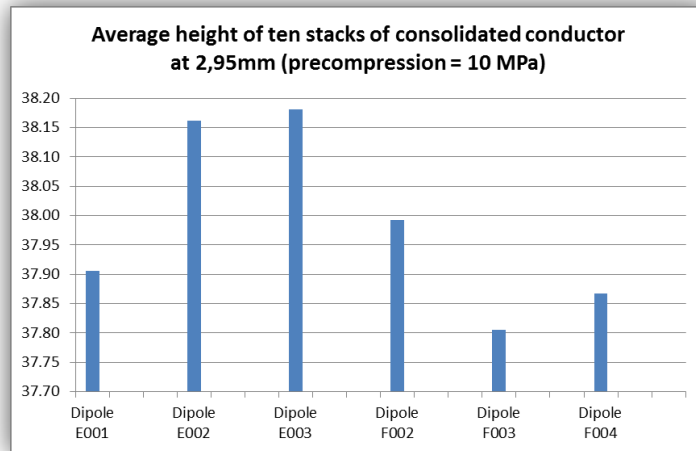
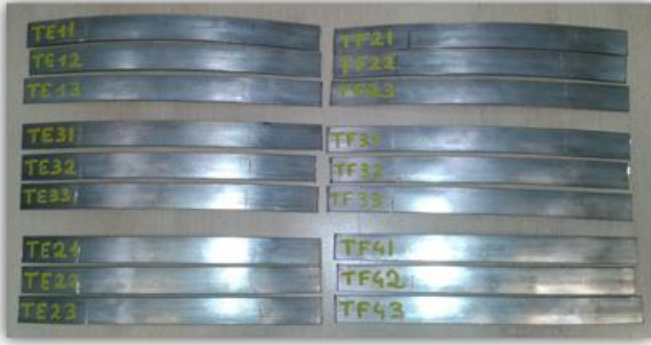



Figure 2: height of stacks for each reel used for the dipole manufacturing

Designation of samples

Samples	Reel	Test	
T-E001-1 T-E001-2 T-E001-3	Dipole E001	<p>Traction at Room temperature on bare conductor consolidated at 2,95mm</p> 	
T-E002-1 T-E002-2 T-E002-3	Dipole E002		
T-E003-1 T-E003-2 T-E003-3	Dipole E003		
T-F002-1 T-F002-2 T-F002-3	Dipole F002		
T-F003-1 T-F003-2 T-F003-3	Dipole F003		
T-F004-1 T-F004-2 T-F004-3	Dipole F004		
Samples	Reel		Test
C-E001-1 C-E001-2 C-E001-3	Dipole E001		<p>Compression in azimuthal direction on ten stack of conductor consolidated at 2,95mm & precompressed at 10 Mpa. Test at room temperature (1), eventually test at 77K (2) & eventually micrography (3)</p> 
C-E002-1 C-E002-2 C-E002-3	Dipole E002		
C-E003-1 C-E003-2 C-E003-3	Dipole E003		
C-F002-1 C-F002-2 C-F002-3	Dipole F002		
C-F003-1 C-F003-2 C-F003-3	Dipole F003		
C-F004-1 C-F004-2 C-F004-3	Dipole F004		

Tests performed

- **Traction test at room temperature on bare conductor:**

Strain of bare conductor is measured with an extensometer. All samples are tested until 5% of strain.

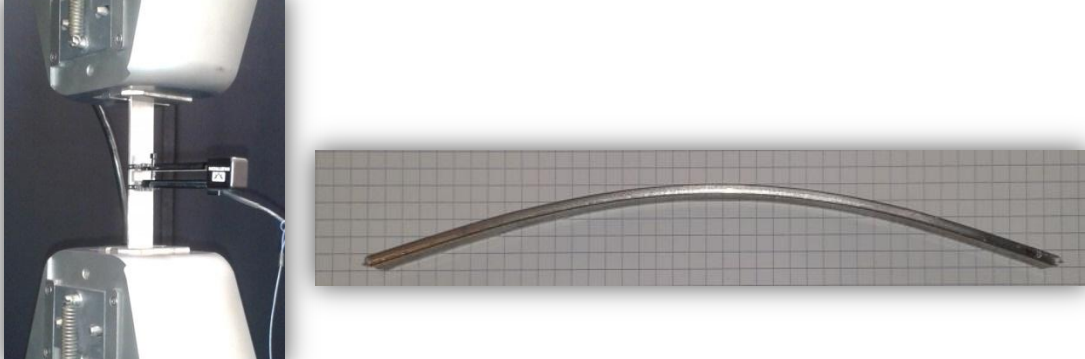


Figure 3: LEFT - strain measurement on bare conductor. RIGHT - deformation of the conductor after test (strain = 5%)

- **Compression test at room temperature in azimuthal direction on impregnated samples:**

Compression tests are performed at room temperature with the following values of load/unload cycle. Between two loads the force comes back to 1 kN.

- 80 MPa (64 kN)
- 100 MPa (80 kN)
- 120 MPa (96 kN)
- 140 MPa (112 kN)
- 160 MPa (128 kN)

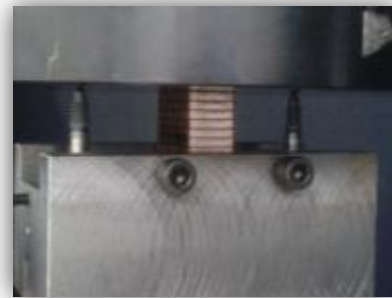


Figure 4: testing configuration for azimuthal direction

Results

- **Mechanical properties in traction:**

- There is no significant dispersion between samples from the same reel (*see figure 5*).
- In the same way there is no significant difference of mechanical behavior between samples from the six reels (*see figure 6*).
- The Young's Modulus of bare conductor in traction is superior to 100 GPa.
- The Yield Strength of bare conductor is between 120 and 145 MPa.

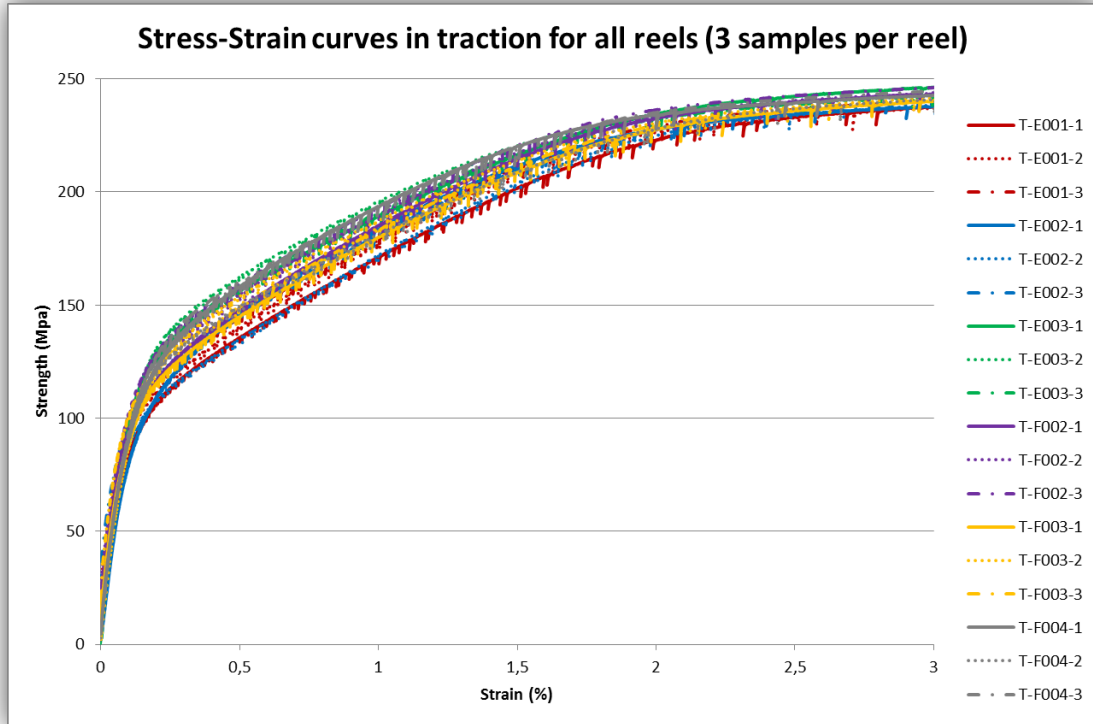


Figure 5: superposition of the 18 stress-strain curves in traction

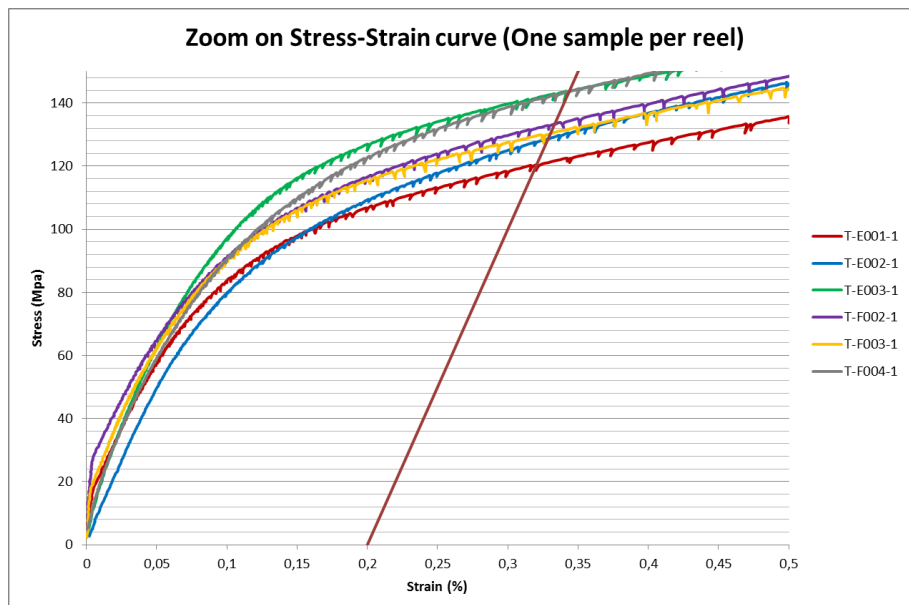


Figure 6: determination of Young's Modulus & Yield Strength

- **Mechanical properties in azimuthal direction:**

- There is no significant difference of mechanical behavior between samples from the six reels (*see figure 7*).
- The Young's Modulus in azimuthal compression is between 16 & 25 GPa and the Yield Strength is about 100 MPa.

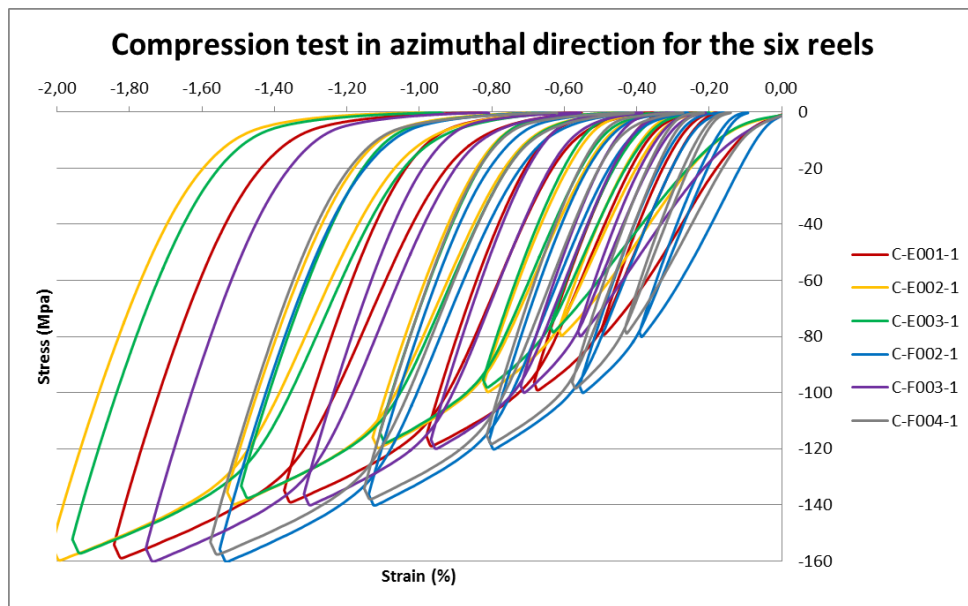


Figure 7: azimuthal properties for the six reels