ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Experimental Methods for Engineering Mechanics

Group 5 - Bonus Assignment

Avellan Marin Nicolas - N°311557
Cassandre Pitz - N°310614
Kateryn Andrea León - N°338309
Abhijeet Singh - N°322914

Ecole Polytechnique Fédérale de Lausanne

Autumn Semester 2022

Abstract

In the context of analysing fracture propagation, the task was to measure the resistance of aluminium coated samples to mimic a fracture experiment. It was decided to study the evolution of coating resistance as we progressively cut it with a razor-blade (equivalent to fracture from an electrical POV). This study was already done by the 2021 class for a different setup (in the Annex) and we intend to observe how their results compare with ours.

Method

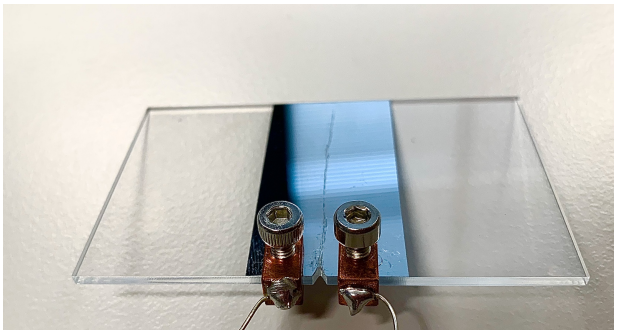

Figure 1: Top view of the sample setup.

The sample is a polymer tile coated with a 49.67mm x 24.98mm layer of aluminium. It is wired to the Ohmeter by two screwed copper clamps placed along the width of the coating on each side of the future cut. We used the 4 wire Ohmeter integrated in the HMC8012 Digital Multimiter.

Results

Please note this curve is offset by 1.5 Ohms because the clamps were placed upside down resulting in steel touching the coating instead of copper. One can notice that the resistance follows the linear trend accurately all the way through independent of crack progress.

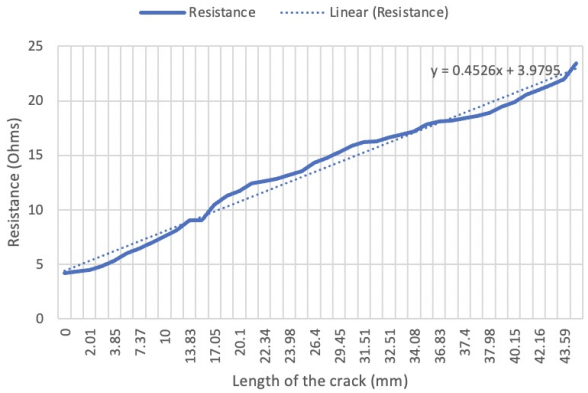

Figure 2: Coating resistance to length of the razor crack compared to a y = 0.4526x + 3.9795 linear interpolation.

Discussion

The 2021 results show a very non-linear trend which are surprising given our observations. However, this may be explained by the way the clamps are positioned along the coating. The past configuration made use of the entire available surface to pass a current because the anode and cathode were much wider. The actual setup compels the current to pick a tight path around the crack thus only utilising the coating region very close to the fracture front. This agrees with the displayed linear trend because the narrow crescent-shaped area through which electrons move in the coating will only start to shrink towards the very end as it enters in conflict with the boundary. It is well within the scope of imagination to think that, should our experiment have continued until complete fracture, we would have recorded the same diverging behaviour detected by our colleagues.

Annex

Group 5 26.10.2021

Resistance evolution during the crack

Experimental determination of the relation between crack length and resistance in the aluminum film

After our first experiment on the traction machine, we realized that the theoretical static relation $R = \rho \frac{L}{w \cdot t}$ for the resistance[1] in the film isn't precise during propagation of the crack. We therefore did an experiment to determine the relation between resistance and crack length. The data from this experiment can then be used to calibrate the measurement on the traction machine.

We obtained the following values:

Crack length [mm]	R [Ohm] (mean)
1.5	3.17
5	3.21
10	3.37
15	3.6
20	3.94
25	4.34
30	4.98
35	5.83
40	7.17
45	9.37
46	10.4
48	12.55
49	16.43

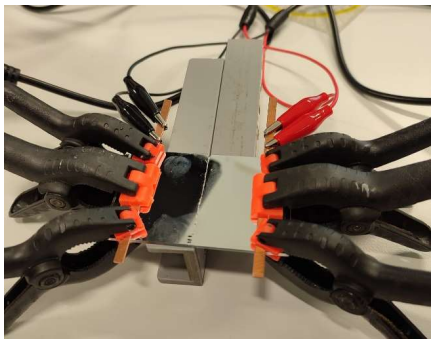

Figure 1: Setup of the experiment. We use a 4-wire measurement of the resistance of the aluminum film on the plate. The crack in the film is simulated by cutting gradually by hand. The four weights fix the cupper strips that connect the film to the wires.

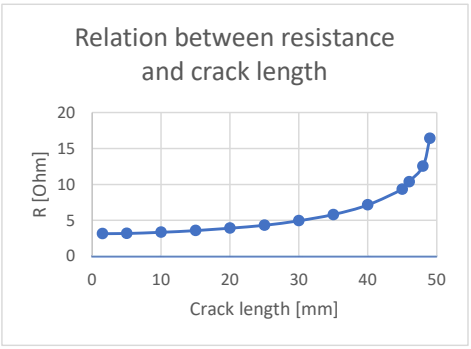

Figure 2: Graph of the measurement that show the relation between crack length and film resistance.

[1] *Wikipedia: Sheet resistance*, (20.10.2021), https://en.wikipedia.org/wiki/Sheet_resistance, where $\rho = resistivity, A = cros - sectional\ area, L = length$