# Different dispersion states of MWCNT in aligned conductive electrospun PCL/MWCNT composites

# Fabricio Molinari,1 Anahí V. Medrano,2 Alejandro Bacigalupe,3 Mariano M. Escobar,3,4 Leandro N. Monsalve2,4

# 1INTI Textiles – Av. Gral. Paz 5445 (B1650WAB), San Martín, Bs.As, Argentina.

2INTI CMNB – Av. Gral. Paz 5445 (B1650WAB), San Martín, Bs.As, Argentina.

3INTI Caucho – Av. Gral. Paz 5445 (B1650WAB), San Martín, Bs.As, Argentina.

4CONICET – INTI – Av. Gral. Paz 5445 (B1650WAB), San Martín, Bs.As, Argentina

*Supplementary information*

**Statistics on fiber diameter**

Optical Images of the fibers collected onto the interdigitated gold electrodes were taken and diameter measurements were analyzed statistically with software Image J. The measures of the diameters were taken after divide the image with a grid (1.5 in2), measures of every cell of the grid were taken and then analyzed with Minitab in order to determinate distribution parameters and to compare the samples each other (see *Figure S1)*.

a)

C:\Users\Mauro Fernandez\Desktop\fabricio\Electrospinning\Fibras PCL NTC para medicion de diametro\0% 20cm 20x.tif

b)

C:\Users\Mauro Fernandez\Desktop\fabricio\Electrospinning\Fibras PCL NTC para medicion de diametro\0,1% 26cm 50x.tif

c)



d)

C:\Users\Mauro Fernandez\Desktop\fabricio\Electrospinning\Fibras PCL NTC para medicion de diametro\0,5% 20cm 20x.tif

e)



*Figure S1. Statistical analysis of diameter if the fibers with (a)0%,(b)0.5% (c)0.9%,(d)2.2% and (e)3.0% by weight content of MWCNT.*

Distribution analysis reveals that diameter distribution could be associated to a normal distribution in the samples with 2.2%, 3.0% of MWCNT. Diameter distribution in fibers with 0%MWCNTs (pvalue 0.029) and fibers with 0.5%MWCNTs (pvalue 0.049) may be approximated to a normal distribution after an analysis of the outlier values. Diameter distribution in fibers with 0,9%MWCNTs could not be associated to normal distribution.



*Figure S2. Descriptive statistics: Graphic comparison through dotplot of diameter of the fibers with 0%, 0.5%, 0.9%, 2.2%, 3.0%)*

a)



b)



*Figure S3. Descriptive statistics: comparison of fiber diameter. (a)histograms and (b) overlapped normal curve fitting of diameter of the fibers at each MWCNT concentration.*

*ANOVA for fiber diameter at different MWCNT conentrations: 0,0%, 0,5%, 0,9%, 2,2% Y 3,0%*

**One-way ANOVA: Diam (micrón) versus Concentración**

Source DF SS MS F P

Concentración 4 48,3499 12,0875 334,91 0,000

Error 355 12,8124 0,0361

Total 359 61,1623

S = 0,1900 R-Sq = 79,05% R-Sq(adj) = 78,82%

Individual 95% CIsFor Mean Basedon

PooledStDev

Level N Mean StDev ---+---------+---------+---------+------

0,00% 75 0,4748 0,0945 (-\*-)

0,50% 70 0,5687 0,1532 (-\*-)

0,90% 75 0,5057 0,1361 (\*-)

2,20% 70 1,1245 0,2571 (-\*-)

3,00% 70 1,3708 0,2583 (-\*-)

---+---------+---------+---------+------

0,50 0,75 1,00 1,25

PooledStDev = 0,1900

GroupingInformationUsingTukeyMethod

Concentración N Mean Grouping

3,00% 70 1,3708 A

2,20% 70 1,1245 B

0,50% 70 0,5687 C

0,90% 75 0,5057 C D

0,00% 75 0,4748 D

Meansthat do not share a letter are significantlydifferent.

Tukey 95% SimultaneousConfidenceIntervals

AllPairwiseComparisonsamongLevels of Concentración

Individual confidencelevel = 99,33%

Concentración = 0,00% subtractedfrom:

Concentración Lower Center Upper

0,50% 0,0077 0,0939 0,1801

0,90% -0,0538 0,0309 0,1156

2,20% 0,5635 0,6497 0,7358

3,00% 0,8098 0,8960 0,9822

Concentración ---------+---------+---------+---------+

0,50% (-\*-)

0,90% (-\*)

2,20% (-\*-)

3,00% (-\*-)

---------+---------+---------+---------+

-0,50 0,00 0,50 1,00

Concentración = 0,50% subtractedfrom:

Concentración Lower Center Upper

0,90% -0,1492 -0,0630 0,0232

2,20% 0,4681 0,5558 0,6434

3,00% 0,7145 0,8021 0,8897

Concentración ---------+---------+---------+---------+

0,90% (-\*)

2,20% (-\*-)

3,00% (-\*-)

---------+---------+---------+---------+

-0,50 0,00 0,50 1,00

Concentración = 0,90% subtractedfrom:

Concentración Lower Center Upper

2,20% 0,5326 0,6188 0,7050

3,00% 0,7789 0,8651 0,9513

Concentración ---------+---------+---------+---------+

2,20% (\*-)

3,00% (\*-)

---------+---------+---------+---------+

-0,50 0,00 0,50 1,00

Concentración = 2,20% subtractedfrom:

Concentración Lower Center Upper

3,00% 0,1587 0,2463 0,3340

Concentración ---------+---------+---------+---------+

3,00% (-\*-)

---------+---------+---------+---------+

-0,50 0,00 0,50 1,00

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***0,0%*** | ***0,9%*** | ***0,5%*** | ***2,2%*** | ***3,0%*** |
| 0,4748 | 0,5057 | 0,5687 | ***1,1245*** | ***1,3708*** |
|  |  |  |  |  |

*Samples on the same blue line can be regarded as part of the same population.*



*Figure S4, Boxplot of fibers diameter with different MWCNT concentration.*



*Figure S5. Residual plots for fiber diameter of different MWCNT concentration.*



*Figure S6- Test for equal variances for fibers diameter of different MWCNT concentration.*

**Determination of Tc,max and Ts,ideal by DSC**

Calorimetric studies were carried out in a TA Q2000 Differential Scanning Calorimeter (DSC) calibrated with indium. Ultra high purity nitrogen was used as a purge gas. Samples of approximately 9 mg each were encapsulated in aluminum pans and sealed. The crystalline thermal history was erased by heating the samples at 100ºC for 3 min. Cooling and subsequent heating scans were registered at 10ºC/min.

The thermal treatment comprises:

(a) Erasure of crystalline thermal history by heating the sample to100ºC for 3 min.

(b) Creation of a “standard” thermal history by cooling to 0ºC.

(c) Partial melting up to a temperature denoted Ts

(d) Thermal conditioning at Ts during 5 min.

(e) DSC cooling scan from Ts, recording the crystallization peak.

(f) Complete melting heating to 100ºC recording the melting peak.

(g) Repeating the procedure from point a) at a lower Ts until annealing effects are observed in the melting peak.

This method was performed at different Ts (70ºC, 68 ºC, 65 ºC, 63 ºC, 61 ºC, 59 ºC, 57 ºC, 55 ºC) (Figure S7).



**a**

**b**

*Figure S7. Heating runs (a) and cooling runs (b) of PCL after different partial melting temperatures (Ts).*