

*THE FIBER SOCIETY*



*Advancing Scientific Knowledge  
Pertaining to Fibers and Fibrous Materials*

**KU LEUVEN**

## **The Fiber Society 2022 Spring Conference**

***Fibers for a Greener Society:  
From Fundamentals to Advanced Applications***

**May 30–31 and June 1, 2022**

### **Conference Co-Chairs**

**David Seveno, *KU Leuven, Belgium***  
**Aart Willem Van Vuure, *KU Leuven, Belgium***  
**Carlos Fuentes, *Luxembourg Institute of Science and Technology (LIST)***  
***and KU Leuven, Belgium***

### **Venue**

***Maria-Theresia College  
Leuven***

## ***Program***

### **Sunday, May 29**

2:00 PM–5:00 PM

5:00 PM–7:00 PM

The Fiber Society Governing Council Meeting (Second Floor, Room 02.10)  
Early-bird Registration and Welcome Reception (Ground Floor, Room 00.03)

## Monday, May 30

- 7:00 Registration (Ground Floor, Room 00.03)  
 7:30 Continental Breakfast (Ground Floor, Room 00.03)
- 8:00 Welcoming Remarks and Announcements (Grote Aula, 00.10) *David Seveno, Conference Co-Chair*  
*Takeshi Kikutani, President, The Fiber Society*
- 8:15 **Plenary Lecture:** Prof. Pasi Kallio, Tampere University  
*Higher Throughput and Reliability for Characterization of Biobased Fibres and Fibre Interfaces Using Microrobotics*

### Morning Sessions

	Grote Aula, 00.10	Kleine Aula, 00.15	MTC, 01.03
	<b>Session: Textiles Production</b> <i>Chair: Xiangwu Zhang</i>	<b>Session: Fiber Surfaces and Interfaces</b> <i>Chair: Carlos Fuentes</i>	<b>Session: Fiber-reinforced Materials/Composites: Testing and Characterization</b> <i>Chair: Aart Willem Van Vuure</i>
9:05	<i>A Dynamic Emissivity Switch Textile for Dual-mode Temperature Regulation</i> Muluneh G. Abebe, University of Mons	<i>Effect of Fibre Volume Fraction on Stress Redistribution in the Presence of a Debonding Broken Fibre Within Realistic Fibre Packings: A Numerical Study</i> Sina AhmadvashAghbash, KU Leuven	<i>A Preliminary Study to Understand the Effect of Natural Fibers on the Desirability and Distinguishability of Biocomposites</i> Tim Huber, University of Canterbury/LIST
9:30	<i>Technical and Qualification Opportunities in Cotton Ginning</i> Justin Kühn, RWTH Aachen University	<i>Centrifugal Assembly of Helical Bijel Fibers for pH-responsive Composite Hydrogels</i> Martin Haase, Utrecht University	<i>Experimental Investigation on Textiles and Mechanical Properties of Quasi-unidirectional Fabric Hemp/Epoxy Composites</i> Chaimae Laqraa, ENSAIT
9:55	<i>Conductive Filament Development for 3D-printing of Smart Textile Applications</i> Sofie Huysman, Centexbel	<i>Droplet Impact on Thin Fibrous Veils</i> Hassan Madkour, École Polytechnique	<i>Nettle-reinforced PLA Green Composites for Automotive Dashboard Application</i> Parna Nandi, IIT Delhi
10:20	<i>Novel Sustainable Artificial Turf Systems from Biobased Polymers</i> Thomas Gries for Franz Pursche, RWTH Aachen University	<i>Challenges on Specific Surface Area Analysis of Cellulosic Materials</i> Anett Kondor, Surface Measurement Systems Ltd.	<i>In-situ SEM Analysis of the Tensile Properties of Microscale Epoxy Specimens</i> Olivier Verschate, Ghent University
10:45	<i>Modifying of Fishing Nets with Microencapsulation Technology for Better Antifouling Performance</i> Gülşah Ekin Kartal, Dokuz Eylül University	<i>Development of a Flax Fiber Treatment to Improve Fiber and Elium®-UD Flax Composite Properties</i> Frédéric Addiego, LIST	<i>Open</i>
11:10	<b>Break (Ground Floor, Room 00.03)</b>		
	<b>Session: Fibers for Healthcare and Medical Applications</b> <i>Chair: Rudolf Hufenus</i>	<b>Session: Fiber Surfaces and Interfaces</b> <i>Chair: Takeshi Kikutani</i>	<b>Session: Fiber-based Sensors</b> <i>Chair: Helge Pfeiffer</i>
11:40	<i>Skin Electrode Impedance Characterization of Textile-based ECG Electrodes</i> Abreha Bayrau Nigusse, Ghent University	<i>Multiscale Characterization of the Interfacial Region in Cord-reinforced Rubber for Tire Applications: Initial Structure and Evolution Upon Thermal Treatment</i> Frédéric Addiego for Gregory Mertz, LIST	<i>Investigation of Production Influences on the Electrical, Mechanical and Electro-mechanical Properties of Resistive-based Filament Sensors</i> Jeanette Ortega, RWTH Aachen University

12:05	<i>Enhanced Sheath/Core Adhesion in PET/PA6 Bicomponent Fibers</i> Hafiz Muhammad Kaleem Ullah, ENSAIT	<i>Surface Treatments Effects on Fabrics Frictional Sound Characterizations</i> Hamza Dhim, Université de Haute-Alsace	<i>Melt Spinning of a Partially Miscible Polymer Blend Filled with Carbon Nanotubes for Water Detection</i> Julie Regnier, ENSAIT
12:30	<i>Influence of External Pressure on Liquid Absorption and Retention of Cotton Nonwovens</i> Rupali, IIT Delhi	<i>Self-shaping Liquid Crystal Fibers</i> V.S.R. Jampani, Jozef Stefan Institute	<i>Lessons from Spider Silk: Ambient Spinning of Fibres with Humidity-tunable Properties Using Supramolecular Chemistry</i> Darshil Shah, University of Cambridge
12:55	<i>Open</i>	<i>Monitoring Body Fluids in Textiles: Combining Impedance and Thermal Principles in a Printed, Wearable, and Washable Sensor</i> Wim Deferme, Hasselt University	<i>An Optical Fibre Sensor Based on Surface Plasmon Resonance</i> Helge Pfeiffer, KU Leuven

1:20 **Lunch (Ground Floor, Room 00.03)**

1:30 **Poster Session (Ground Floor, Incoming Hall, 00.17)**

### Afternoon Sessions

	<b>Grote Aula, 00.10</b>	<b>Kleine Aula, 00.15</b>	<b>MTC, 01.03</b>
	<b>Session: Textiles Production</b> <i>Chair: Thomas Gries</i>	<b>Session: Fiber Surfaces and Interfaces</b> <i>Chair: Frédéric Addiego</i>	<b>Session: Fiber-reinforced Materials/Composites: Testing and Characterization</b> <i>Chair: David Anthony</i>
3:00 Keynote Talks	<i>Challenges and Opportunities of a Defossilised Textile Industry</i> Thomas Gries, RWTH Aachen University	<i>Imbibition and Collapse in a Swelling Textile</i> Pierre Van de Velde, École Polytechnique	<i>Viscoelastic Properties of Plant Fibers: Dynamic Analysis and Nanoindentation Tests</i> Vincent Placet, Université de Bourgogne Franche-Comté
3:35	<i>Linseed Flax Fibre-based Wrap Spun Yarn: Early Steps Toward a Truly Sustainable Value-chain Development</i> Mahadev Bar, Université de Toulouse	<i>Formation of Stereocomplex Crystals Through Annealing of Sea-Islands Bicomponent Fibers of PLLA and PDLA</i> Takeshi Kikutani, Tokyo Institute of Technology	<i>Exploration of Properties of Disentangled UHMWPE Tape as a Soft Body Armour Material</i> Mukesh Bajja, IIT Delhi
4:00	<i>Effect of Crystallizability on Mechanical Properties of Continuous Polymer Nanofibers</i> Yuris Dzenis, University of Nebraska	<i>Inverse Gas Chromatography: Molecular Probes at the Rescue to Gather Information on Fiber Surface Interactivity</i> Eric Brendlé, Adscientis SARL	<i>Single Plant Fiber Transverse Compression: Investigation of Influential Parameters and Identification of Mechanical Properties</i> Jason Govilas, Université de Bourgogne Franche-Comté
4:25	<i>Meltspun Shape Memory Polymer Filaments for Applications in 4D Textiles</i> Jeanette Ortega for Felix Krooß, RWTH Aachen University	<i>Functionalization of Wrapped Flax Rovings Using Biobased Molecules for Composite Applications</i> Khouloud Tilouche, IMT Mines Alès	<i>Hygrothermal Durability of Flax Fibre Composites Under Cyclic Humidity Ageing</i> Alexandros Prapavesis, KU Leuven
4:50	<i>A Novel PVA-based Desizing Method Using UV</i> Sanjay Panda, IIT Delhi	<i>Thermally-induced Structural Changes of Resorcinol Formaldehyde Latex Adhesive Used in Cord-Rubber Composites</i> Carlos Fuentes for David Ruch, LIST/KU Leuven	<i>Micro-robotics and Micro-fibril Angle Measurement for Biobased Fibres Characterization</i> Ali Zarei, Tampere University

5:15 **After-hours Beverages (Ground Floor, Room 00.03)**

6:30–7:30 **Reception at the Town Hall, Leuven**

## Tuesday, May 31

- 7:30 Continental Breakfast (Ground Floor, Room 00.03)
- 8:00 Announcements (Grote Aula, 00.10) *Aart Willem Van Vuure, Conference Co-Chair*
- 8:15 **Plenary Lecture:** Prof. Alexander Bismarck, University of Vienna  
*Natural Fibres from Micro- to Nanoscale but Better Together*

### *Morning Sessions*

	<b>Grote Aula, 00.10</b>	<b>Kleine Aula, 00.15</b>
	<b>Session: Cellulose Fibers</b> <i>Chair: Ali Khodayari</i>	<b>Session: Fiber-reinforced Materials/Composites: Manufacturing and Modeling</b> <i>Chair: Daniel Wagner</i>
9:05	<i>Comprehensive Viscoelastic Mechanical Characterization and Material Modelling of Cellulose Fibers</i> Ulrich Hirn, TU Graz	<i>Linear Stability Analysis of Non-isothermal Glass Fiber Drawing</i> Benoit Scheid, Université Libre de Bruxelles
9:30	<i>Relating the Properties of Regenerated Cellulose Fiber to the Details of Microstructure</i> Aakash Sharma, Jülich Centre for Neutron Science	<i>Computational and Experimental Optimisation of Nozzle Geometry and Commingled Hybrid Yarns to Develop Textile Preforms and Thermoplastic Composites</i> Ganesh Jogur, IIT Delhi
9:55	<i>Tensile Properties of Technical Enset Fibers in Solid and Porous State and the Weibull Statistics of Failure Prediction</i> Mengstu Ashebre Arefe, KU Leuven	<i>Carbon Nanotube-grafted Carbon Fiber Production: A Scaling Challenge</i> David B. Anthony, Imperial College London
10:20	<i>Comparison of Hemp Cultivation and Fiber Quality in Two Different Types of Soil in the East of France in 2020</i> Aurélie Decker, Université de Haute-Alsace	<i>SeaBioComp: Development and Demonstrators of Durable Biobased Composites for a Marine Environment</i> Elke Demeyer, Centexbel
10:45	<i>Guideline for the Development of New Biobased Yarns from Sustainable Feedstocks</i> Henning Löcken, RWTH Aachen University	<i>Improvement of Interfacial Adhesion in Bamboo Fibre Polymer Composites by Ultraviolet Light Treatment</i> Carlos Fuentes, LIST/KU Leuven

### 11:10 **Break (Ground Floor, Room 00.03)**

	<b>Grote Aula, 00.10</b>	<b>Kleine Aula, 00.15</b>	<b>MTC, 01.03</b>
	<b>Session: Fibers for Health and Medical Applications</b> <i>Chair: Birgit Stubbe</i>	<b>Session: Cellulose Fibers</b> <i>Chair: Ulrich Hirn</i>	<b>Session: Nanofibers: Production, Characterization, Modeling, and Testing</b> <i>Chair: Caroline Schauer</i>
11:40	<i>Biomedical Applications of Polymeric Fibers and Films</i> Vladimir Reukov, University of Georgia	<i>Beam, Flax, and Sun: Use of Synchrotron Beamlines to Investigate Flax Fibres Behaviour and Specificities</i> Alain Bourmaud, Université de Bretagne Sud	<i>Wet Spinning Imogolite Nanotube Fibres</i> Milo S.P. Shaffer, Imperial College London
12:05	<i>Development of a Biocompatible Multifilament with Controlled Resorbability for Textile Structures for Adipocytes Cell Growth</i> Aurélie Cayla, ENSAIT	<i>Is It Necessary to Use Long Scutched/Hackled Fibres for Plant Fibre Load-bearing Composites?</i> Marie Grégoire, Université de Toulouse	<i>Electrospinning of Epoxy Fibers</i> Daniel Wagner, Weizmann Institute of Science
12:30	<i>Suspended Non-electrospun Nanonets for Quantitative Biology</i> Amrinder S. Nain, Virginia Tech	<i>Harvesting Time of Hemp for Textile Application: Growth of Primary and Secondary Fibres</i> Lola Pinsard, Université de Toulouse	<i>Stand-alone Silica Nanofibrous Membranes for Advanced Catalytic and Purification Applications</i> Eva Loccufier, Ghent University

12:55	<i>Open</i>	<i>Molecular Dynamics in Aid of Better Understanding Cellulose and Hemicellulose</i> Ali Khodayari, KU Leuven	<i>Open</i>
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1:20 **Lunch (Ground Floor, Room 00.03)**

### *Afternoon Sessions*

	<b>Grote Aula, 00.10</b>	<b>Kleine Aula, 00.15</b>
	<b>Session: Optical Fibers and Fibers for Energy Applications</b> Chair: <i>Ian Hardin</i>	<b>Session: Nanofibers: Production, Characterization, Modeling, and Testing</b> Chair: <i>Milo S.P. Shaffer</i>
2:50 Keynote Talks	<i>Functional Fibers and Nanofibers for Energy Storage: Past, Present, and Future</i> Xiangwu Zhang, North Carolina State University	<i>Spinning Fibers Composed Solely of Quantum Dots and Their Ligands</i> Larissa M. Shepherd, Cornell University
3:25	<i>Percolation-based Nanodielectrics of Conductive and Core-shell Nanoparticles for High-voltage Structural Carbon Fibre Composite Capacitors</i> Ruben Windey, KU Leuven	<i>AC Electrospinning: Theory and Applications</i> David Lukáš, Technical University of Liberec
3:50	<i>Reduction of Artifacts in MRI: Polymer Optical Fibres for Motion Monitoring in Areas with High Electromagnetic Interference</i> Jan Kallweit, RWTH Aachen University	<i>Natural Polymer Nanoyarns</i> Caroline Schauer, Drexel University
4:15	<i>Functionalisation of Polymer Optical Fibres for the Detection of Trinitrotoluene with Nanoscale Fluorescent Particles</i> Mark Pätzel, RWTH Aachen University	<i>A Polarized Micro-Raman Study of Necked Epoxy Fibers</i> XiaoMeng Sui, Weizmann Institute of Science
4:40	<i>Near-infrared Sintering of Ultrasonically Spray-coated, Silver Nanowire Transparent Electrodes</i> Joao Silvano, Hassalt University	<i>Atmospheric Pressure Plasma Jet Treatment of PLA/PAni Solutions: Enhanced Morphology, Improved Yield of Electrospun Nanofibers</i> Yongjian Guo, Ghent University

5:05 **After-hours Beverages (Ground Floor, Room 00.03)**

**7:00–10:30 Conference Banquet at the Faculty Club, Leuven**

**Speaker Prof. Ignaas Verpoest, KU Leuven**

*Belgium: Not Only Beers and Chocolates but Also Fibres, Textiles, and Composites!*

## **Wednesday, June 1**

7:30 Continental Breakfast (Ground Floor, Room 00.03)

8:00 Announcements (Grote Aula, 00.10)

*Carlos Fuentes, Conference Co-Chair*

8:15 **Plenary Lecture:** Prof. Nicolas Vandewalle, ULiège

*Droplets on Fibers: From Harvesting Water to Microfluidics Applications*

### *Morning Sessions*

	<b>Grote Aula, 00.10</b>	<b>Kleine Aula, 00.15</b>
	<b>Session: Fibers for Healthcare and Medical Applications</b> Chair: <i>Wim Deferme</i>	<b>Session: Textiles Characterization and Testing</b> Chair: <i>Emilie Dréan</i>
9:05	<i>Design of 3D Multilayered Electrospun Membranes Embedding 2D Compounds for Drug Storage and Control of Sustained Release</i> Jocelyne Brendlé, Université de Haute-Alsace	<i>Removing Harmful Finishes to Recycle Waste Acrylic Textiles</i> Brecht Tomme, Ghent University

9:30	<i>Antibacterial Effect and Woven Bandage Fabric Properties Treated with Sodom Apple Extract, Metal Oxides, Metal Sulphate, and Nanoparticles</i> Gurumurthy B. Ramaiah, Ethiopian Technical University	<i>A Novel Protocol to Determine Sweat-induced Skin Wetness Thresholds and Fabric Moisture Management Properties</i> Farzan Gholamreza, University of British Columbia
9:55	<i>Bioresorbable Core-Sheath Bicomponent Filaments and Meshes for the Treatment of Genital Prolapse</i> Birgit Stubbe, Centexbel	<i>Effect of Weave and Areal Density on Mechanical Properties of Outer Layer Woven Fabric for Extreme Cold Weather Clothing</i> Ranjna Kumari, IIT Delhi
10:20	<b>Break (Ground Floor, Room 00.03)</b>	
	<b>Grote Aula, 00.10</b>	<b>Kleine Aula, 00.15</b>
	<b>Session: Textiles Modeling</b> <i>Chair: David Seveno</i>	<b>Session: Textiles Characterization and Testing</b> <i>Chair: Emilie Dréan</i>
10:50 Keynote Talks	<i>Air Permeability and Filtration of Multilayer Fabric Systems for Use in Cloth Face Masks</i> Katarina Goodge, Cornell University	<i>Antistatic Fibers for High-visibility Workwear</i> Rudolf Hufenus, Empa
11:25	<i>Data-driven Modeling and Machine Learning to Determine Similarity of Elastic Knitwear Products in the Finishing Process</i> Leon Reinsch, RWTH Aachen University	<i>Voltametric Behaviour and Electrochemical Polymerization of Pyrrole for Preparation of Electro-conductive Polyester Fabric</i> Ankur Shukla, IIT Delhi
11:50	<i>From Fibers to Yarn: Torsion Hercules Number</i> Jérôme Crassous, Université de Rennes	
<b>12:15 Close of Conference</b>		

**2:30–4:00 Optional visit and tour of the Department of Materials Engineering at the Arenberg campus. Registration and details available at the conference registration desk on Monday, May 30.**

## Poster Session

Monday, May 30, 1:30 p.m., Ground Floor, Incoming Hall (00.17)

Presenter	Title
Anett Kondor	<i>Surface Characterization of Natural Fibers and Determination of Fragrance Adsorption Isotherms by Inverse Gas Chromatography</i>
Aakash Sharma	<i>Microstructural Difference in Regenerated Cellulose Fibers Manufactured from Viscose and Lyocell Processes</i>
Bianca Swanckaert	<i>Ion-exchange Nanofiber Membranes for Advanced Water Treatment Applications</i>
Katarina Goodge	<i>Nanofibers Directly Electrospun onto Nonwoven Substrate for Use in Cloth Face Masks</i>
Amrinder Nain	<i>Mechanical Characterization of Suspended Nanofibers</i>
Sander Rijckaert	<i>Building the Third Dimension: Microstructure and Mechanics of Additive Manufactured Continuous Aramid Fiber/PETG Composites with Variable Fiber Content Through In-nozzle Impregnation</i>
Justin Kühn	<i>Strengthening and Analyzing Hemp Cultivation and Processing in Europe</i>
Emmanuelle Richely	<i>Predicting the Mechanical Behaviour of a Natural Composite: The Flax Fibre</i>
Henning Löcken	<i>Applying the TED Method for the Development of Novel Satellite Reflector Surface</i>
Aude Sagnimorte	<i>A Biocompatible Microfiber Force Probe</i>
Ali Moghimiardakani	<i>The Effect of Fibre Architecture on the Mechanical Properties of Natural Fibre Composites</i>
Mariangela Mateo	<i>Study of the Characteristics of Ichu Fibres for Use as Reinforcement in Composites</i>
Ulrich Hirn	<i>Deteriorating Dispersibility and Network Wet Strength in Hydroentangled, Wetlaid Wet Wipes</i>
Tathagata Das	<i>Design and Development of Aerogel-embedded Nomex Nonwoven Fabric for Extreme Heat-protective Clothing</i>
Cindy Elschner	<i>Dissolution Behaviour of Silicate Hydrolytically Active Glass Fibres</i>
Martin Haase	<i>Flowing Liquid Through Nanostructured Fluid-bicontinuous Fibers</i>

# We Gratefully Acknowledge Our Sponsors





Fiber-reinforced  
Materials/Composites:  
Testing and  
Characterization

# Carbon Nanotube-grafted Carbon Fiber Production: A Scaling Challenge

David B. Anthony<sup>1</sup>, Hugo G. De Luca<sup>2</sup>, Hassan Almousa<sup>2</sup>,  
Emile S. Greenhalgh<sup>3</sup>, Alexander Bismarck<sup>4</sup>, Milo S.P. Shaffer<sup>1,2</sup>

<sup>1</sup>Chemistry Department, Imperial College London, White City Campus, London, UK

<sup>2</sup>Materials Department, Imperial College London, South Kensington Campus, London, UK

<sup>3</sup>Aeronautics Department, Imperial College London, South Kensington Campus, London, UK

<sup>4</sup>Institute of Materials Chemistry, Faculty of Chemistry, University of Vienna, Vienna, Austria

m.shaffer@imperial.ac.uk; d.anthony08@imperial.ac.uk

Modification of the interaction between a fiber and the interphase, or interface, of the matrix can increase the apparent interfacial shear strength as a route to producing higher performing fiber reinforced composite materials. Methods to alter this interfacial region in composites include chemical bonding through sizing on the fibers, modification of the bulk matrix, or through the attachment of nanomaterials to the fiber surface, which has the additional benefit of mechanical interlocking and lateral support. Carbon nanotubes (CNTs) were identified as a promising candidate for inclusion at this critical interface in composites since the '90s. Grafting CNTs to the fiber surface can be achieved chemically, or by growing them directly through chemical vapor deposition (CVD). The latter has promise to have greater adhesion between the nanotubes and the fiber but requires high temperature processing. Carbon fibers are susceptible to damage in the conditions used in CNT growth and reducing any damage from this CVD process has been prioritized. Conditions have now identified to synthesize CNT-grafted carbon fibers without loss of performance of the underlying fiber, and attention turned to increasing the scale of production. The emergence of continuous CVD reactors capable of synthesizing CNT-grafted fibers permits larger quantities of hierarchical fibers to be made, however currently there are only a handful of laboratory scale open spool-to-spool reactors known.

We present one of these reactors, which can produce continuously CNT-grafted-carbon, and -quartz fibers. In our process we use a potential difference during the growth of CNTs on carbon fibers preserving the underlying fiber strength/stiffness and synthesizing a uniform CNT coverage throughout the tow. This continuous reactor design allows for a large CVD parameter window to be explored, and conditions can be altered to synthesize CNTs between 100-500 nm, with a multiwalled CNT diameters of ~10 nm. Manufacture of CNT-grafted-fiber material upwards of 50 m on 12K tows is possible and subsequently composite coupons can be made which contain solely hierarchical fiber reinforcement. Characterization of the CNT-grafted fibers at the single fiber and tow level, and incorporated in epoxy reinforced coupons will be shown with mechanical, microscopy, and interfacial fiber-matrix properties provided.

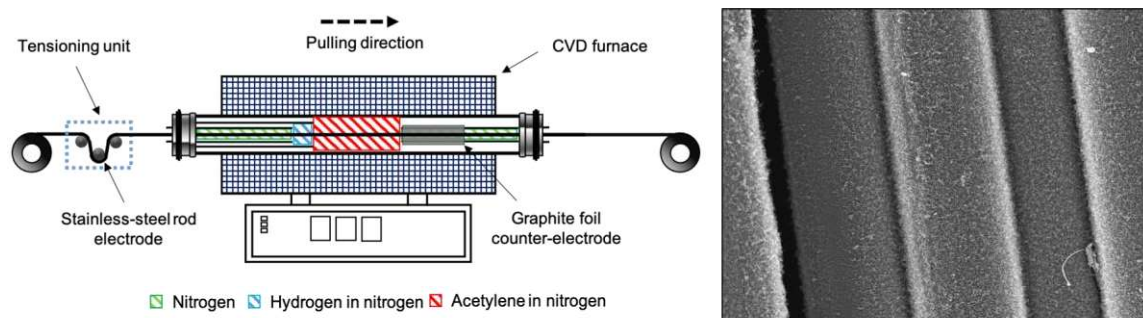


Figure 1: Continuous open spool-to-spool CVD reactor schematic (left), and CNT-grafted carbon fiber (right).

## ACKNOWLEDGMENT

The authors kindly acknowledge the funding for this research provided by UK Engineering and Physical Sciences Research Council (EPSRC) programme Grant EP/T011653/1, "Next Generation Fibre-reinforced Composites: A Full-scale Redesign for Compression." In collaboration with the University of Bristol.