SNM: High-Throughput Electrospinning of Photocatalytic Mats for Energy Harvesting

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Objectives

The scope of our project is to **advance ceramic nanofiber electrospinning** ensuring high process yield, process and product repeatability and reproducibility, along with optimized quality control, resulting in a commercially viable, scalable, nanomanufacturing process that can produce functional nanoceramics

- *Continuous Manufacturing of 3D, Heterogeneous, Nanostructured Grid-like Mats*
- *Mat dimensions: 50cm wide, unlimited length-consisting of 20nm size particles*
- *Mat will act as Visible-Light Photocatalytic Membrane for Solar Water Splitting*
- *Mat will Utilize the Whole Solar Spectrum and will Float on Water Ponds*

Continuous Production resulted in this large-scale nano-structured non-woven mat

(unpublished Research, P. Gouma, SUNY SB)

Technical Barriers

3D ceramics are currently produced *in lab-settings in minute quantities (0.2kg/hr).* The proposed methods are expected *to increase their production rates up to* *several kg/hr* so as to prove their nanomanufacturing both scalable and affordable

- *Use of a single step process to fabricate* ***large scale nanofibrous ceramic mats***

- *Increasing the production rate while keeping the cost reasonable*

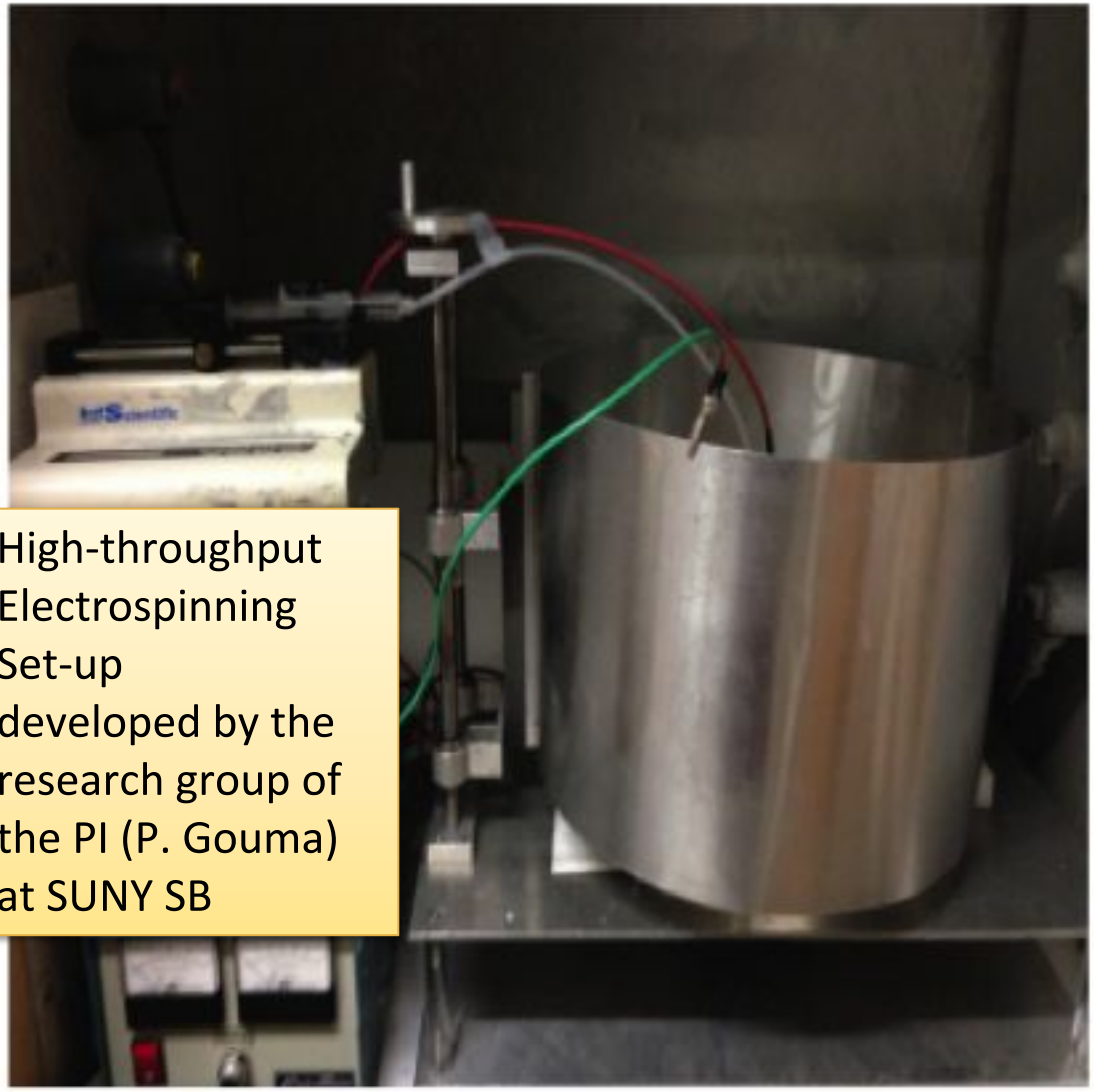
- *Fabricate self-supported 3D mats of ceramic nanofibers with controlled architectures for use in functional applications*

Nanofibrous Ceramic Photocatalytic Mat
(P. Gouma, SUNY SB)

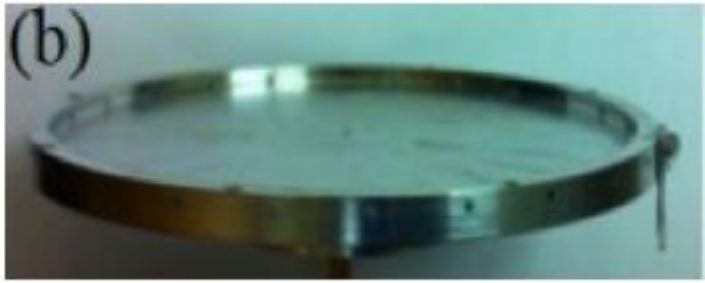
Approaches for Meeting Challenges

- ***Novel High-Throughput Set-up Design***
- ***Stabilizing the electric field at the tip***
- ***Developing a rotating source system***
- ***Mechanical characterization & modeling of the nanofibrous mats***
- ***Assessing the quality of the photocatalytic mats based on Water Oxidation Catalysts***

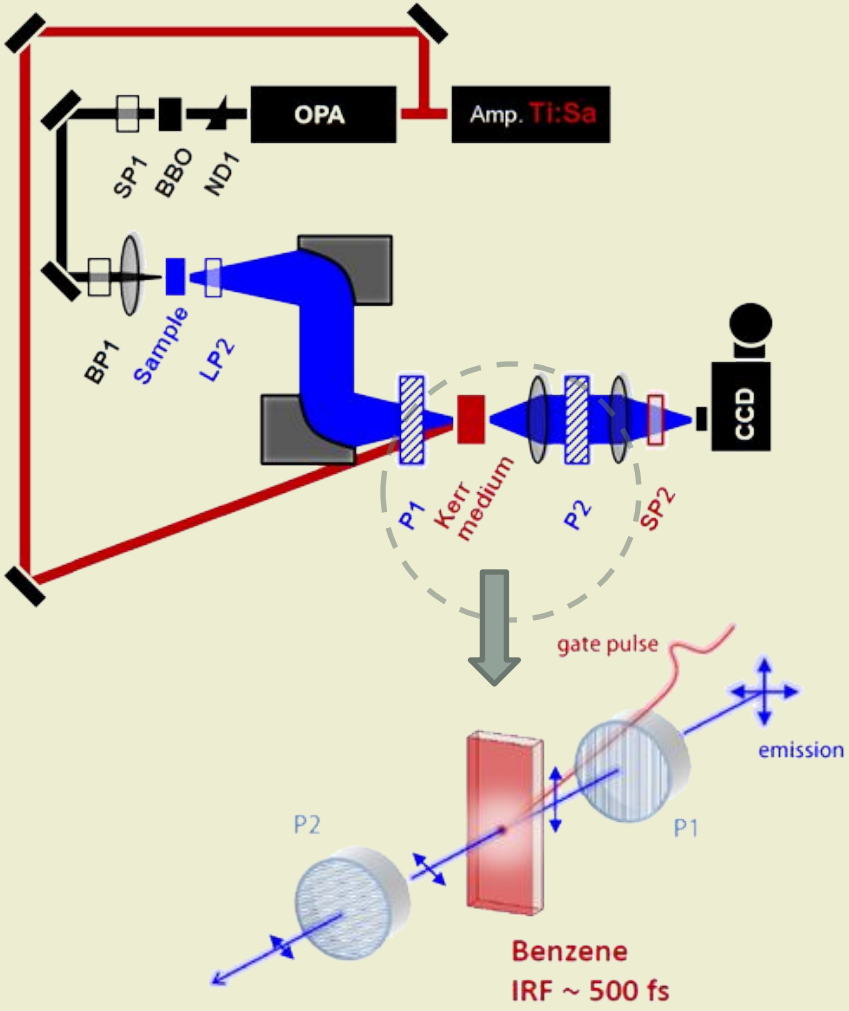
Novel High-Throughput Set-up Design



High-throughput Electrospinning Set-up developed by the research group of the PI (P. Gouma) at SUNY SB



Spectrally-resolved transient emission spectroscopy



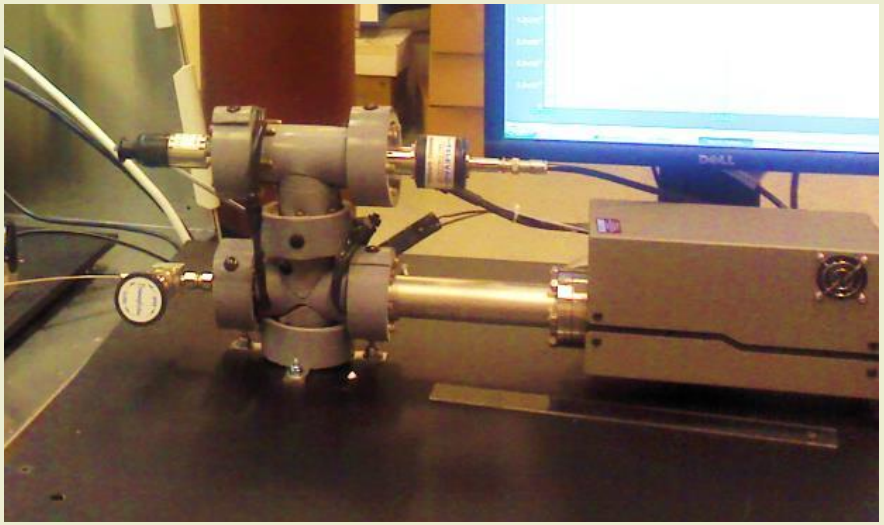
- Time-resolved studies are necessary to determine the carrier separation rate
- The technique measures time resolved emission spectrum over a wide spectral range
- Based on an optically-gated Kerr medium, the gate pulse from Ti:Sa defines a sub-ps time delay window for the emission photons to transmit through a pair of crossed polarizers.

Mingzhao Liu, CFN, BNL

Water Splitting Reactor

Hydrogen Gas Detection

PEC cell w/ gas ports



Residue gas analyzer

Gas analysis tool under development. Residual gas analyzer was recently installed to analyze gas molecules with m/q 1 – 200. This will allow our team to measure PEC activity while performing gas analysis

Mingzhao Liu, CFN, BNL

Expected Research Outcomes

Process Upgrade and Optimization through Iteration of:

- Modeling of the mat structures to guide the process design
- Mechanical property evaluation for optimization of process parameters
- Assessment of photoelectric properties to inform material selection and precursor parameters

Commercialization Opportunities

Industry interests:

- *High-Throughput Electrospinning Process*
- *Photocatalytic Self-supported NanoMats*
- *New Energy Source (Water Ponds as Inexpensive Water Splitting Reactors)*

Our interest is to set up a start-up to commercialize:

- ***novel nanomanufacturing equipment/process***
- ***3D ceramic photocatalytic non-woven mats***
- ***solar water splitting reactor configuration***

that will be produced in this work

Benefits of the SNM program

- **The SNM program is excellent as it allows for interdisciplinary research at the forefront of nanotechnology and its applications**
- **It's unique focus on the scalable production of nanostructures, devices, and systems ensures that lab-based breakthrough research advances to the level of commercial-ready technology**
- **This program takes technological advances to the next level while supporting fundamental research on materials and methods, both experimental and computer-simulated**
- **For our team, SNM provides a unique opportunity to explore novel nanomaterial platforms, assess diverse applications for these materials, while at the same time we are developing scalable processes and methods for industrial production and use**