

FABRICATION AND MEASUREMENTS OF NIS JUNCTIONS TO CHARACTERIZE PLASMA ETCHING

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THE NANOWIRES PROJECT

Introduction

Two types of InAs Nanowires coming from Copenhaguen :

- Without barrier, and covered with Al
- With InGaAs barrier, without Al

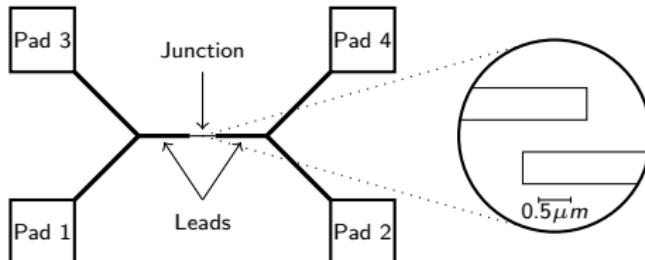
For the covered ones :

- Al heavily oxidized by the travel
- Get rid of this oxide by Plasma Etching
- Fabrication of NIS structures to characterize the Plasma

EXPERIMENTAL PROTOCOL

Parameters

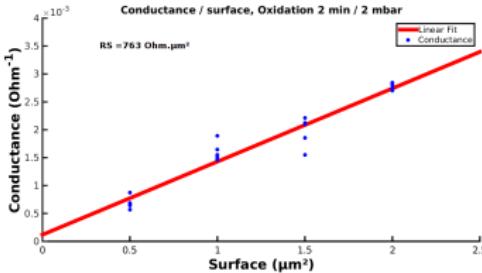
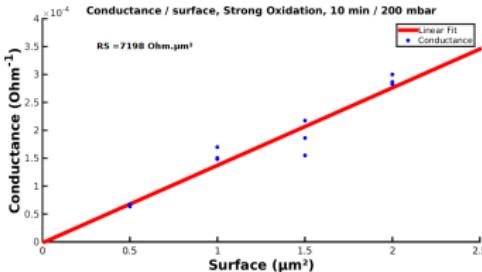
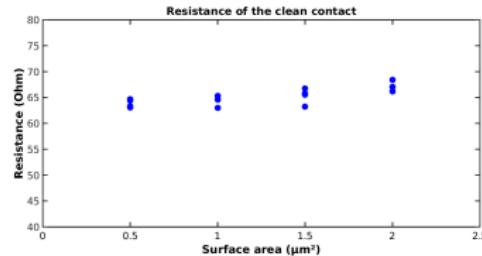
- 4 Pads pattern



- 4x5 matrix with 4 Surface areas : $0.5, 1, 1.5 \text{ & } 2 \mu m^2$
- 5 EBL doses, from 2000 to 3000 by $250 c/\mu m^2$
- Development 20s MIBK, 20s Methyglycol, IPA
- Al 20nm, Cu 25nm
- Optionnal : Oxidation and Plasma (Pressure= $10^{-4} mbar$, Power= $40mA$, Extraction= $-0.8kV$, then $0.25kV$, Ion Energy= $1.5kV$)
- 4 probe measurements with a probestation

REFERENCE SAMPLES

Room temperature measurements



- Clean Contact Al + Cu without Plasma

$$R = \sum_{Cu,Al} \frac{\rho l}{S} \simeq 78\Omega$$

- Strong Oxidation reference 10min / 200mbar without Plasma

$$RS = 7198\Omega.\mu\text{m}^2$$

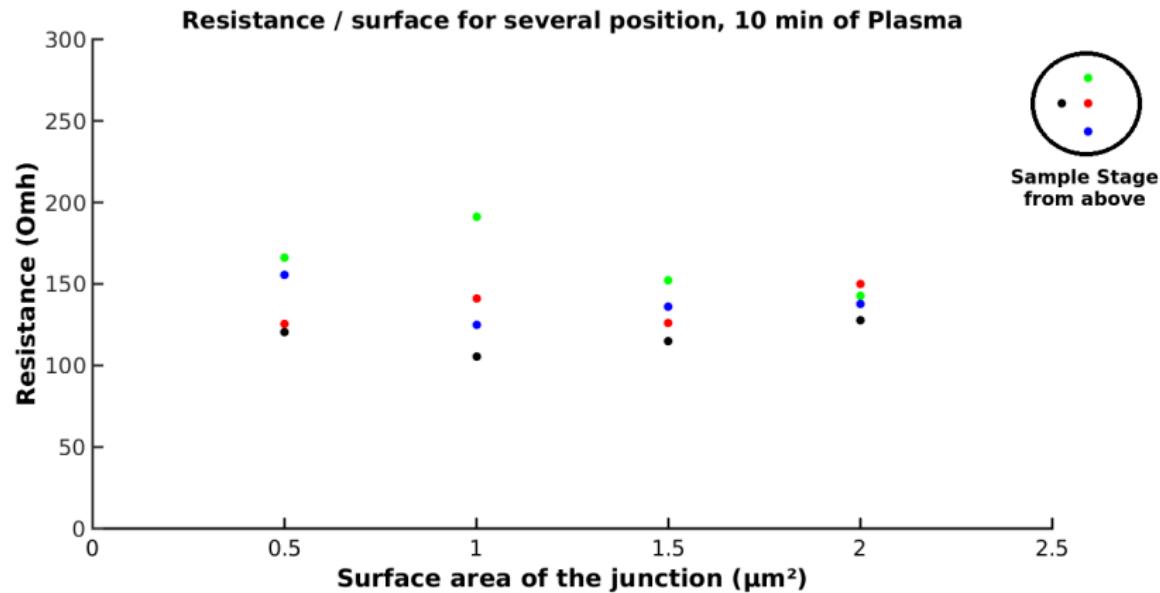
- Regular Oxidation reference 2min / 2mbar without Plasma

$$RS = 763\Omega.\mu\text{m}^2$$

PLASMA TESTS I

Room temperature measurements

- Position of the sample, Plasma Etching 10 min, before Oxigen cleaning



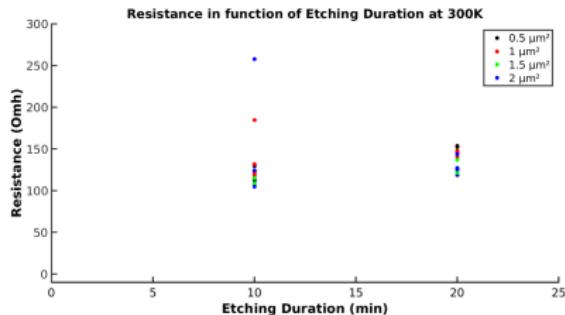
⇒ Plasma is homogeneous & 10 min seems enough to etch the oxide : no surface dependance and same order of magnitude as clean contact.

PLASMA TESTS II

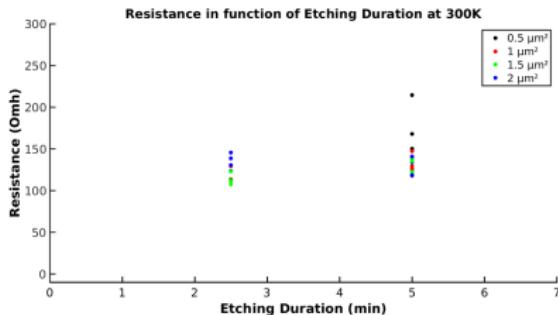
Room temperature measurements

- Duration of the Plasma Etching

- Before Oxigen cleaning



- After Oxigen cleaning

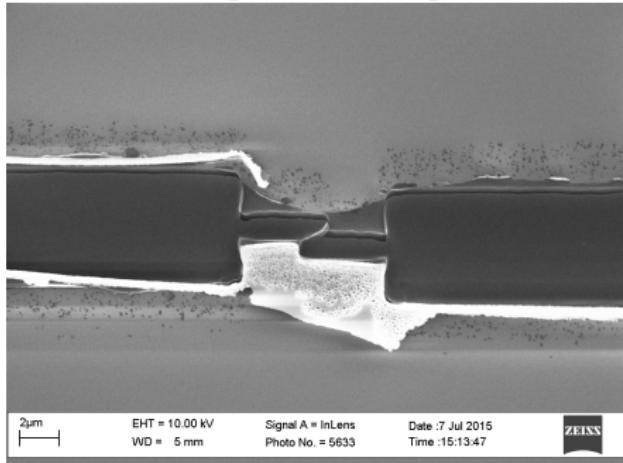


⇒ Similar results for totally different parameters before and after the cleaning. Before, it seems 10 min of Plasma was a good time, after the cleaning, it seems that less than 5 min is enough and that 10 min is too much.

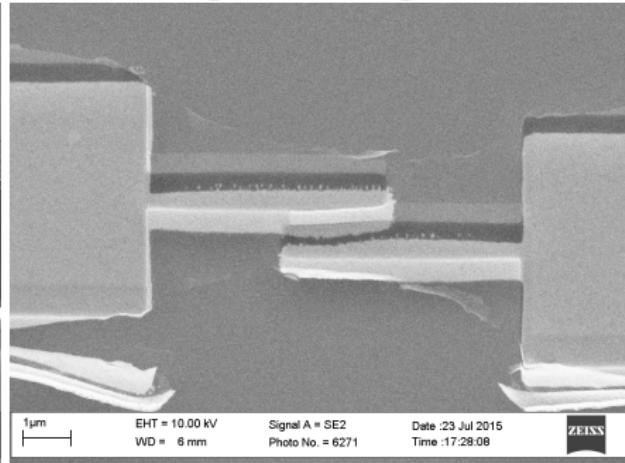
PLASMA TESTS III

Room temperature measurements

- Failed Samples with 10 min of Plasma and Oxidation
- Before Oxigen Cleaning
- After Oxigen cleaning



2μm
EHT = 10.00 kV
WD = 5 mm
Signal A = InLens
Photo No. = 5633
Date : 7 Jul 2015
Time : 15:13:47



1μm
EHT = 10.00 kV
WD = 6 mm
Signal A = SE2
Photo No. = 6271
Date : 23 Jul 2015
Time : 17:28:08

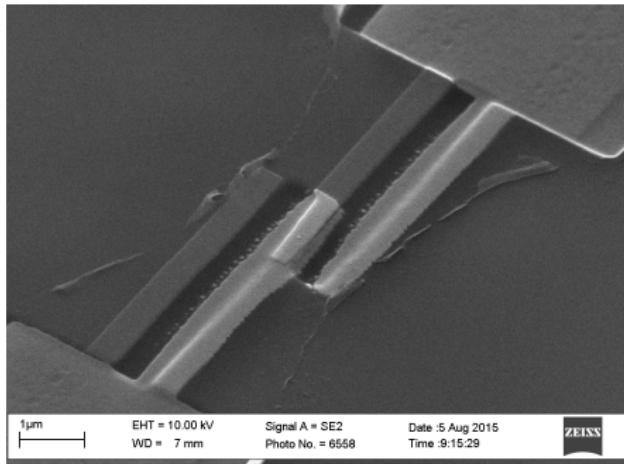


→ Exact same parameters (Oxidation 10min / 200mbar, Plasma Etching 10min, Oxidation 2 min/2mbar). Before the cleaning : resist burned. After the cleaning, we do not really understand what we see.

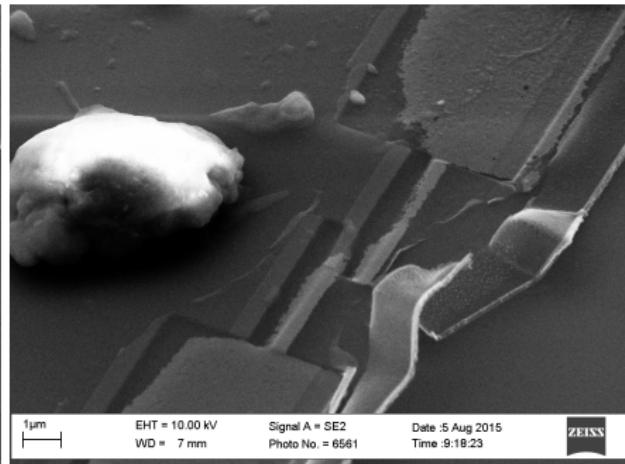
PLASMA TESTS IV

Room temperature measurements

- Wafer etching : 10 min of plasma is too much after the cleaning. Same sample as before, with a tilted angle in SEM.



1μm EHT = 10.00 kV Signal A = SE2
WD = 7 mm Date : 5 Aug 2015
Photo No. = 6558 Time : 9:15:29



1μm EHT = 10.00 kV Signal A = SE2
WD = 7 mm Date : 5 Aug 2015
Photo No. = 6561 Time : 9:18:23

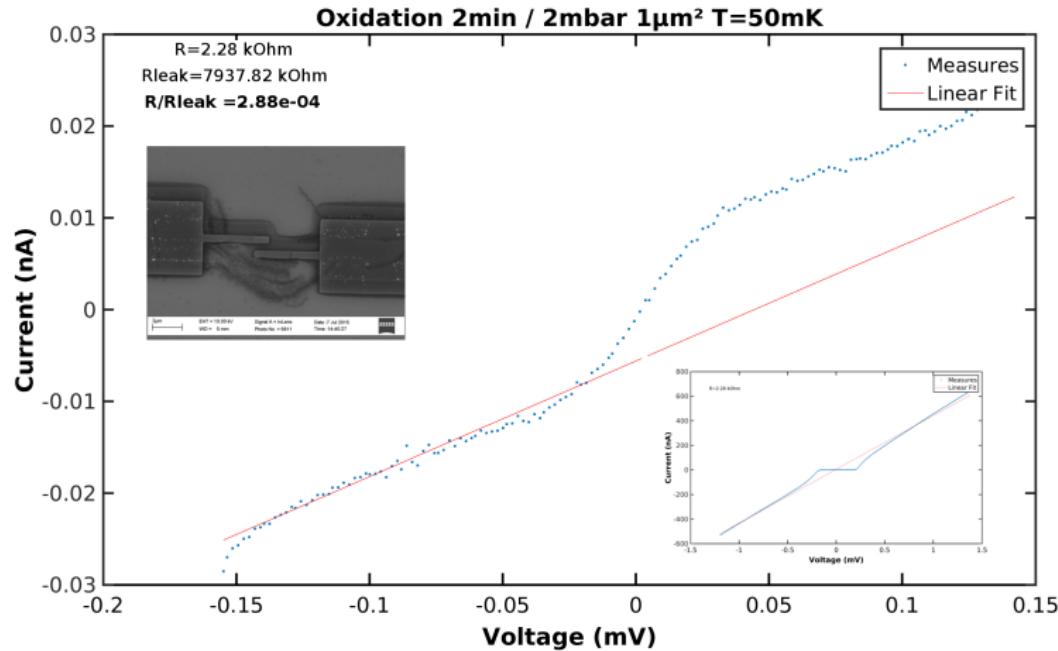


These samples had a $10\text{k}\Omega$ resistance at room temperature, now we can understand why : there are no Al leads anymore which increase the resistance.

BEFORE THE LISA MAINTENANCE

Low temperature measurements

- Regular Oxidation 2min / 2mbar NIS without Plasma.
Leakage $\simeq 10^{-4}$



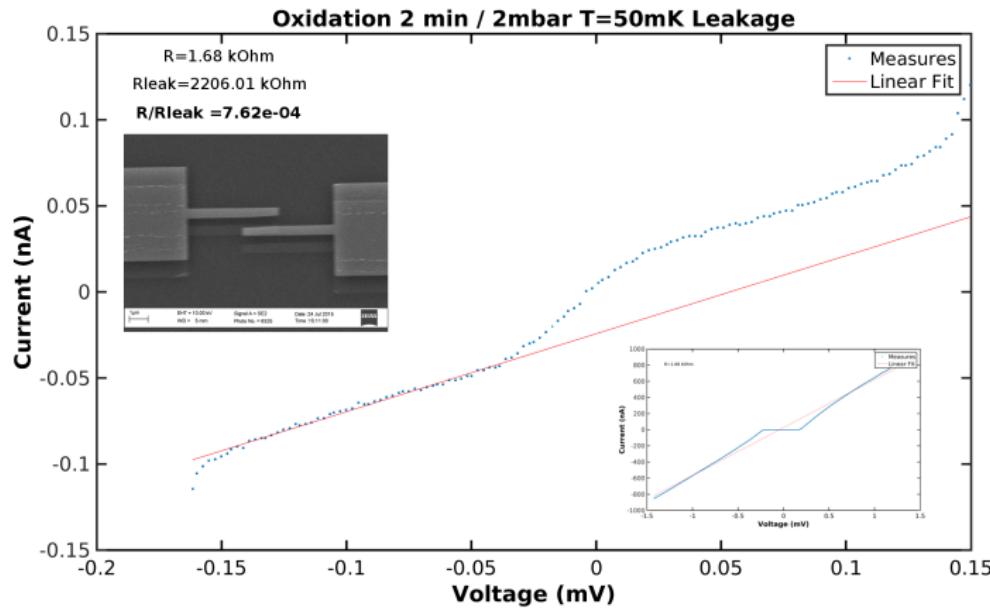
⇒ Correct leakage.

AFTER LISA MAINTENANCE I

Low temperature measurements

- Regular Oxidation 2min / 2mbar NIS just after the maintenance without Plasma.

$$\text{Leakage} \simeq 10^{-4}$$

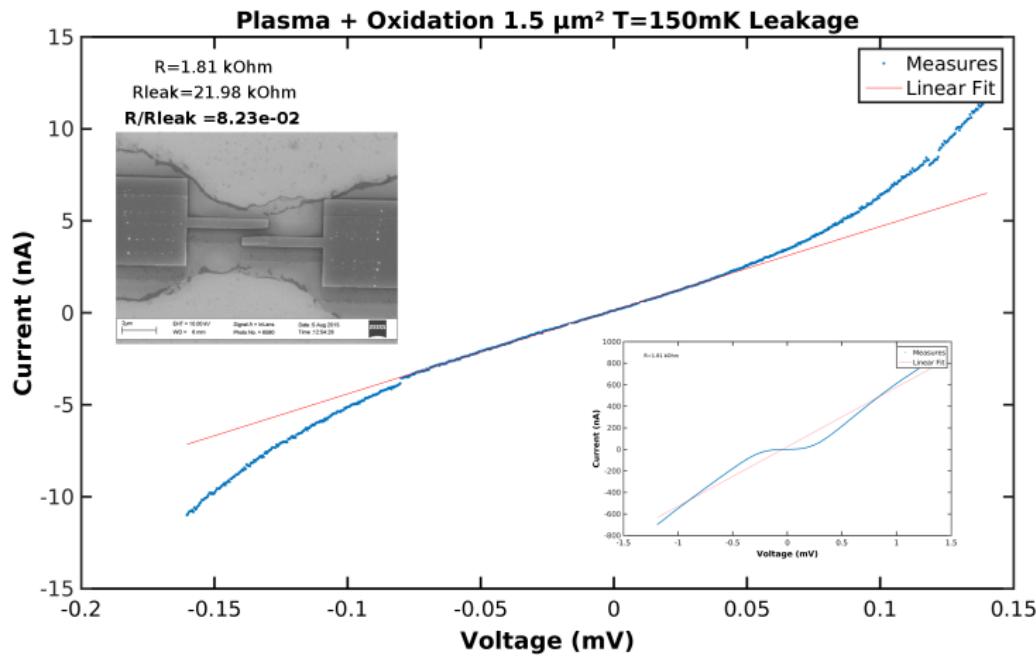


AFTER LISA MAINTENANCE II

Low temperature measurements

- Plasma Oxidation

$$\text{Leakage} \simeq 10^{-2}$$



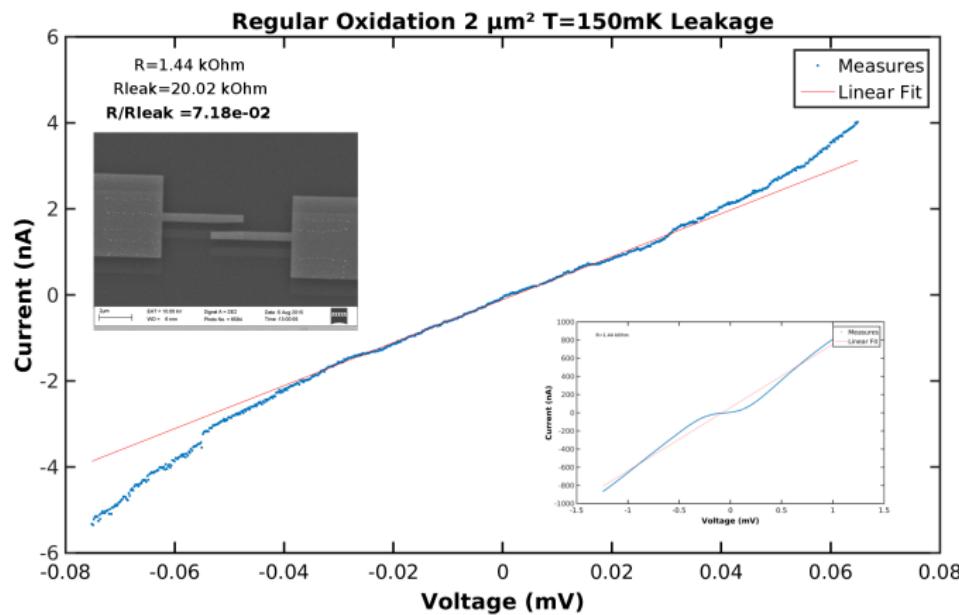
⇒ The leakage is quite bad but...

AFTER LISA MAINTENANCE III

Low temperature measurements

- Regular Oxidation reference

Leakage $\simeq 10^{-2}$



It is about the same order of magnitude for a Plasma + Oxidation sample and a Regular Oxidation Sample.

CONCLUSION

Summary

- Before the cleaning, when the plasma worked well : 10 min were good to etch Al Oxide created by 10 min / 200mbar of O_2 , the samples without Plasma had a good leakage (10^{-4}).
- The Plasma started to have problems and burned the resist of several samples, samples without Plasma remained good.
- The Plasma gun was cleaned, the parameters changed : 5 min were enough to etch Al Oxide created by 10 min / 200mbar of O_2 , 10 min of Plasma etched the wafer, the samples without plasma still had a good leakage (10^{-4}).
- The leakage of all the junctions started to be poor (10^{-2}).
- Hoping that this week end maintenance will fix it up.

CONCLUSION

Thank you for your attention !

If you have any questions please ask.