

PADME group meeting

Misure IV e wire bonding

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Outline:

1. Electric characterization

- *graphite electrodes*
- *diamond*

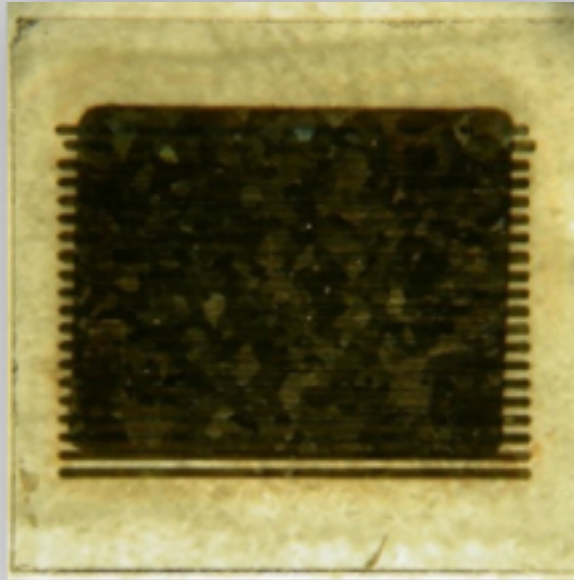
2. Bonding (*wedge bonding, ball bonding (?)*)

3. Nanofabrication (?) and other technologies (*GaN, SAW*) (?)

1. Electric characterization : detector grade

Front: graphitic strips on diamond (detector grade)

Back: graphitic pad



Resistivity measurements

1.1 Graphite electrodes by TLM method;

1.2 Diamond substrate by

- TLM

- leakage current;

1.3 Dielectric characterization of the graphite/diamond/graphite as a capacitor

Geometrical parameters of grafitized electrodes on diamond*

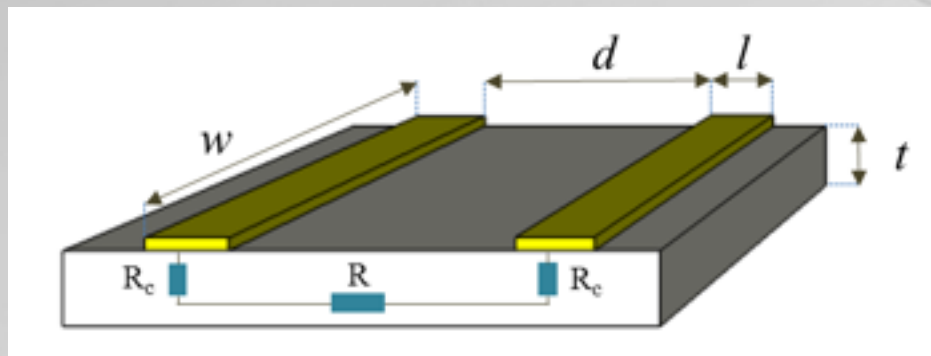
<i>Diamond thickness</i>	<i>Electrode length</i>	<i>Electrode width</i>	<i>Electrode</i>	<i>Number of electrodes</i>
325 μ m	3.5mm	100 μ m	68 μ m	20

* From SEM analysis

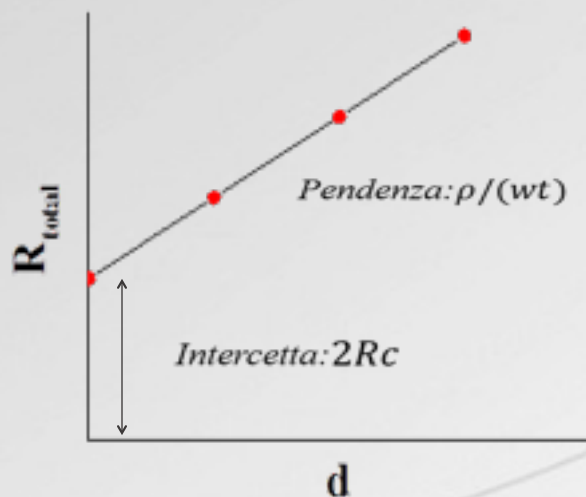
1. Electric characterization: detector grade

1.1 Resistivity measurement of graphite electrodes by using TLM method

• TLM method

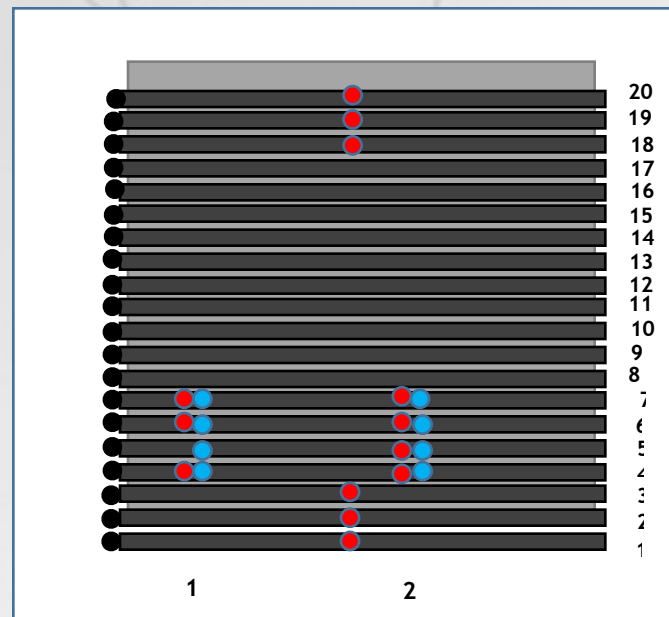


$$R_{total} = 2R_c + \left[\frac{\rho}{wt}\right]d$$



Misure effettuate sul campione:

In fig sono indicate le linee considerate per la caratterizzazione TLM

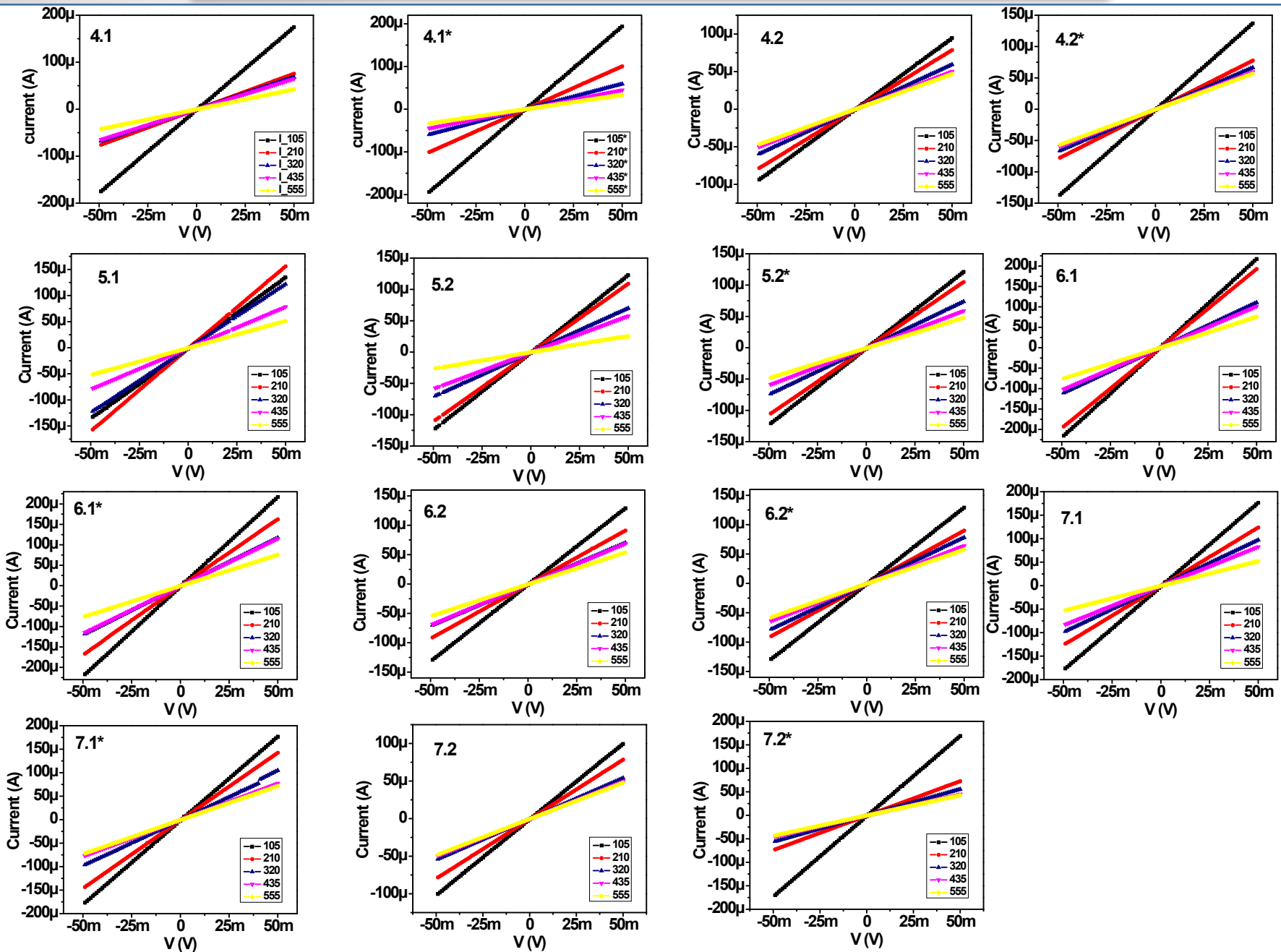


- i-V a distanza crescente
- i-V a distanza decrescente

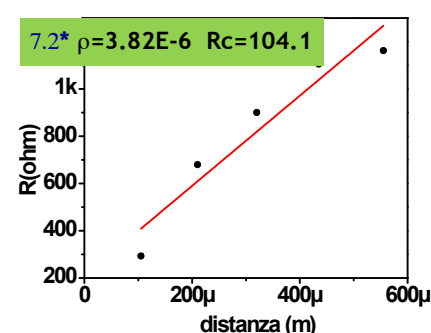
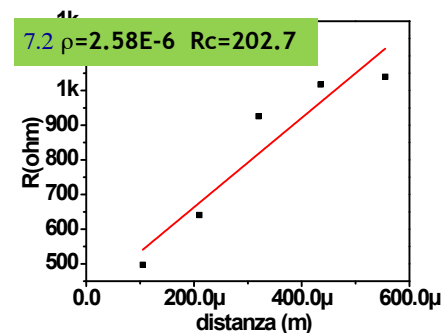
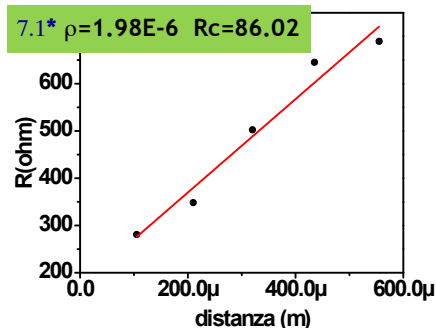
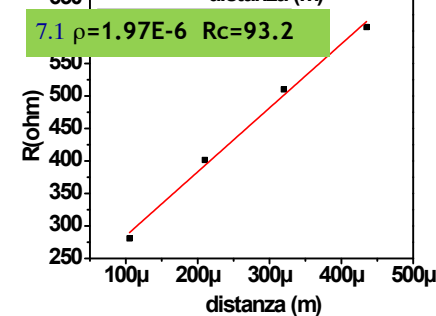
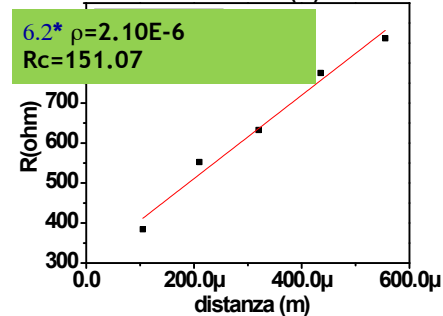
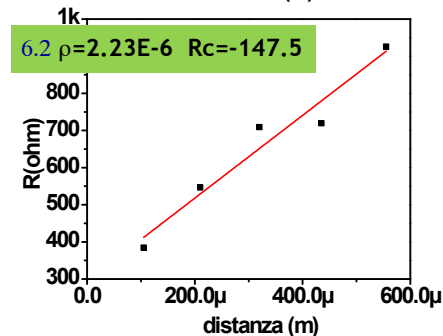
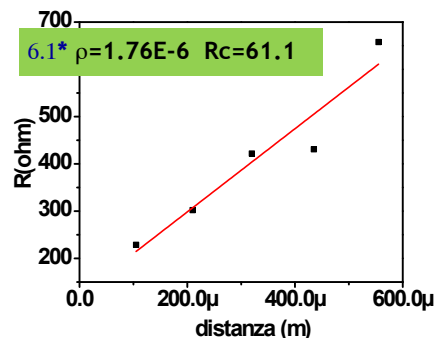
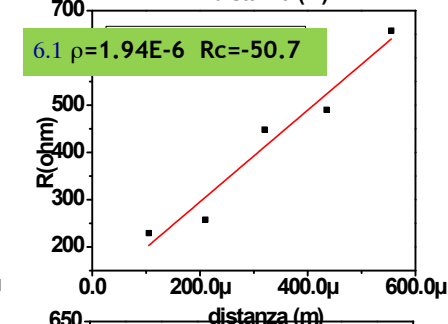
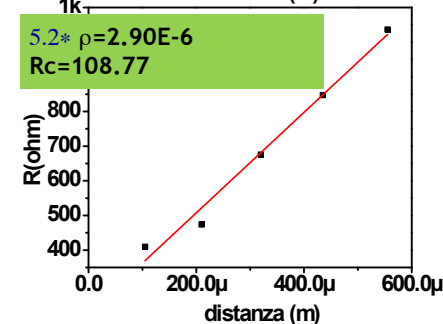
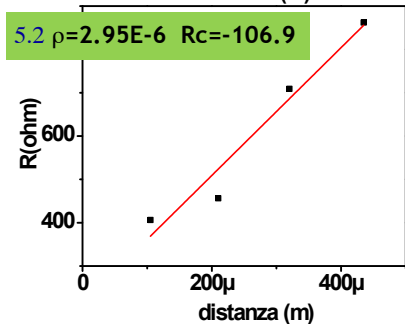
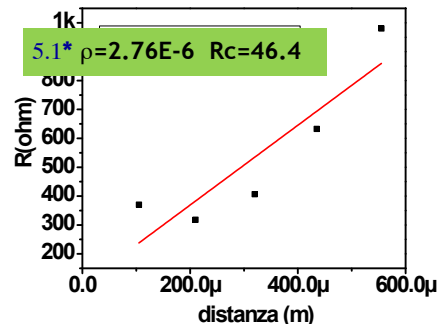
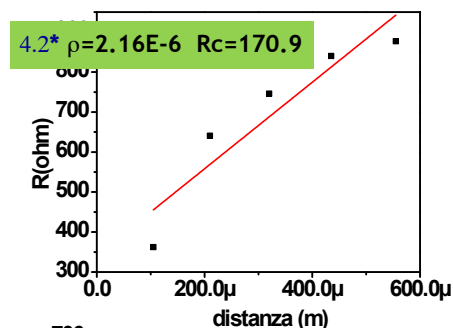
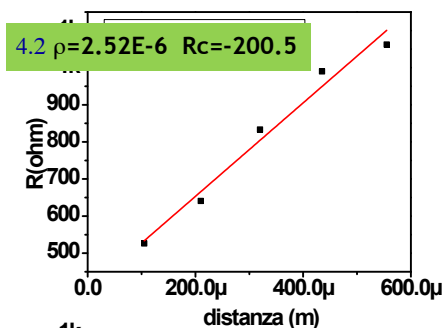
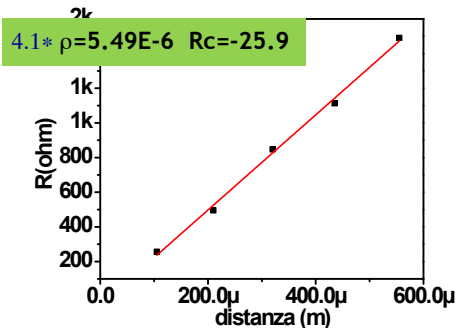
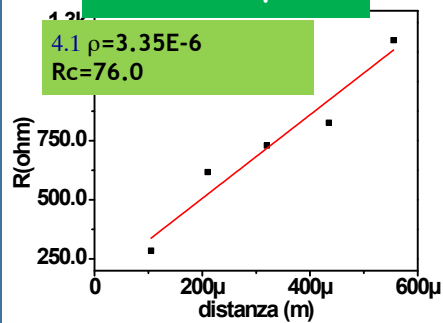
$\Delta d \approx 100 \mu\text{m}$ per le linee 4/5/6/7

$\Delta d \approx 500 \mu\text{m}$ per le linee 1/2/3/18/19/20

i-V al variare della distanza con passo $\Delta d \approx 100\mu\text{m}$



$\Delta d \approx 100 \mu\text{m}$



Note:

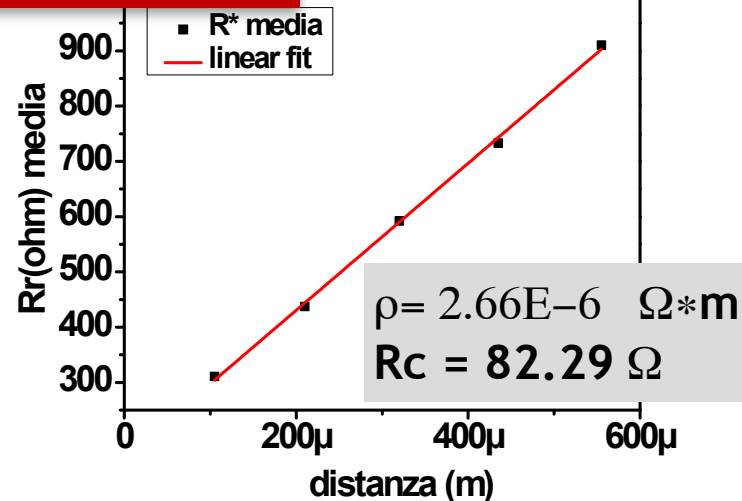
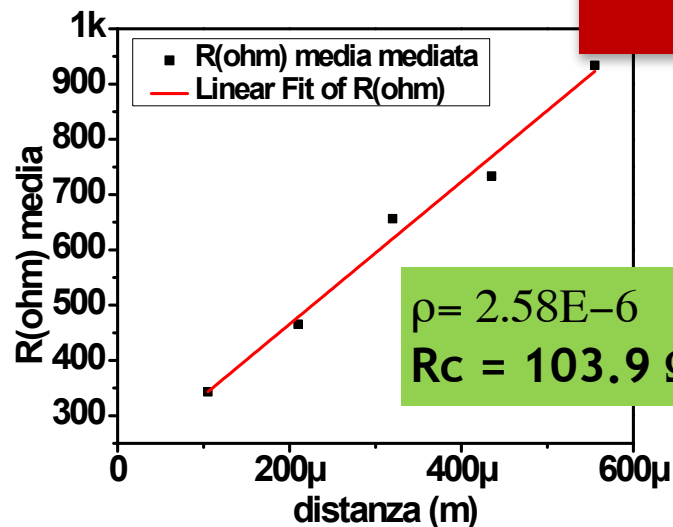
Resistivity in ($\Omega^*\text{m}$)

R_c in (Ω)

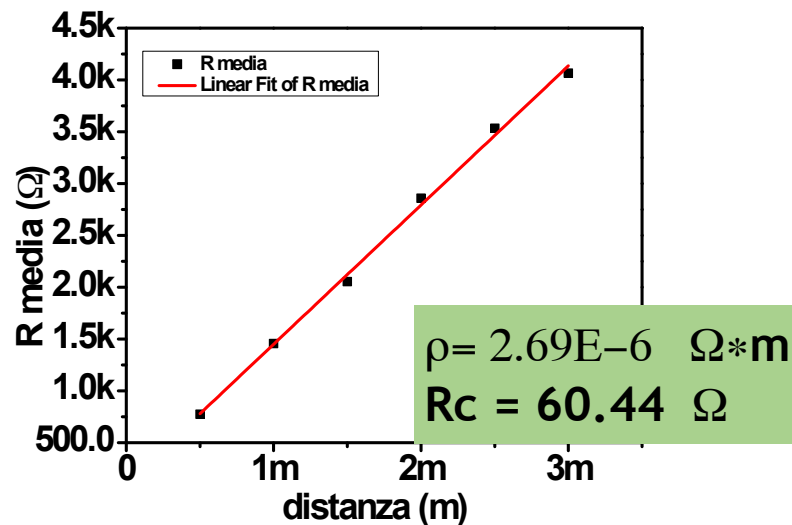
Name: 1st nro riga; 2nd nro TLM serie e “*” indica la misura eseguita per valori crescenti di distanza

$\Delta d \approx 100 \mu\text{m}$

Results-mean values



$\Delta d = 500 \mu\text{m}$



Reference

Gold	83.69	2.060E-08	MHASM2	conductivity converted from resistivity
Graphite	0.22	1.276E+05	7.837E-06	CSNDT
Hafnium	4.91	3.510E-07	MHASM2	conductivity converted from resistivity

From NTD resource center

Graphite resistivity 10^{-5} - 10^{-6} V.I. Konov, Laser Photonics Rev.6 (2012) 739-76

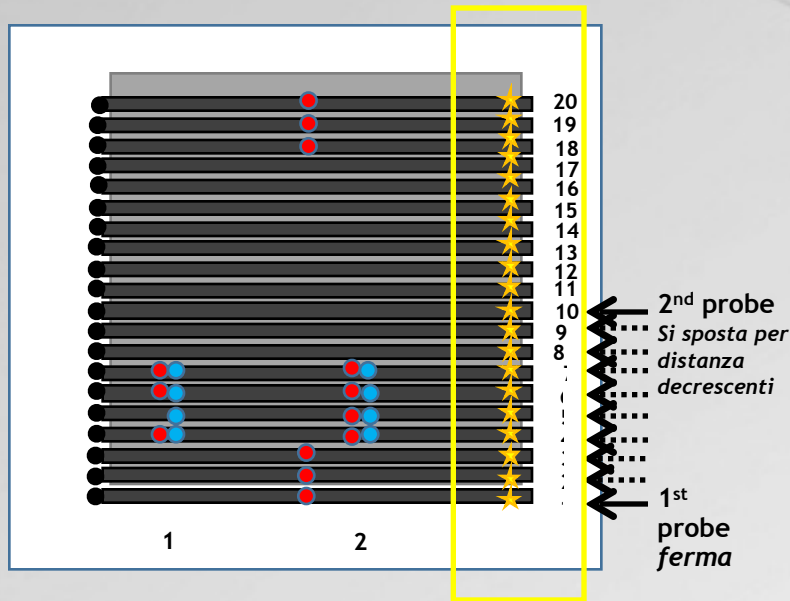
Radius tip: $20 \mu\text{m}$

Thickness of graphite stripe $\approx 50\text{nm}$

1. Electric characterization : detector grade

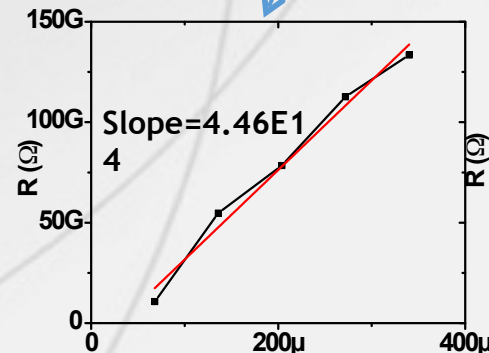
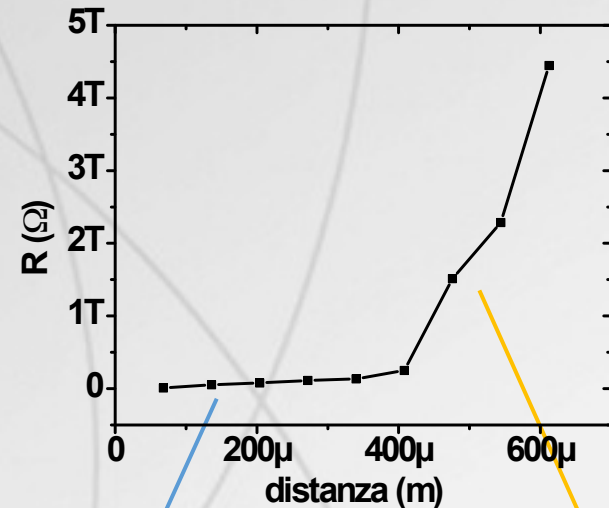
1.2 Resistivity measurement of diamond substrate by using the TLM method

Metodo TLM

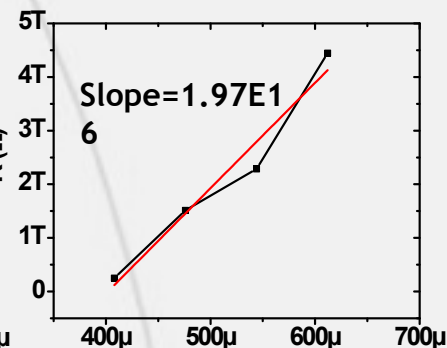


- i-V a distanza crescente
- i-V a distanza decrescente
- ★ TLM per caratterizzare il diamante

Dalle misure i-V e' stata ricavata la resistenza (R) al variare delle distanze (d) tra i contatti. Dal grafico R-d si ottiene la resistivita' del diamante considerando la riga lunga **3.5mm** e lo spessore del diamante interessato al trasferimento di carica pari a **325um**.



$$\rho = 5.070E8 \, \Omega \cdot m$$

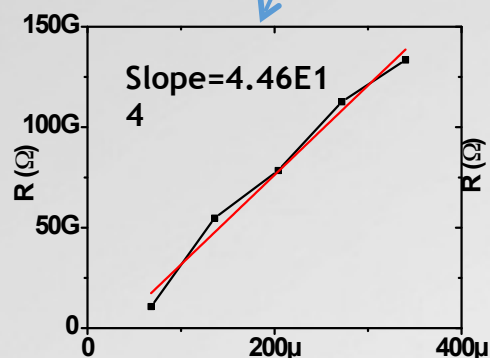
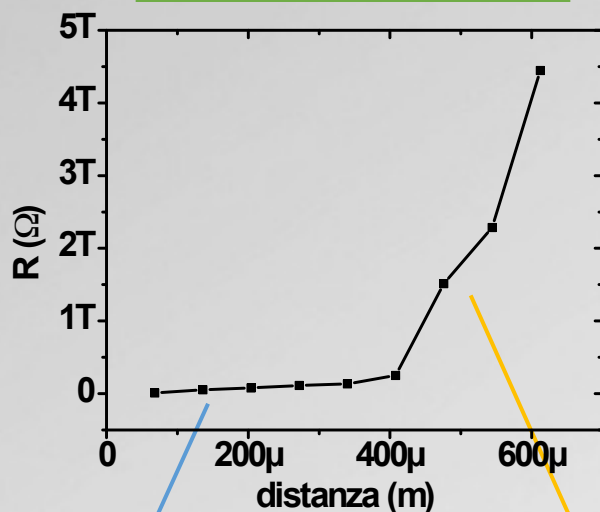


$$\rho = 2.24E10 \, \Omega \cdot m$$

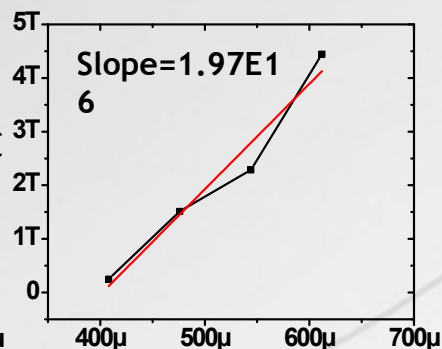
1. Electric characterization: detector grade

1.2 Resistivity measurement of diamond substrate by using the TLM method

Before cleaning



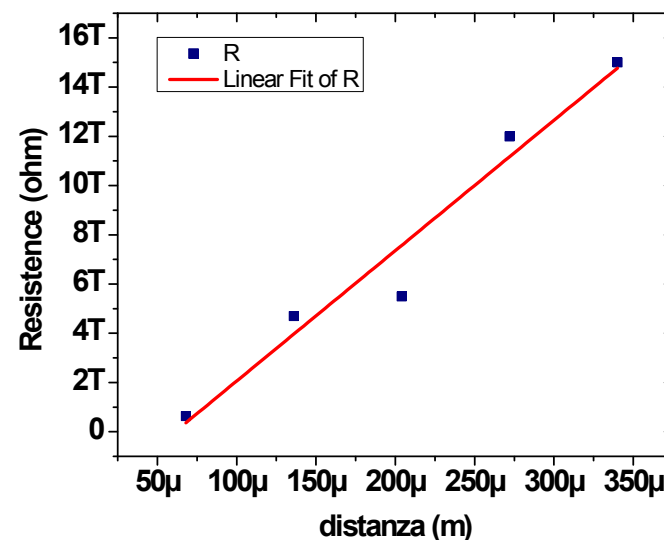
$$\rho = 5.070E8 \Omega \cdot m$$



$$\rho = 2.24E10 \Omega \cdot m$$

After cleaning

il campione e' stato sonicato per 3' in acetone e 3' in isopropilico.

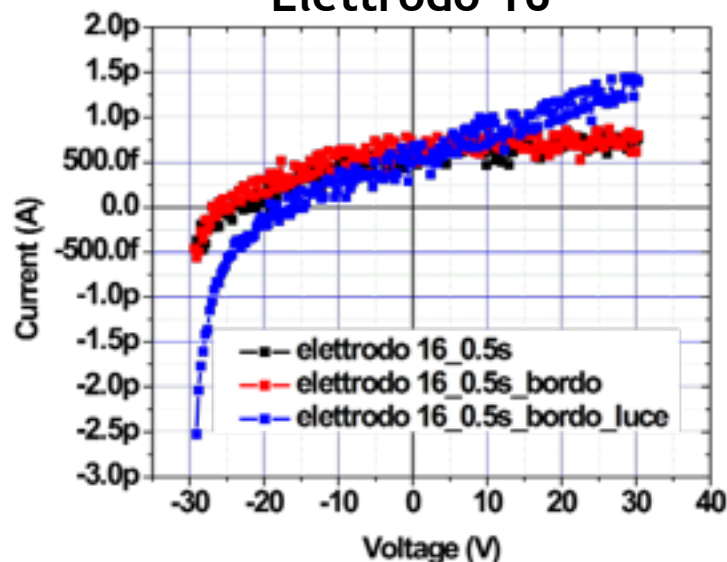


$$\rho = 6.03E10 \Omega \cdot m$$

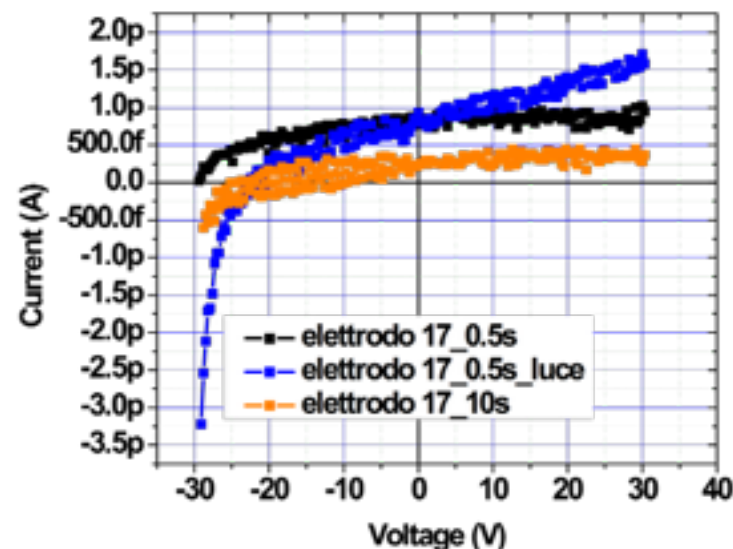
1. Electric characterization: detector grade

1.2 Resistivity of diamond substrate estimated by leakage current (vertical measurement)

Elettrodo 16



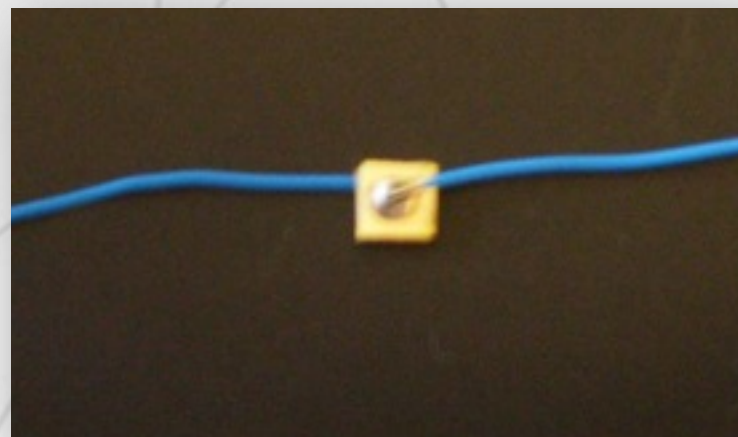
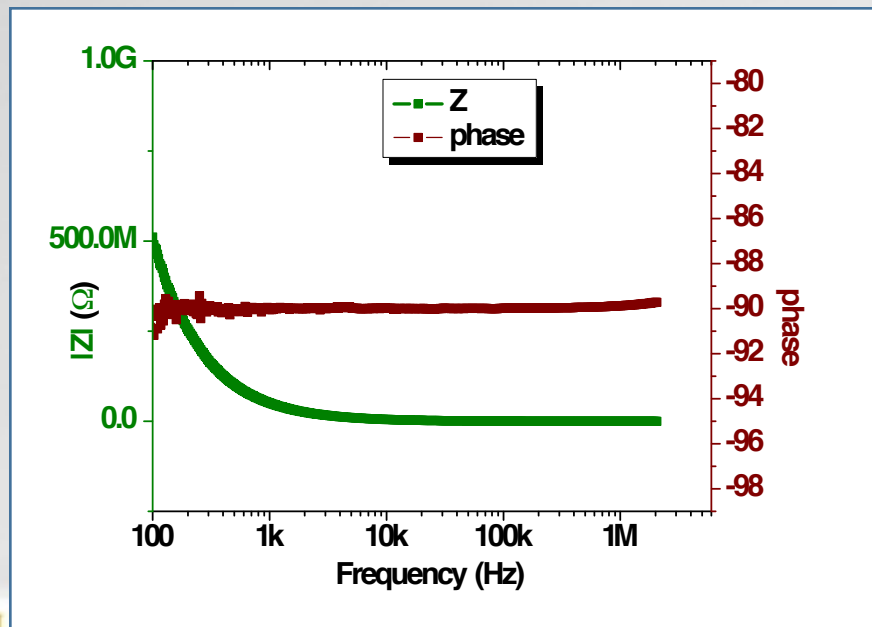
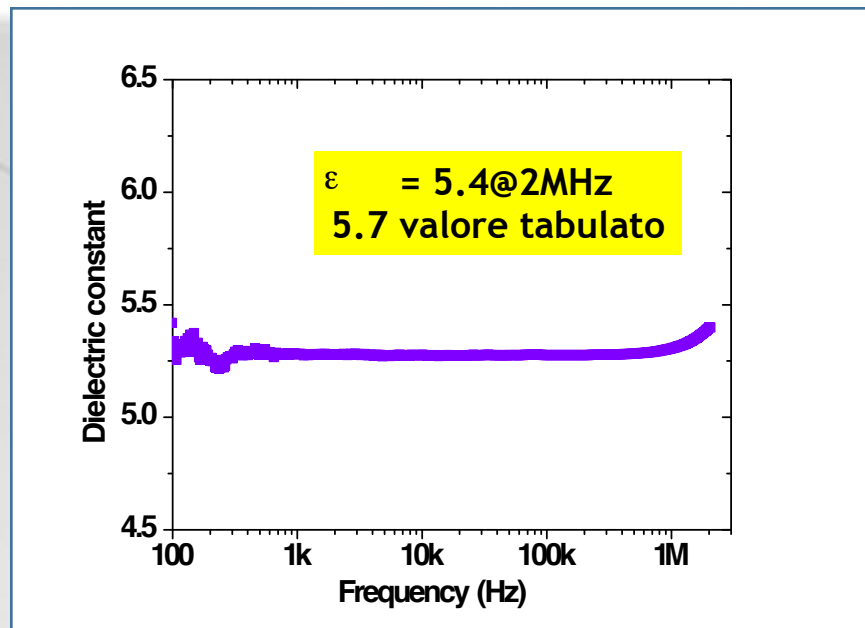
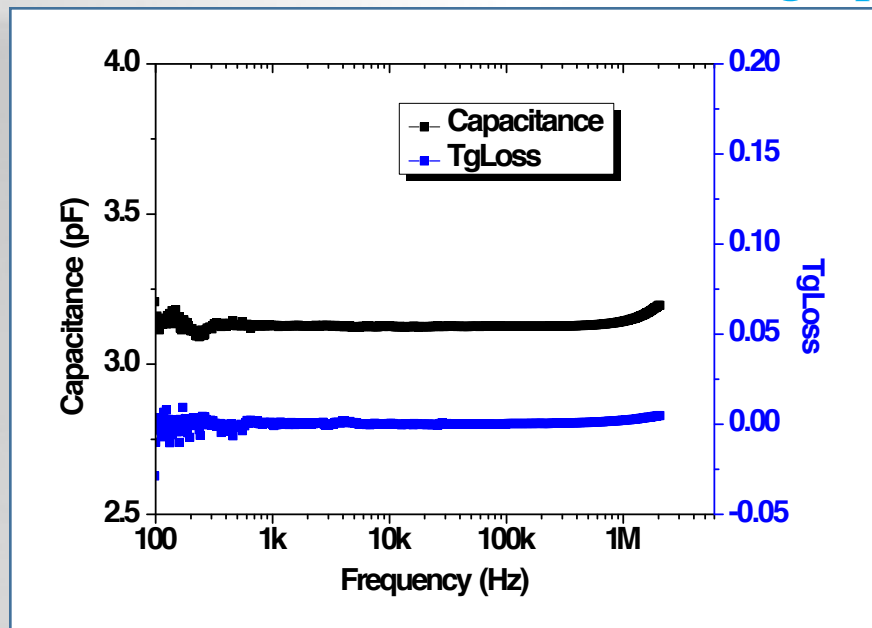
Elettrodo 17



contatti	Condizioni di misura	R (	ρ (Ω *m)	R media (buio) (Ω) ρ media (buio)	Riferimento	
16_bottom	buio	1.46E14	1.57E11	$R=2.48E14$ $\rho=2.67E11$	>10	
	luce	3.63E13	3.91E10			
17_bottom	buio	4.17E14	4.49E11			$\rho=RS/l$ $S=100\mu m*3.5mm$ $l=325\mu m$
	luce	3.90E13	4.20E10			

1. Electric characterization: detector grade

1.3 Dielectric characterization of graphitized diamond



1. Electric characterization: thermal grade

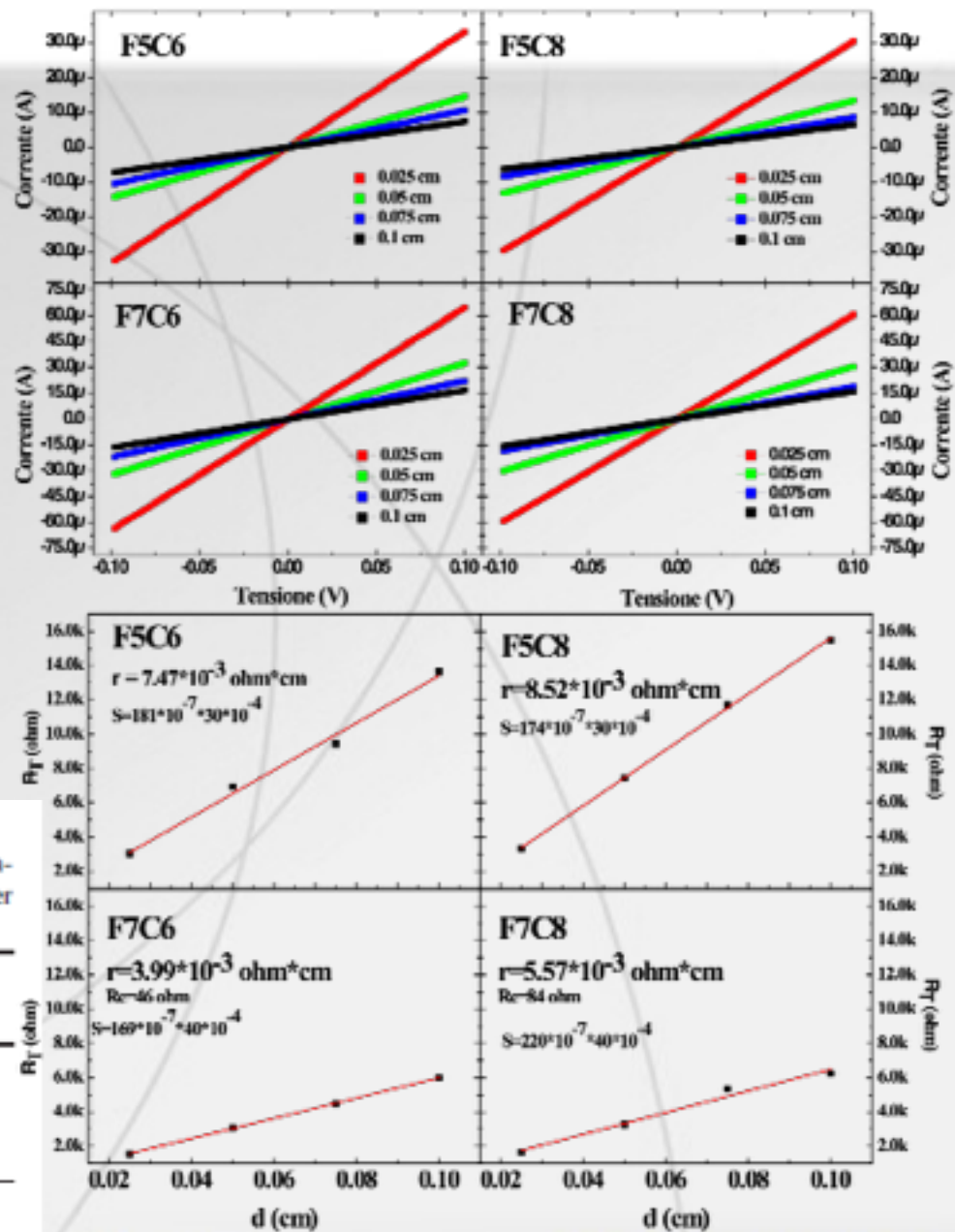
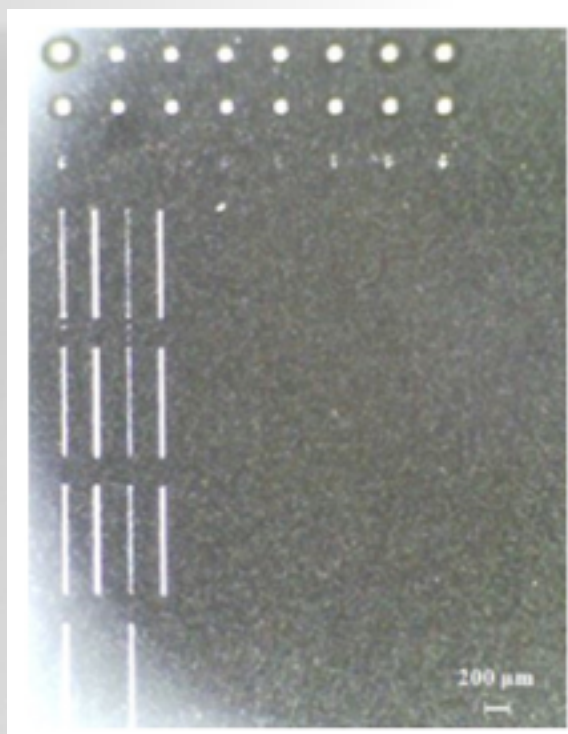
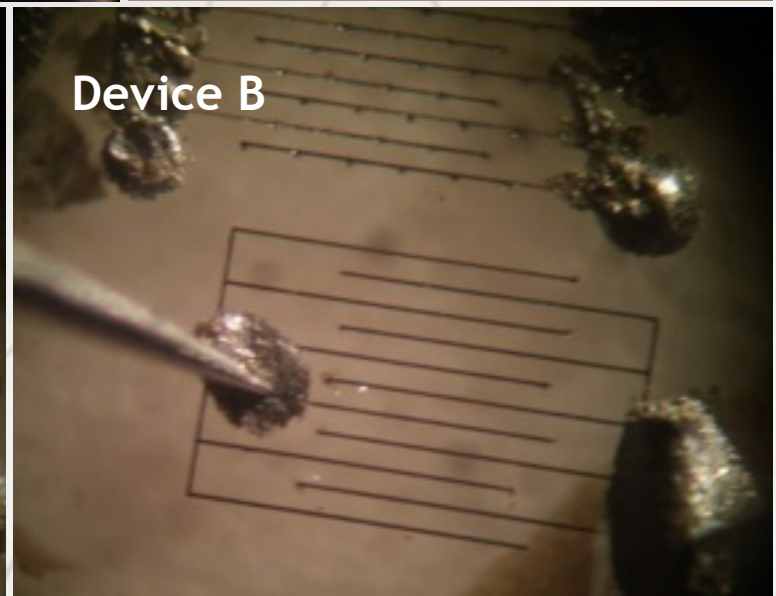
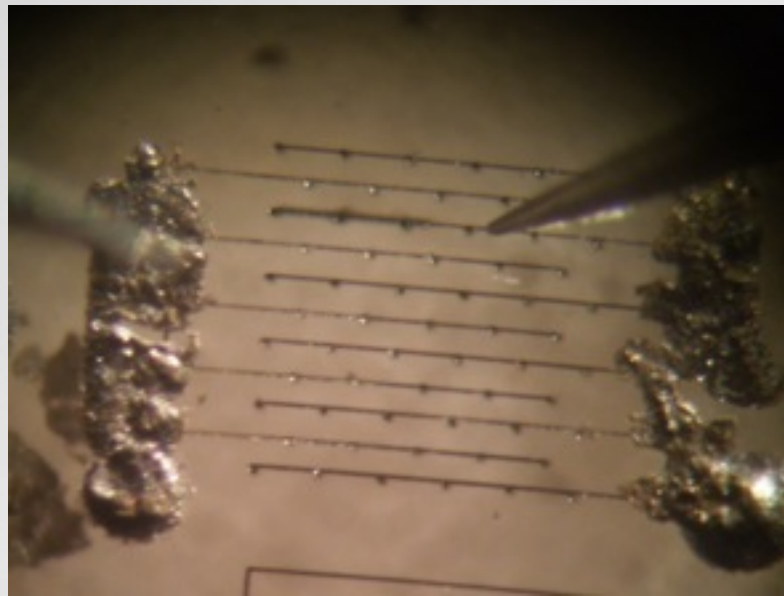
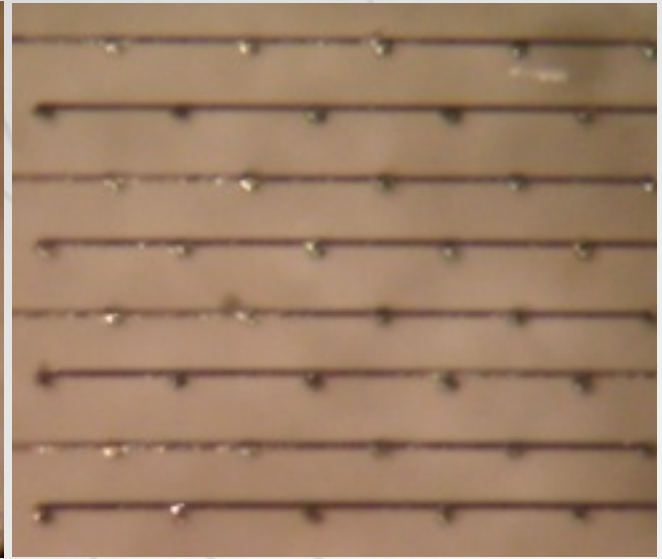


Table 2

Geometric parameter (length l , width w , thickness t) and resistivity values (ρ) of the graphitic strips realized at different irradiation fluence values ($F = 5$ and 7 J/cm^2) and laser scan cycles ($C = 6$ and 8).

Strips	l (m)	w (m)	t (m)	ρ (Ωm)
F5C6	1×10^{-3}	3×10^{-5}	1.81×10^{-7}	7.5×10^{-5}
F5C8	1×10^{-3}	3×10^{-5}	1.7×10^{-7}	9×10^{-5}
F7C6	1×10^{-3}	4×10^{-5}	1.69×10^{-7}	4.0×10^{-5}
F7C8	1×10^{-3}	4×10^{-5}	2.26×10^{-7}	5.5×10^{-5}

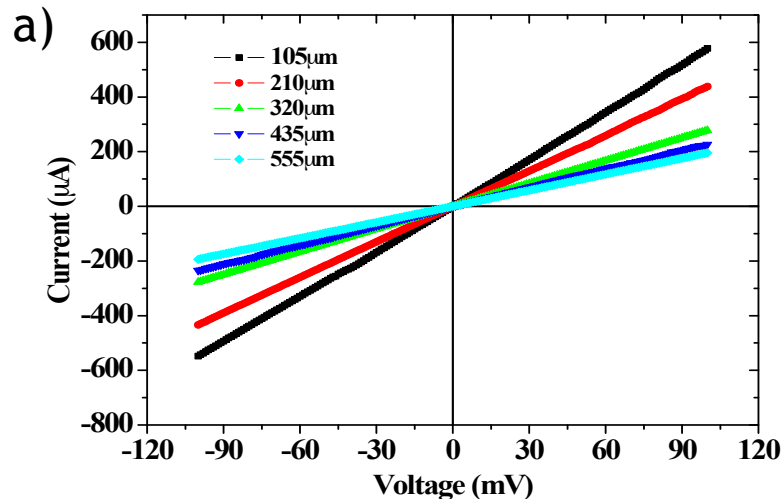
1. Electric characterization: 3D graphitic electrodes in diamond substrate



1. Electric characterization: 3D graphitic electrodes in diamond substrate

Device B

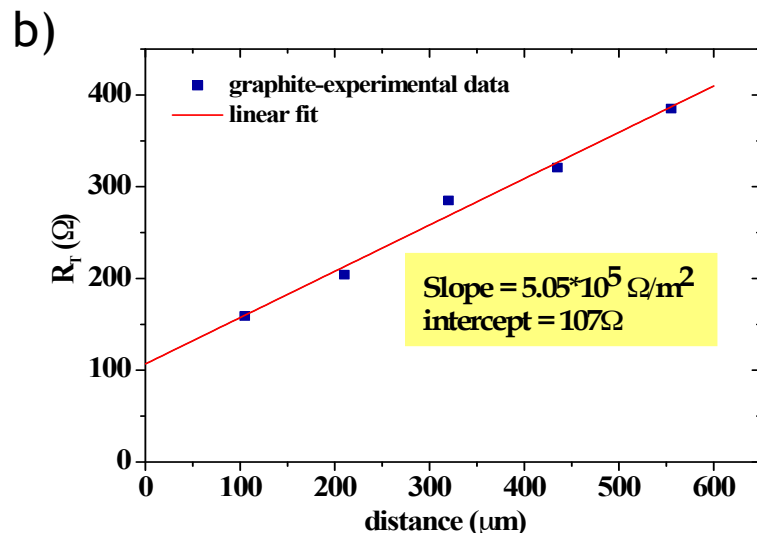
Characterization of graphite electrodes



- (a) Typical trend of TLM measurements on graphite line. This characterization was repeated six times on different interdigitated fingers of the structure without vertical graphite channel.
- (b) Mean value of total resistance, R_T , in function of the distance between two contacts.
- (c) Table of the graphite resistivity value depending from the thickness of graphite lines t :

$$\rho_G = \text{slope} \cdot w \cdot t$$

where the slope was obtained from the linear fit of the R_T vs distance plot and w was estimated to be 20 μm .



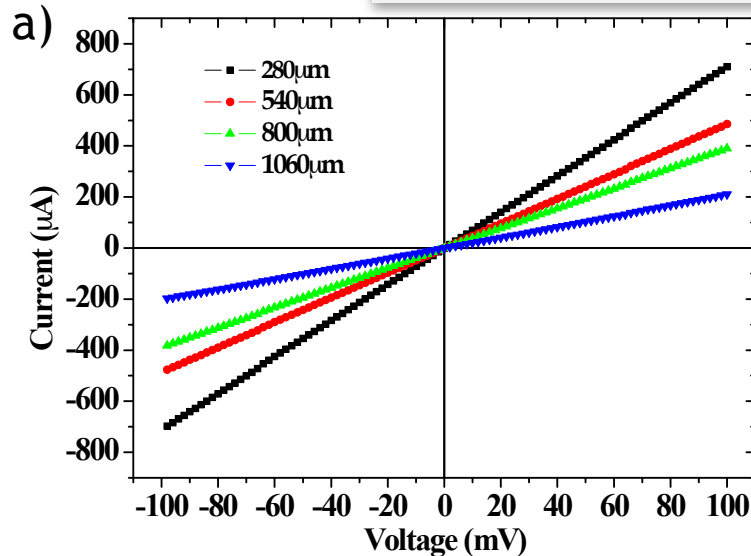
c)

t (nm)	ρ ($\Omega \cdot \text{m}$)
10	1.01E-07
20	2.02E-07
30	3.03E-07
40	4.04E-07
50	5.05E-07
60	6.06E-07
70	7.07E-07
80	8.08E-07
90	9.09E-07
100	1.01E-06
120	1.21E-06
150	1.51E-06

1. Electric characterization: 3D graphitic electrodes in diamond substrate

Device A

Characterization of graphite electrodes



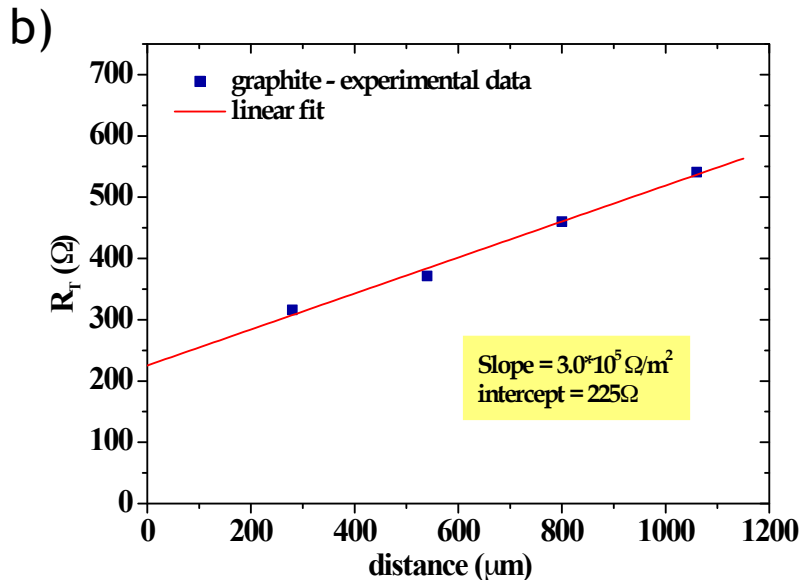
(a) This characterization was performed on different interdigitated fingers of the structure with vertical graphite channels. The probes were positioned on the top of the vertical graphite channel keeping fixed the first and moving the second along the line.

(b) Mean value of total resistance, R_T , in function of the distance between two contacts.

The distance between two consecutive channels was estimated to be of 280 μm .

Considering also in this case $w=20\mu\text{m}$ and $t=60\text{nm}$ was obtained:

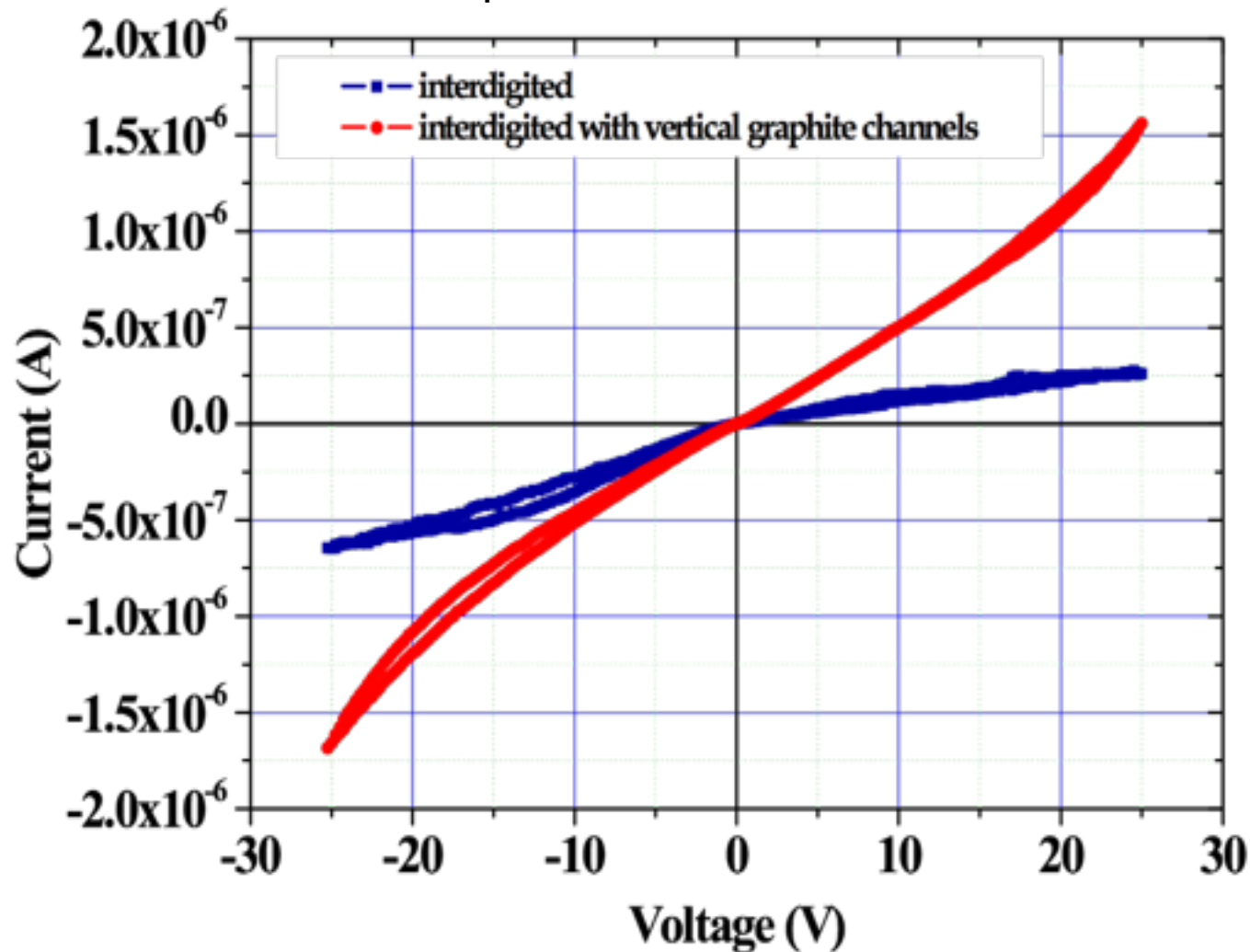
$$\rho_G = 3.6 \cdot 10^{-7} \Omega\text{m}$$



1. Electric characterization: 3D graphitic electrodes in diamond substrate

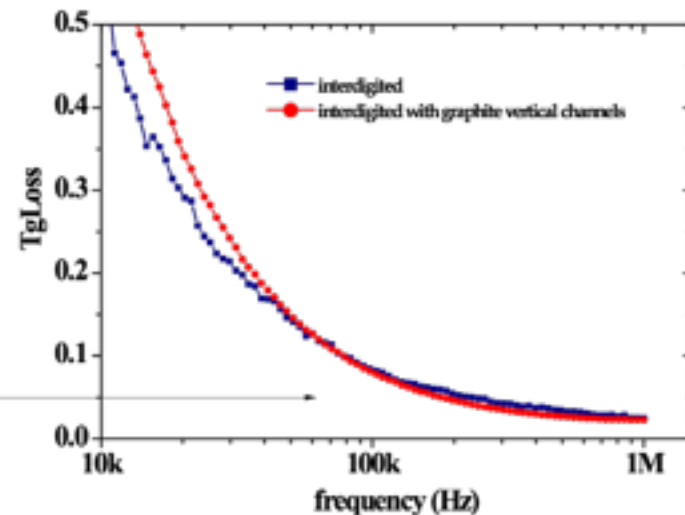
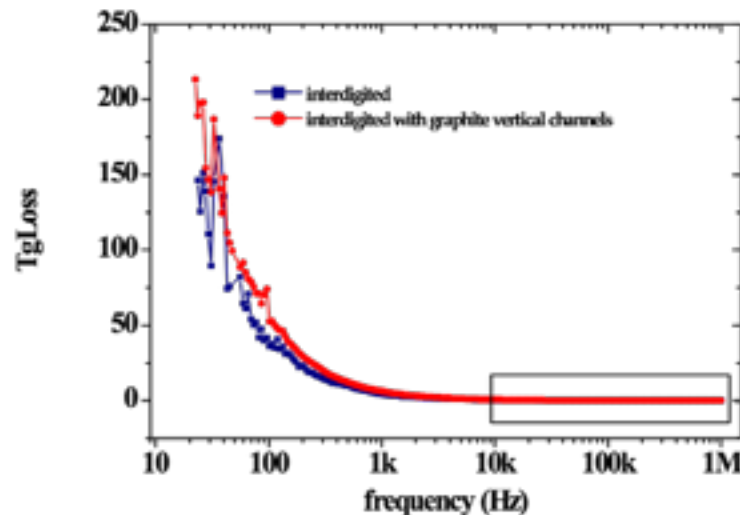
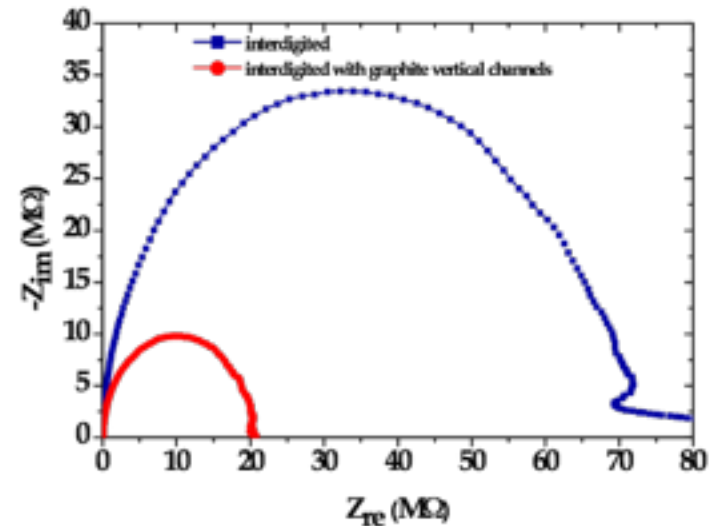
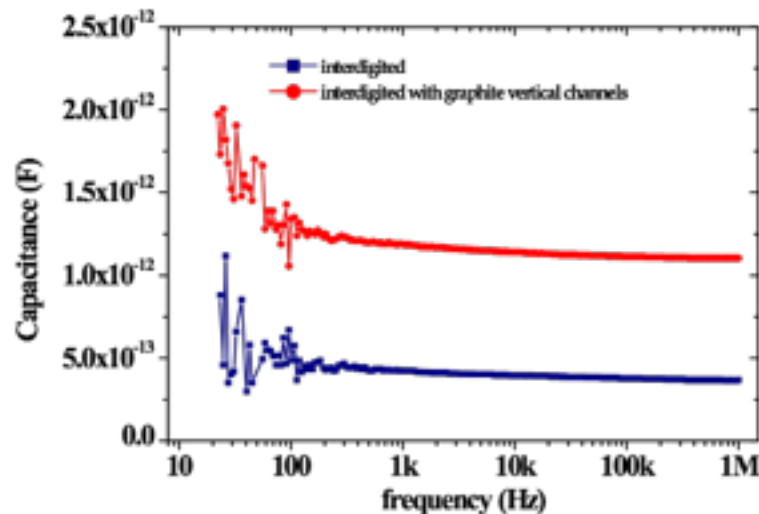
I-V curve

In plane i-V

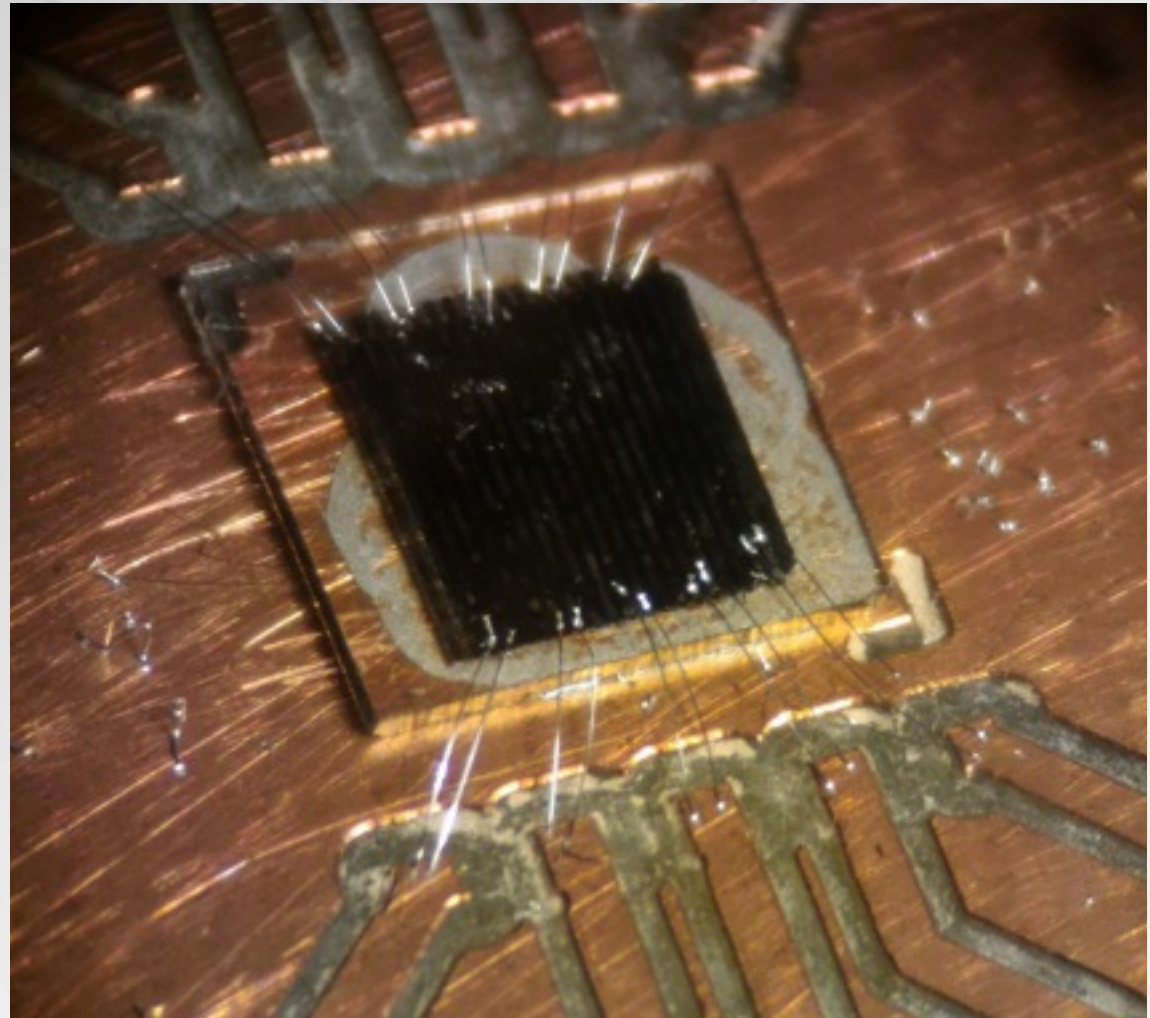
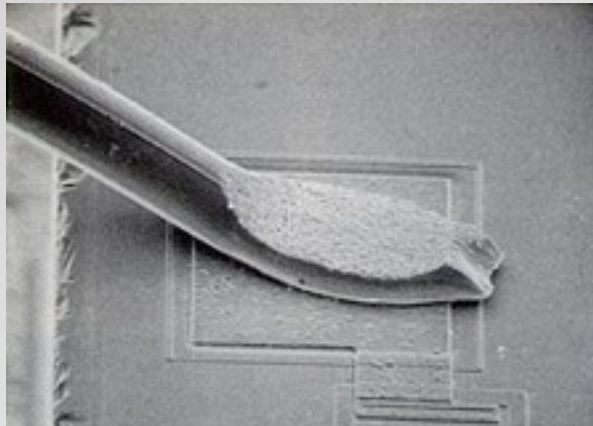


1. Electric characterization: 3D graphitic electrodes in diamond substrate

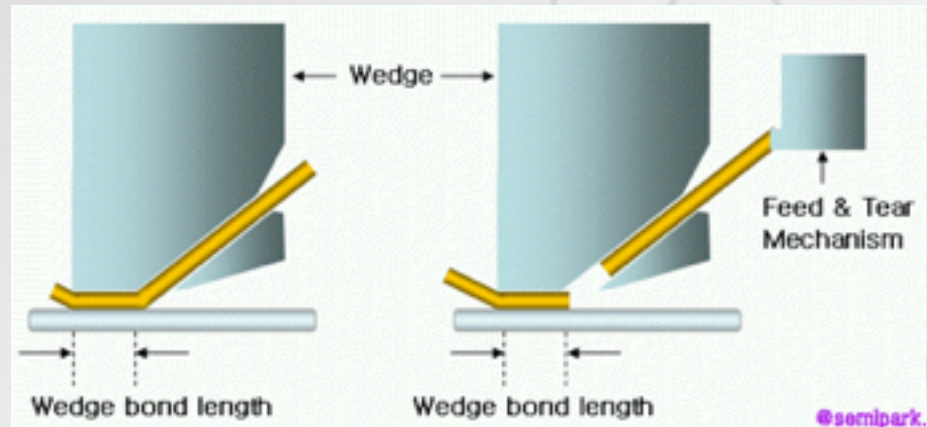
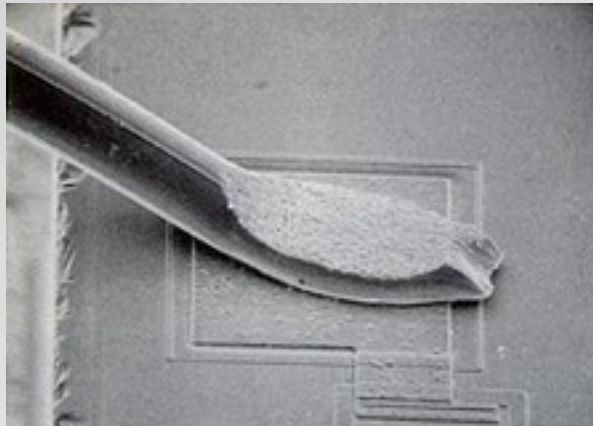
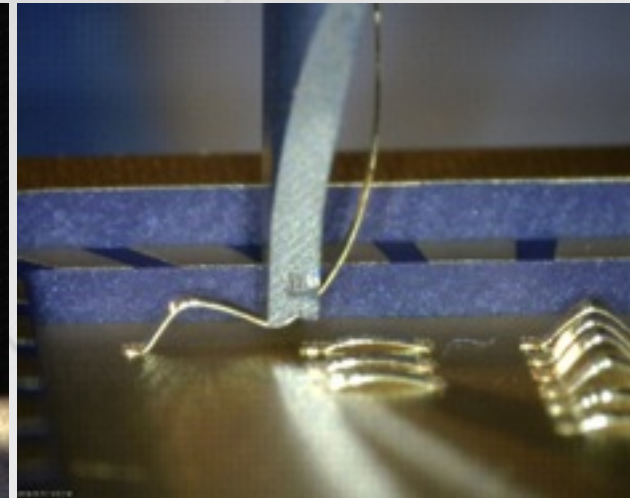
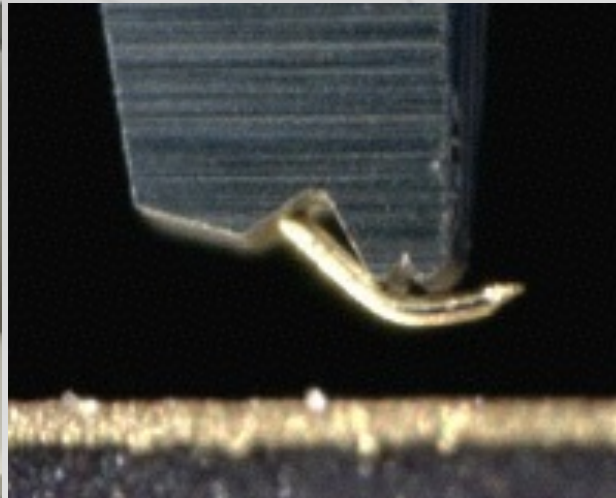
In plane capacitance measurement



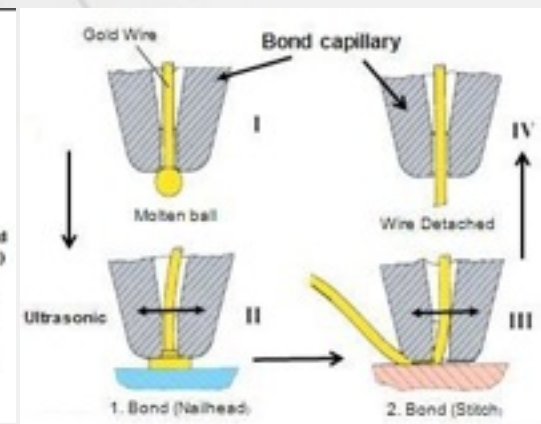
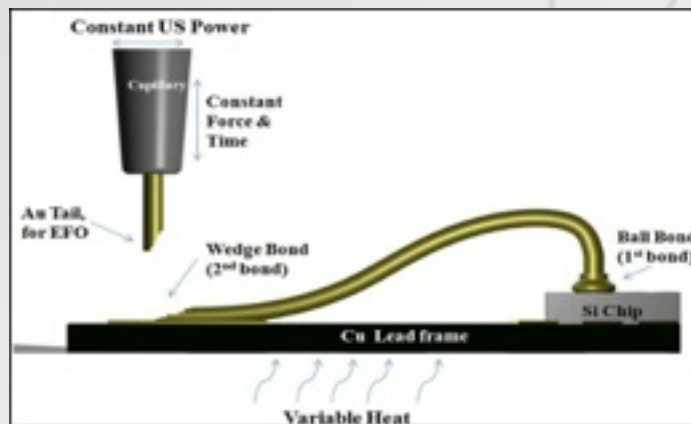
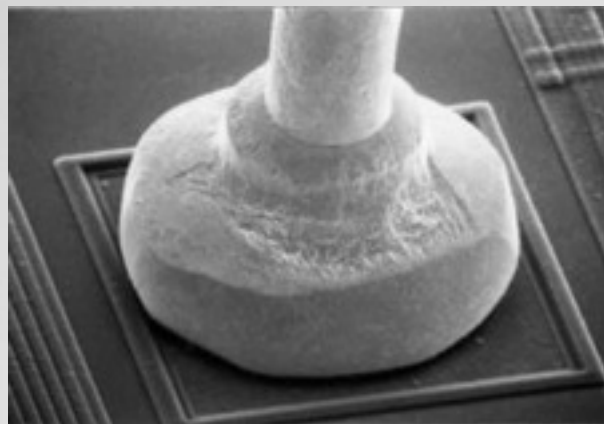
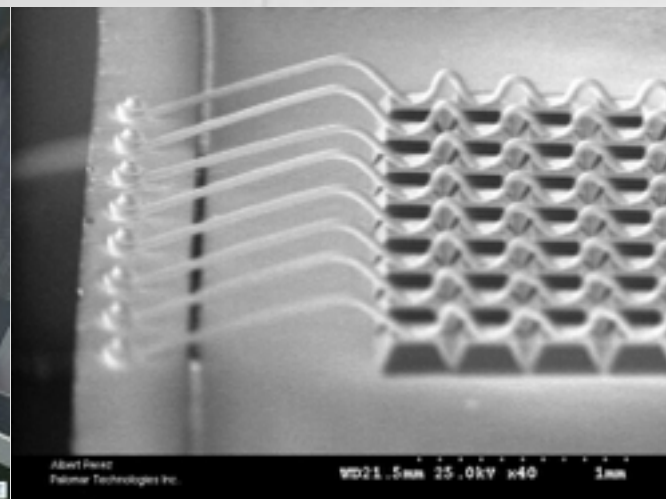
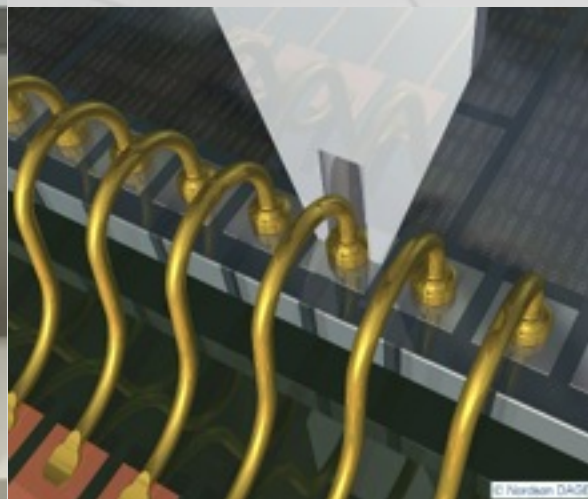
2. Bonding



2. Wedge Bonding



2. Ball Bonding



3. Needs

