UTPA-UMN PREM

FORCESPINNING OF NOVEL NANOFIBERS

Presented by:

Karen Lozano (PI)
Professor, Julia Beecherl Endowed Chair

At:

Annual PREM Meeting
May 20, 2013

UTPA-UMN PREM

1) To expand and consolidate a team of researchers at UTPA into a sustainable Center of Excellence to support materials science research in a Hispanic serving institution.

2) Provide junior faculty with a research platform to start or promote their materials science research and education careers.

University of Minnesota, MRSEC Twin Cities, MN

1400 miles

University of Texas Pan-American, Edinburg, TX

Research Objectives

1.To explore NP based materials including laser-induced aggregation of nanocrystallites, and NP-in-photonic crystal materials systems for application in photovoltaic solar cells.

UTPA partners: **Yuankun Lin, Jose J. Gutierrez;**
MRSEC partners: **Uwe Kortshagen, Eray Aydil**

2.To explore soluble conjugated polymers for spin-processable, low cost, plastic light emitters, and to explore conjugated-polymer-in-photonic crystal systems as a low-threshold laser.

UTPA partners**: Jose J. Gutierrez, Yuankun Lin**
MRSEC partners: **Russell J. Holmes and Dan Frisbie**

3. Photocatalytic, Multiferroic and Electrochemical Active Nanostructured Materials

UTPA – **Yuanbing Mao**

MRSEC Partner – **Eray Aydil and Andre Mkhoyan**

4. To develop self-healing materials with block copolymers as key ingredients to ultimately produce smart flexible materials.

UTPA partners- **Magda Chipara, Karen Lozano**

MRSEC partners- **Timothy Lodge, Marc Hillmyer**

5. Nanofiber Development (added project)

UTPA partners- **Karen Lozano**

MRSEC partner- **Marc Hillmyer**

Objectives of UTPA-UMN PREM

To attract, energize, and recruit students to **provide** them with state of the art research opportunities (develop their skills and abilities) to **foster** their desire to pursue graduate degrees in the materials science field.

STATISTICS

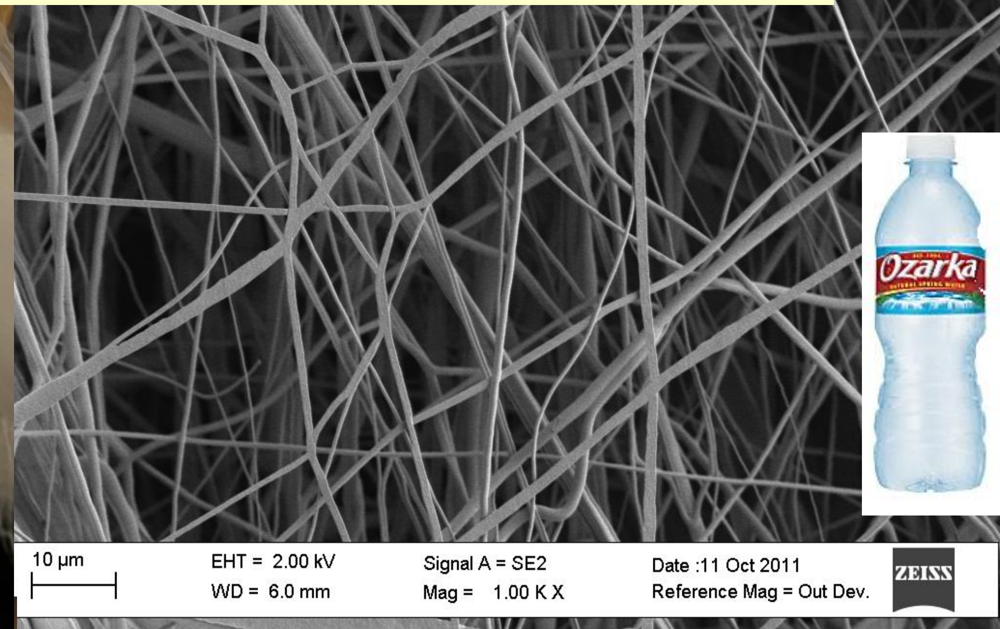
TEAM	#/URM 09-10	#/URM 10-11	#/URM 11-12	#/URM 12-13	Graduated	Pipeline	REU UMN/UTPA
UG	25/20	28/26	36/26	28/25	38/34	23 (60%)	16
MS	5/3	15/14	15/10	11/6	15/11	3 (20%)	
Postdoc	1	1	1	2/2			

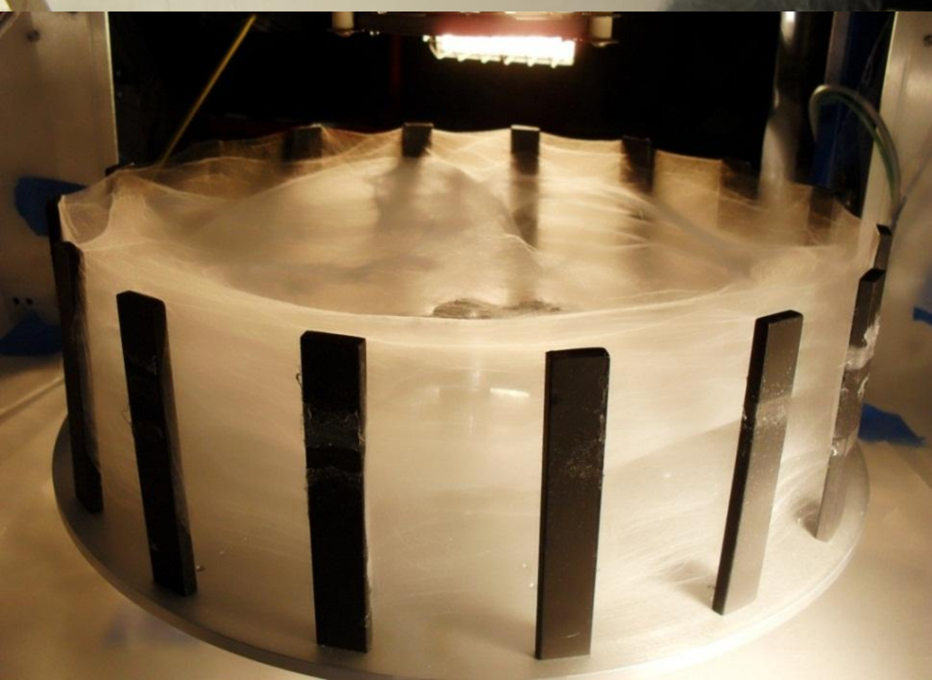
Where are they now?

Rice University
Georgia Tech
Texas A &M
Vanderbilt Medical School

University of Minnesota
University of North Texas
Tufts University
UT Medical School

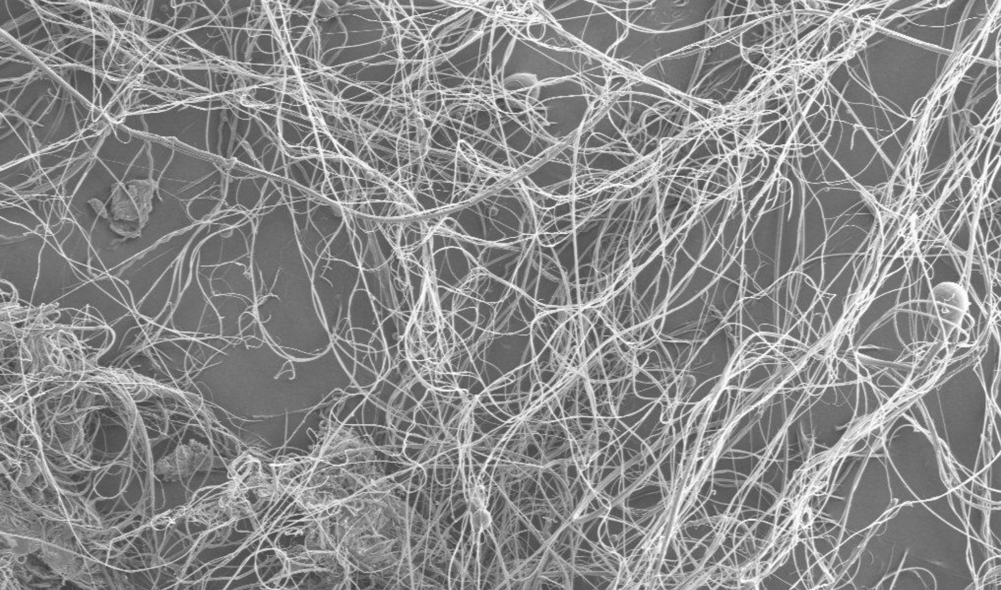
“An Alternative Method to Mass-Produce Nanofibers”

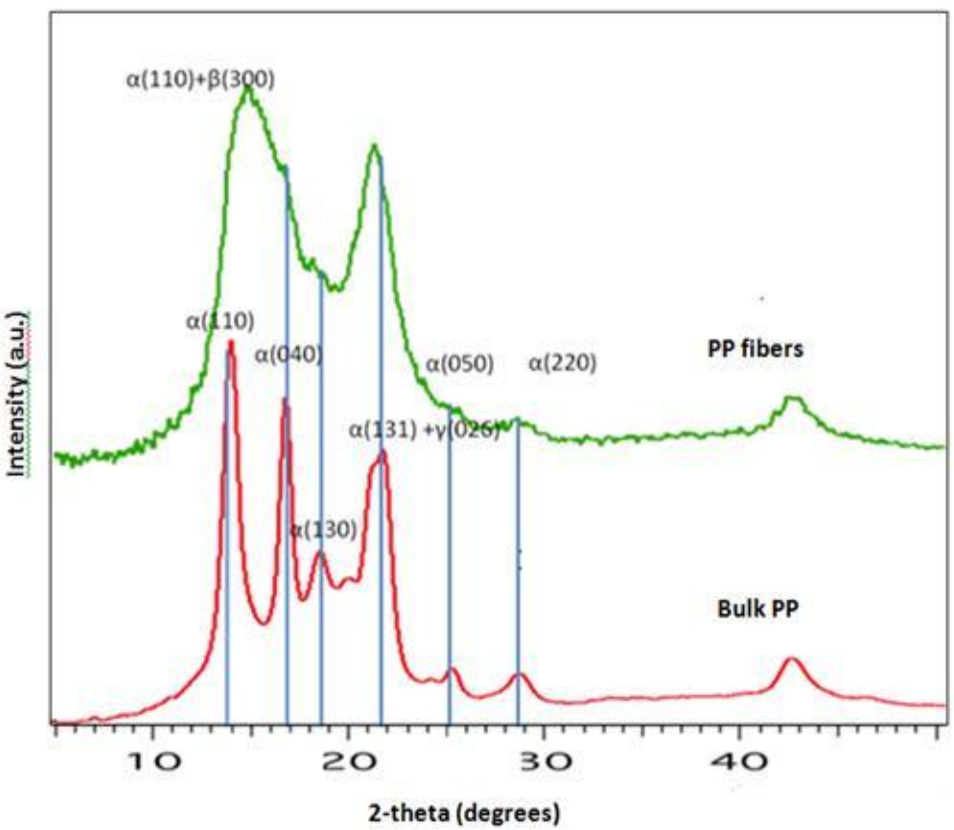


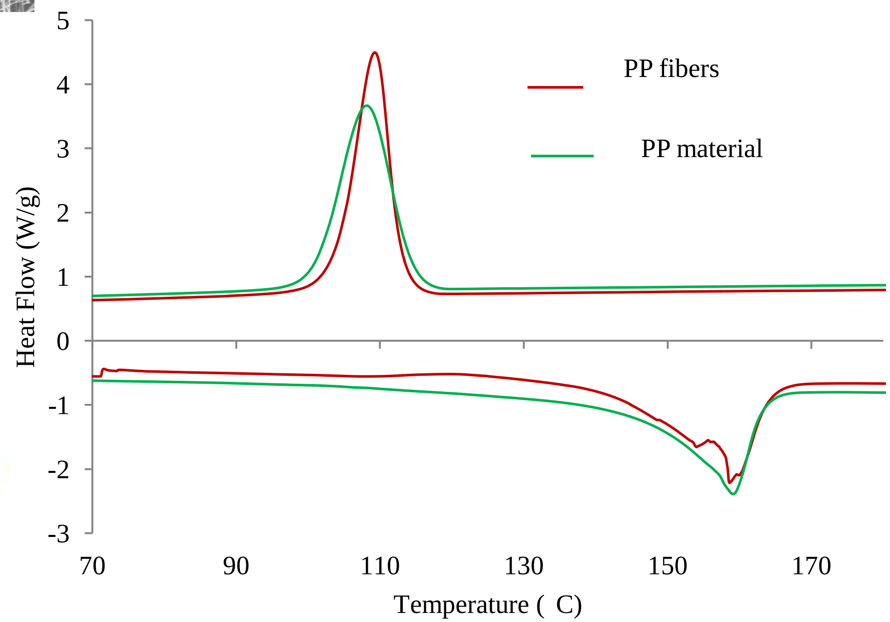


Polypropylene

< 500nm melt process

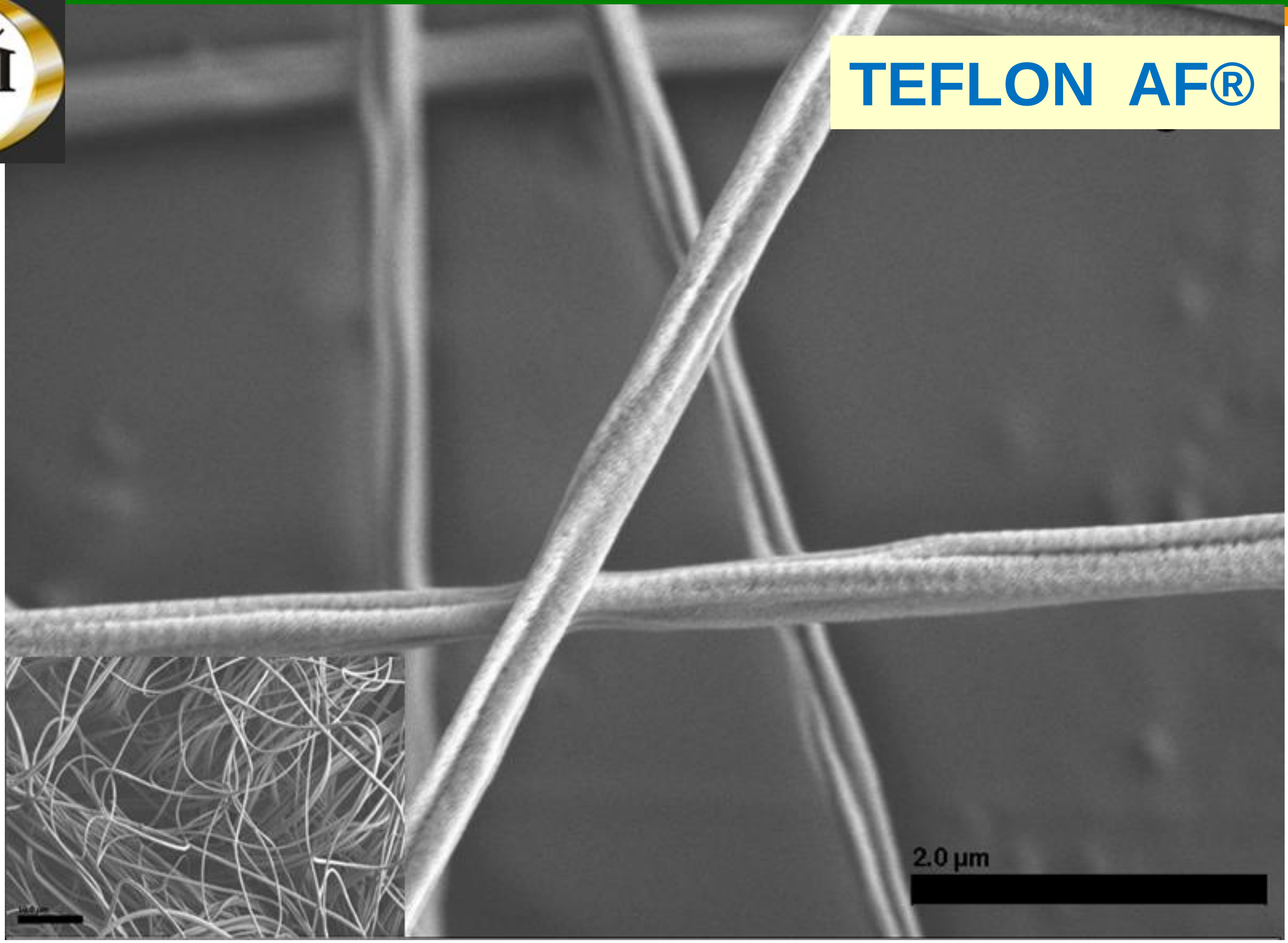






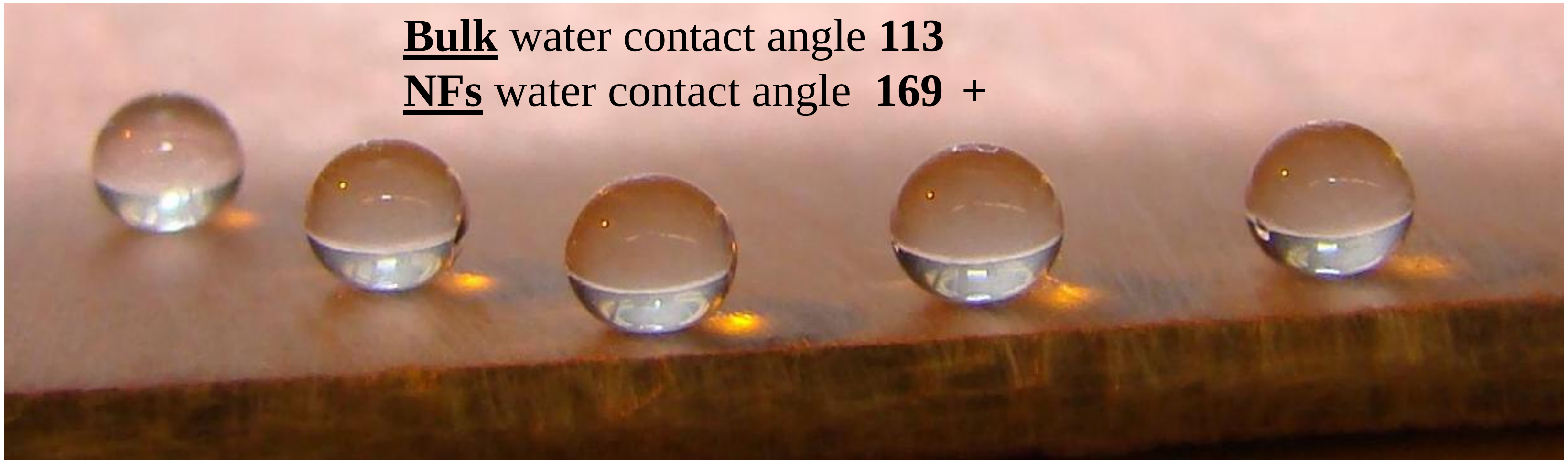
Raghaven, Bharath; Soto, Haidy; and **Lozano, Karen**; "Fabrication of Melt Spun Polypropylene Nanofibers by Forcespinning" Journal of Engineered Fibers and Fabrics; **8**, 1, 2013

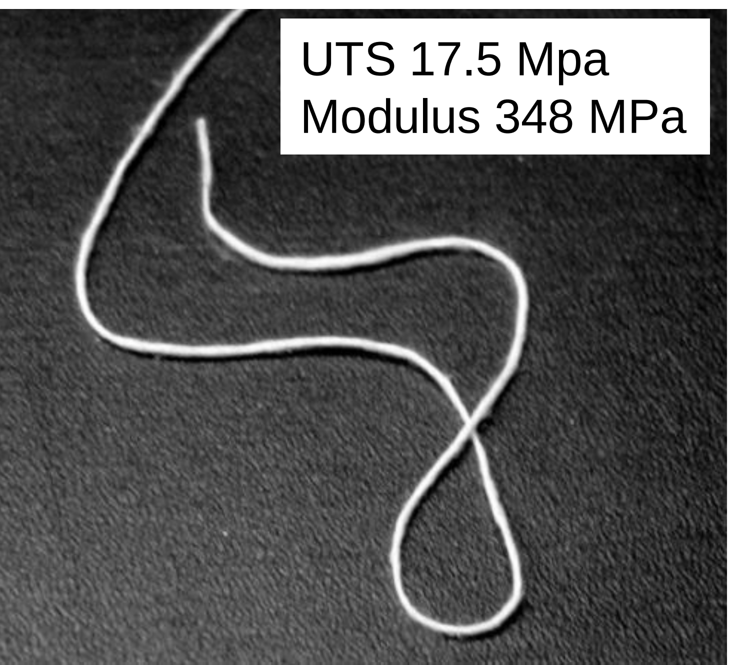
TEFLON AF®

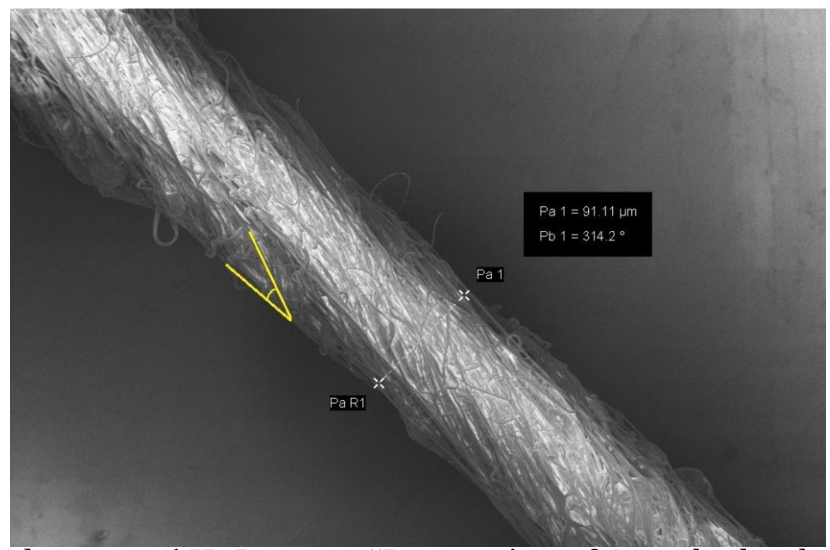


Orifice (Gauge)	Angular velocity (rpm)	Fiber Diameter (nm)	Collector distance (cm)	Contact angle (°)	Rolling Angle (°)
25	8000	826±226	7	156±3	4±1
27	8000	673±137	7	162±2	2±1
30	8000	362±58	15	169±3	2±1
TAF 1600 Film				113±1	>15

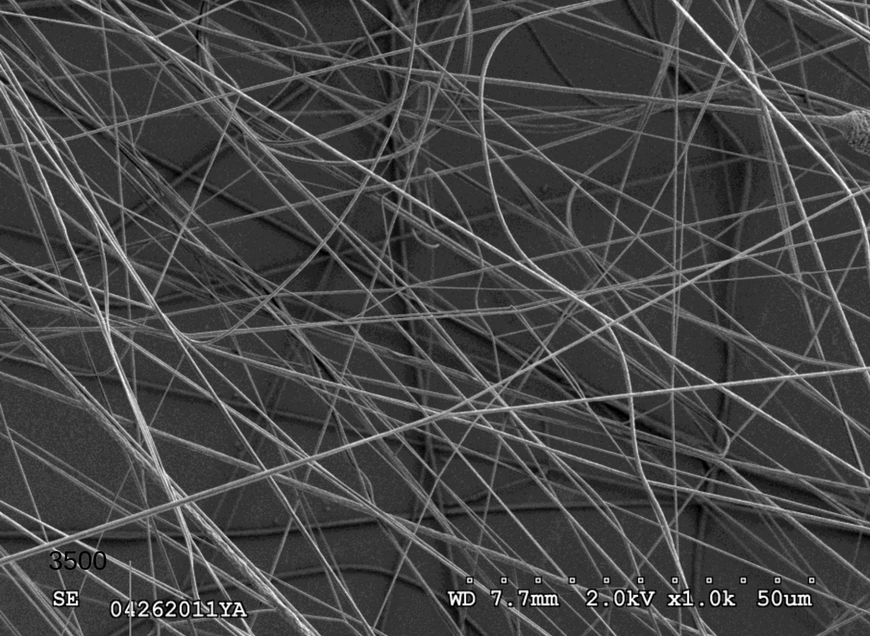
CON





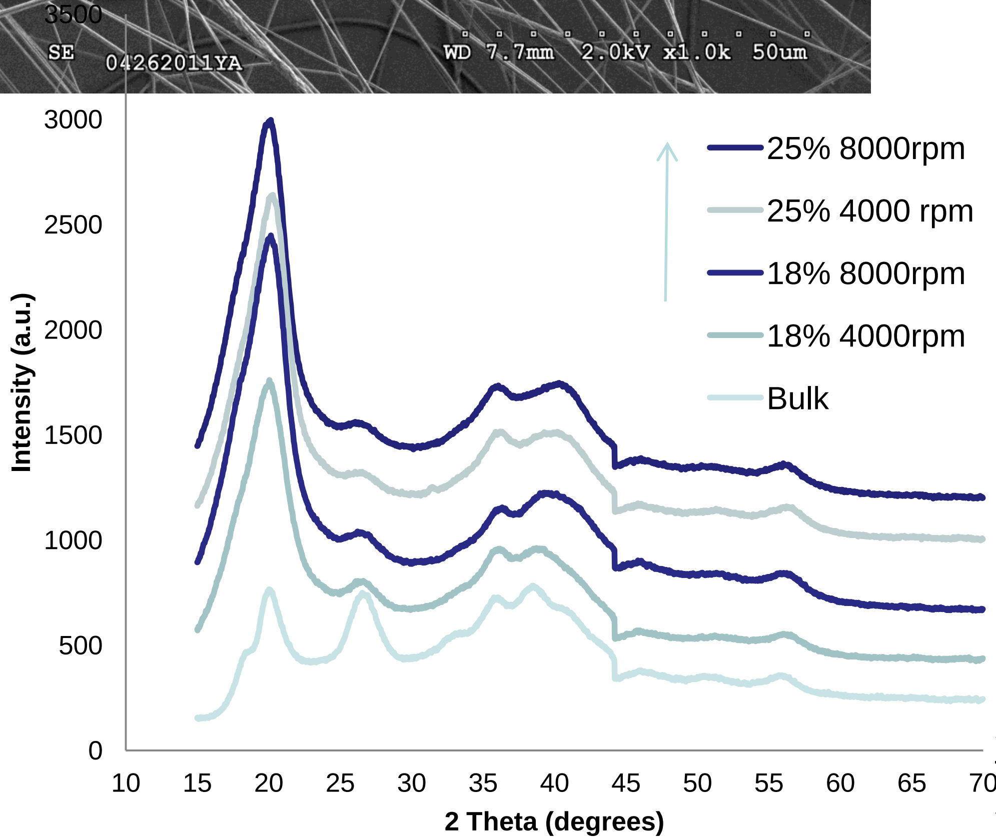


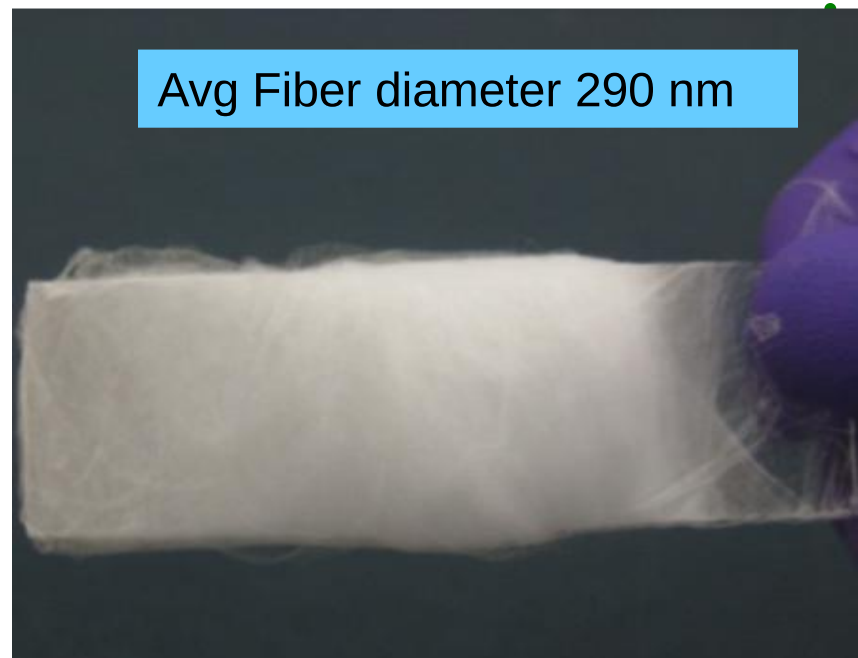
Y. Rane, A. Altecor, and K. Lozano; "Preparation of Superhydrophobic Teflon® AF 1600 sub-micron fibers and yarns using the ForcespinningTM Technique" In press Journal of Engineered Fibers and Fabrics



Polyvinylidene Fluoride

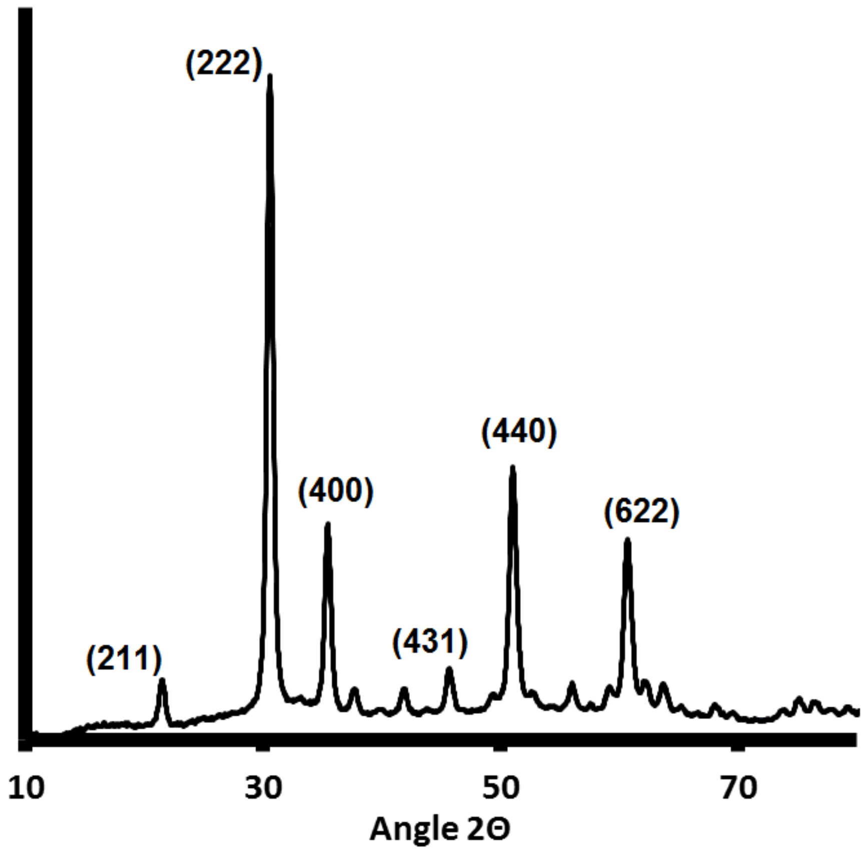
Enhanced piezoelectric/pyroelectric properties

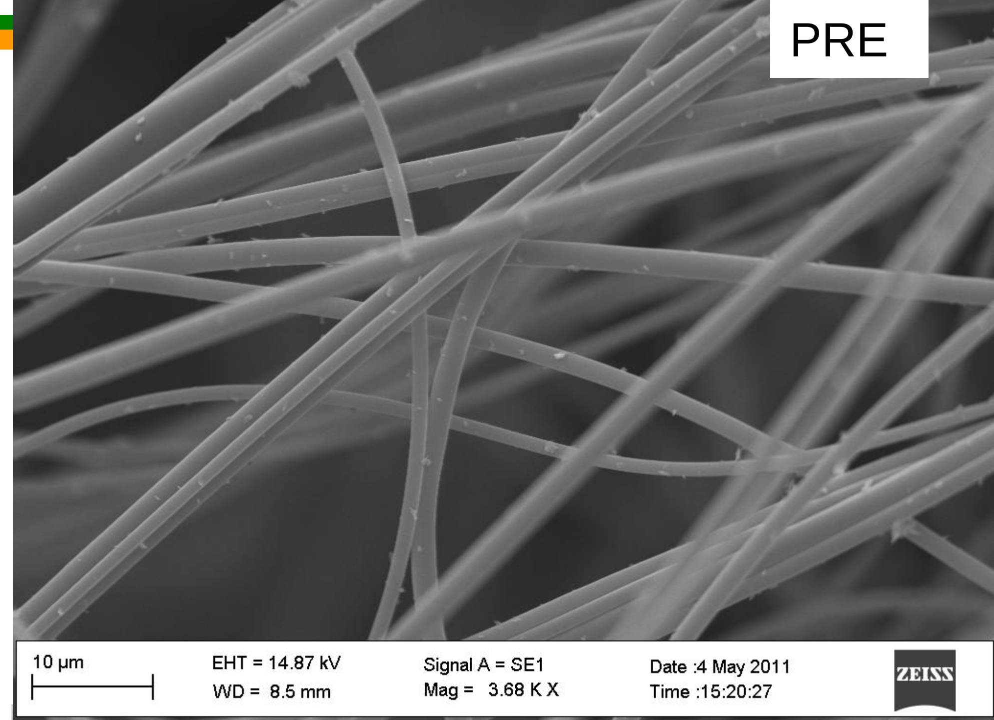


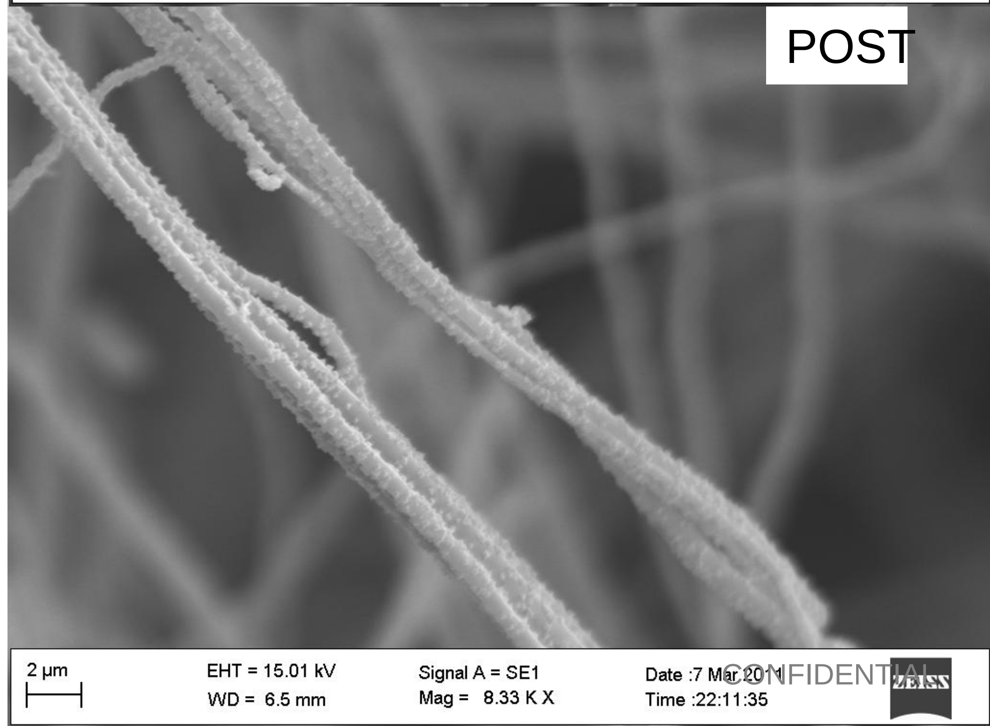


Vazquez, B., **Vasquez, H.**, **Lozano, K**. (2012). Preparation and characterization of Polyvinylidene Fluoride Nanofibrous Membranes by ForceSpinning methods, Polymer Engineering and Science, Volume 52, Issue 10, pages 2260–2265, 2012

Indium-Tin Oxide

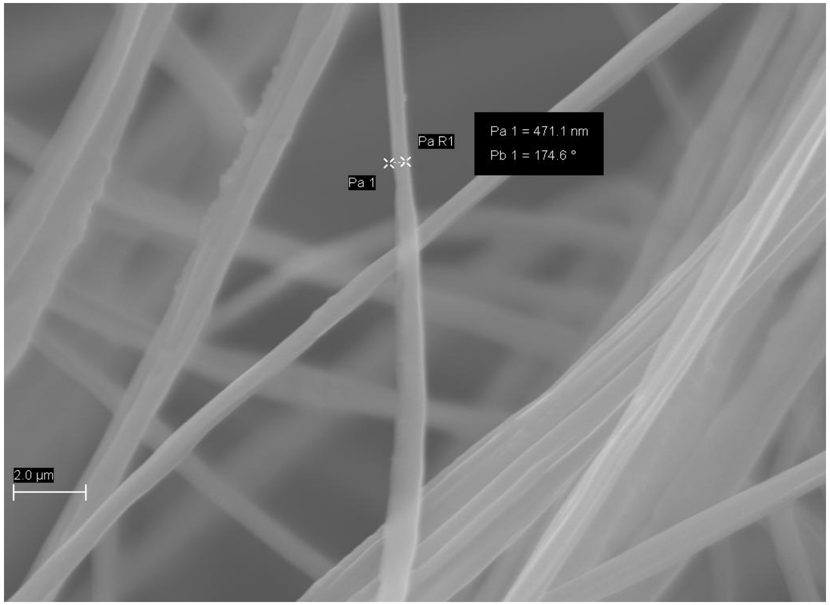






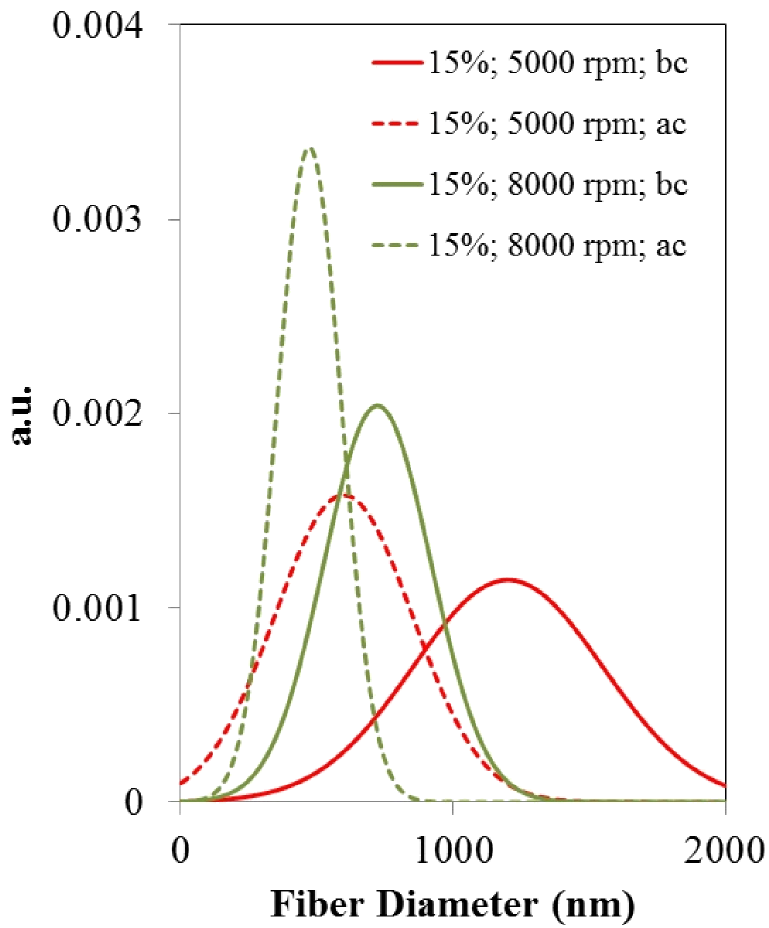
Altecor, A., **Mao, Y.**, **Lozano, K.** "Large-scale synthesis of tin-doped indium oxide nanofibers using water as solvent" *Functional Materials Letters*, 5 (2012)

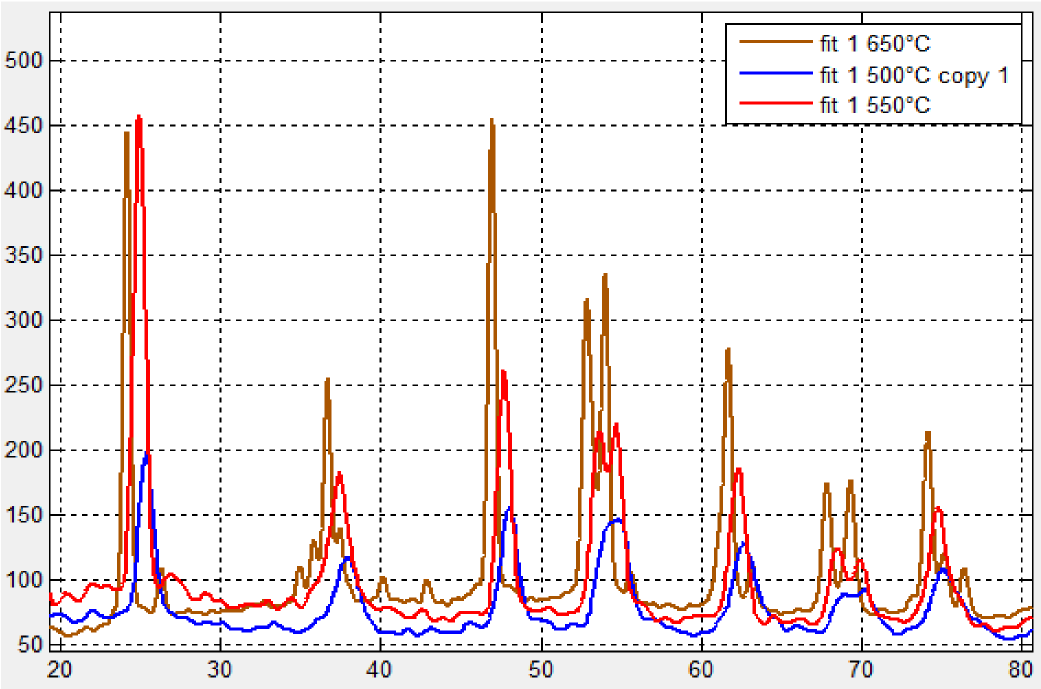
BEH-PPV nanofibers



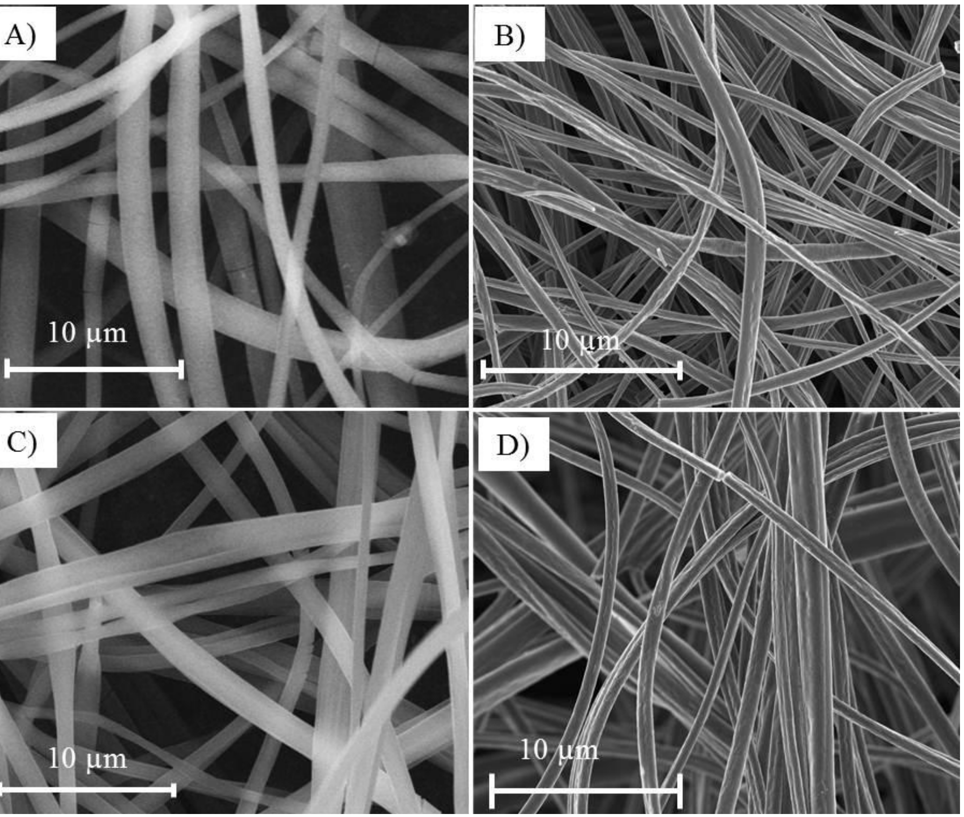
<u>Simon Padron</u>, <u>Richard Patlan</u>, Jose Gutierrez, <u>Nestor Santos</u>, Thomas Eubanks, and Karen Lozano; "Production and Characterization of Hybrid BEH-PPV/PEO Conjugated Polymer Nanofibers by Forcespinning™" Journal of Applied Polymer Science, Volume 125, Issue 5, pages 3610–3616,.

Titanium Dioxide

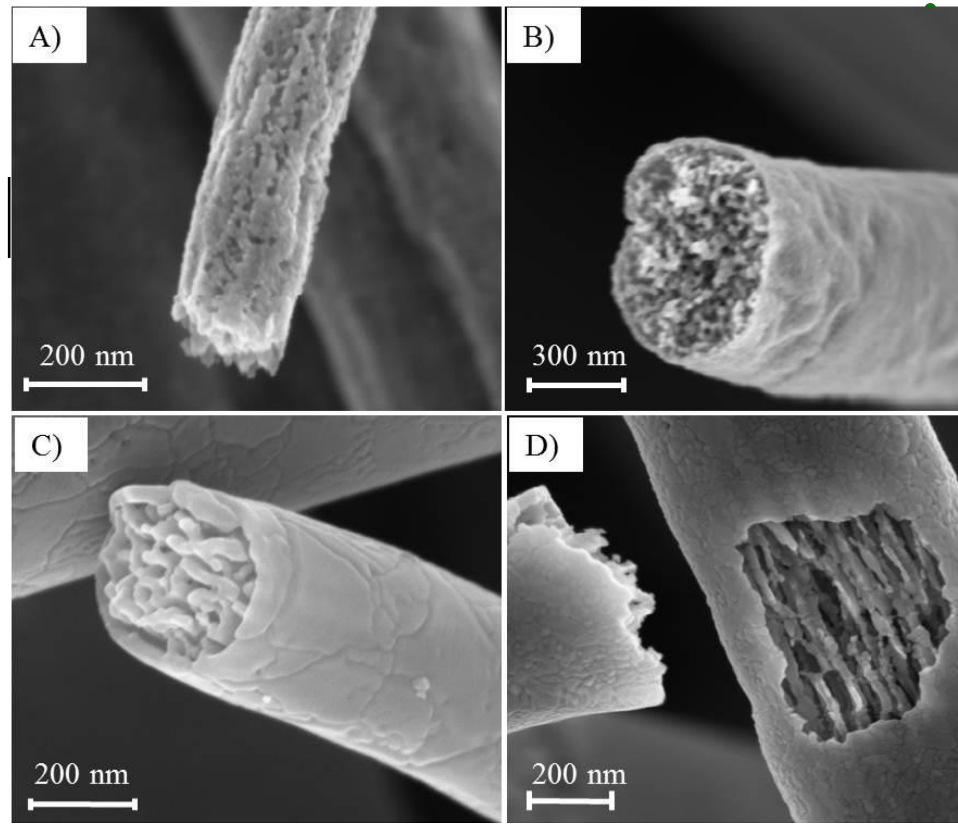




Angle 2θ



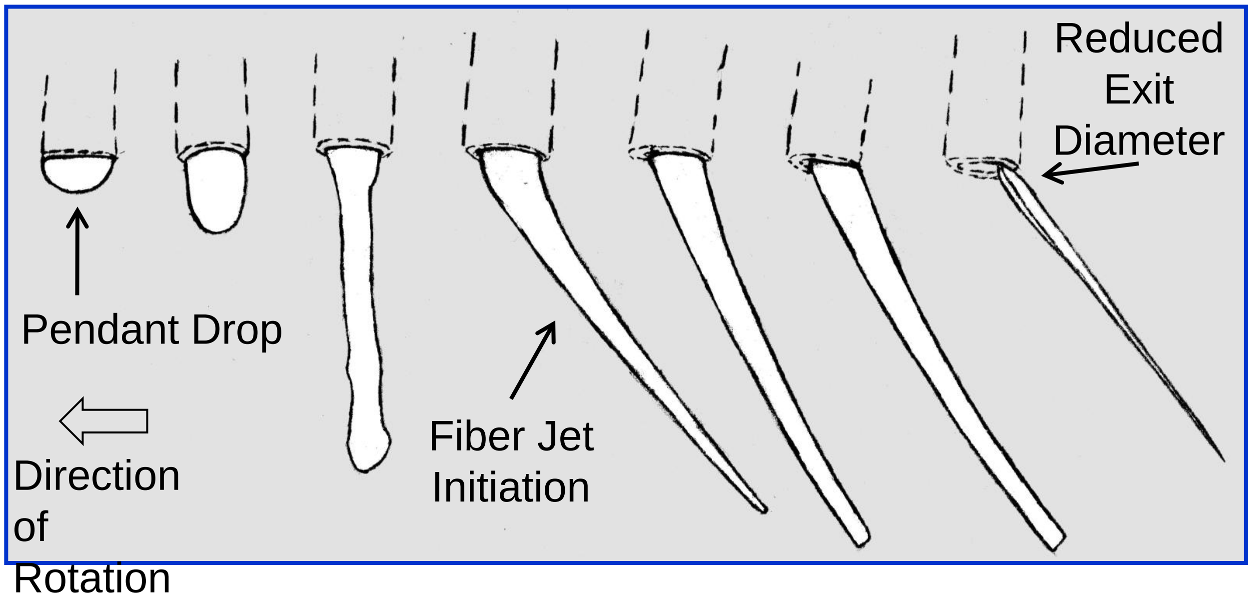
TiO_2 Nanofibers , before (A, C) and after (B, D) calcination.



SEM image showing the mesoporus structure on the surface (A) and TiO crystals in the interior of the nan (B-D).

FIBER JET INITIATION STUDIES

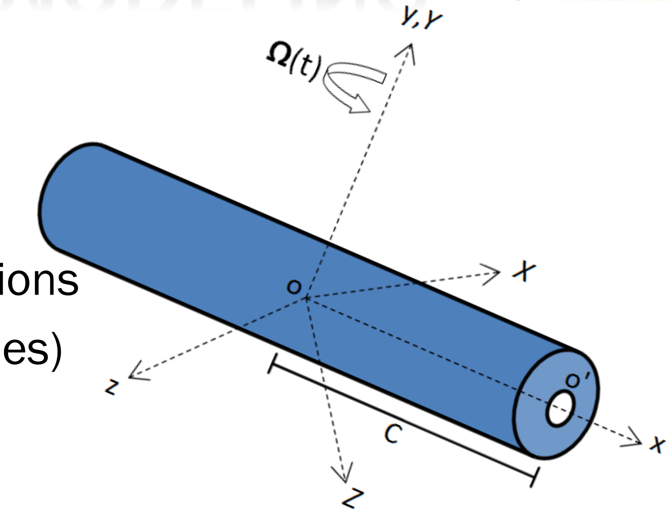
Evolution of fiber jet at needle orifice for nanofiber production through forcespinning.



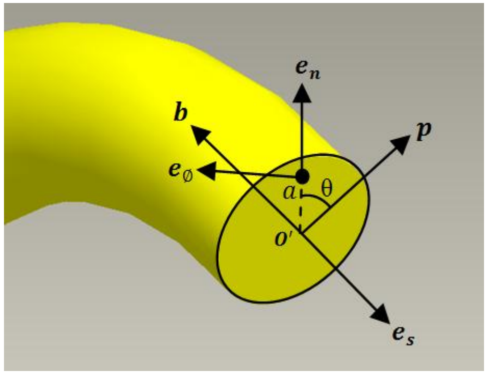
High speed capture of fiber jet produced through forcespinning

FORCESPINNING™ MODELING

- Components
  - Coordinate systems
  - Derivation of the Governing Equations
  - Determine constraints, initial, and boundary conditions
  - Approximation method (ex. Method of Multiple Scales)
  - Differential Equation Solving Software (ex. Matlab, Mathematica)



- Trajectory and final diameter size of the produced fibers are based on:
  - Angular velocity of spinneret
  - Spinneret geometry
  - Body Forces
  - Collector Diameter
  - Polymer properties
  - Solvent Evaporation Rate (solutions)
  - Temperature (melts)
  - Environment



NEURONS

Nurturing Education, Undergradaute Research & Opportunities in Nanotechnology Symposium