Improvised Electrsopinning Set up for Thicker Ceramic Nanofiber Mat for High Power Targets

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Introduction and Objectives

- In high energy particle physics there is a demand for multi-MW high performance particle production targets.
- Nanofiber microstructure will have better performance than current solid targets in mitigating increased thermal tress waves, radiation damage.
- Objective is to fabricate thicker ceramic/metallic nano-fiber with high strength, thermal shock resistance using low cost electrospinning process.

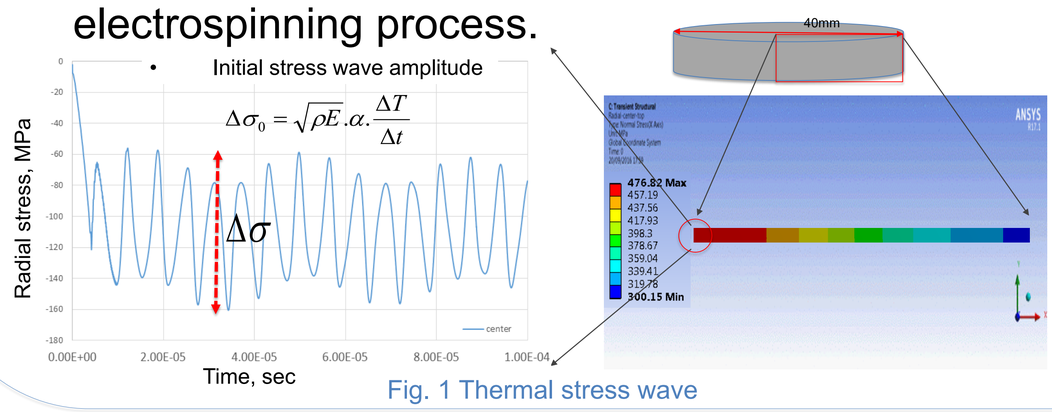
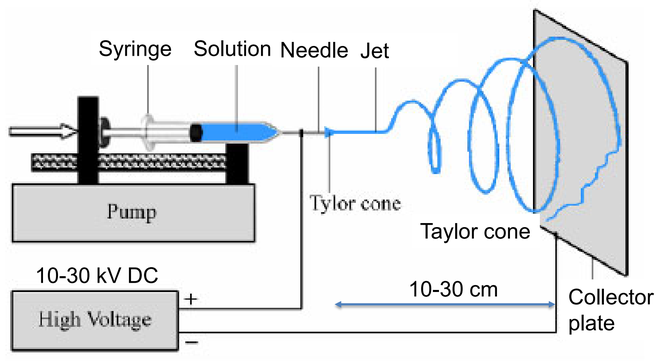


Fig. 1 Thermal stress wave

Electrospinning process



Process carried out at room temp. and atm. pressure

Fig. 2a Electrospinning set up

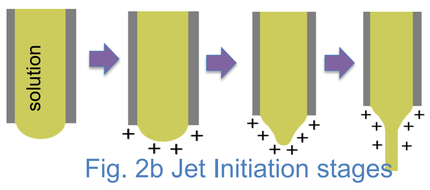


Fig. 2b Jet Initiation stages

Process initiates when electrostatic repulsion over comes surface tension

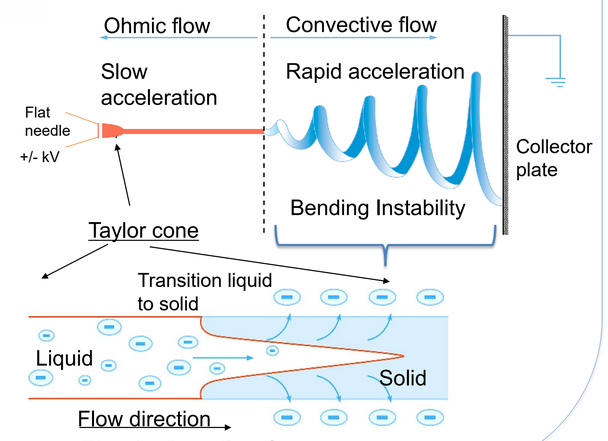
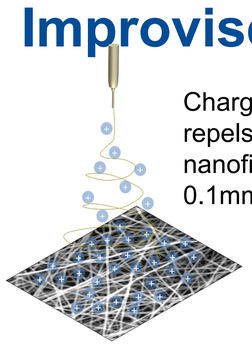
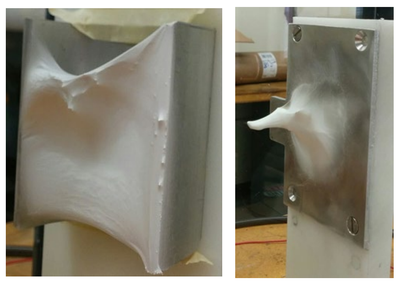


Fig. 2c Details of process zone

Improvised electrospin set up



Charge accumulation repels oncoming nanofibers at around 0.1mm thick



Out of plane growth nanofiber mat

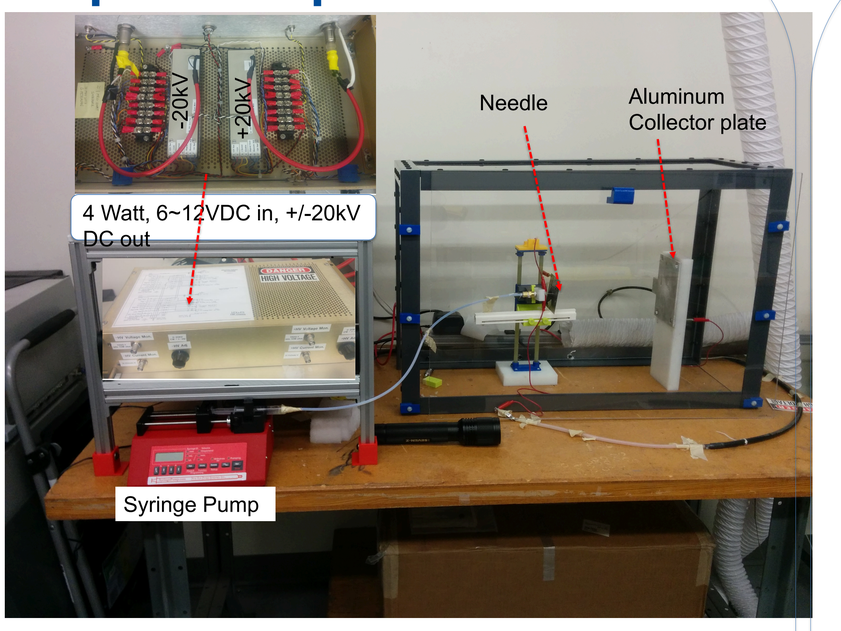
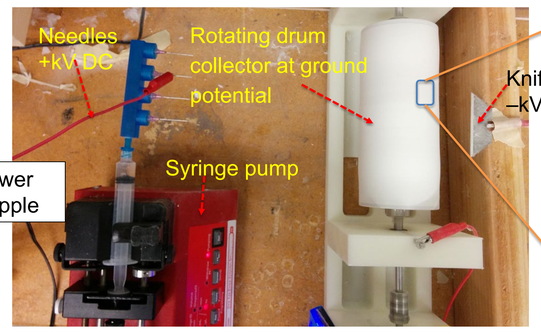


Fig. 3 Lab scale electrospin unit with dual polarity power supply

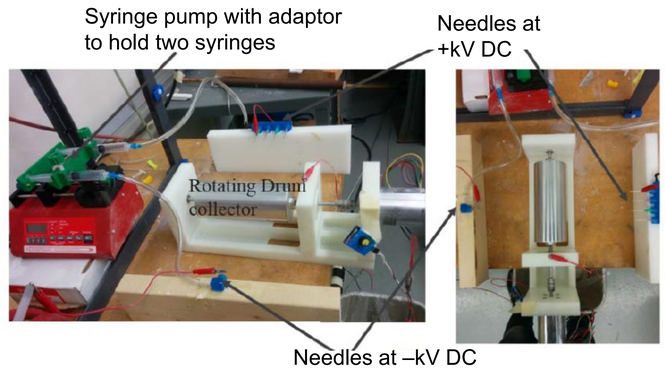
- Much safe to use (120W→4W!)
- Mobile compact unit →Can be run on 9 or 12 V battery
- Dual polarity operation

Thicker mat with ionizer



Thicker mat > 2mm

Fig. 4a Dual polarity electrospinning- ionizer



Rotating drum collector brings the positively charged nanofiber to negatively charged ions / nanofibers and neutralize them

Fig. 4b Dual polarity electrospinning- opposite charged needles

Ceramic/metallic nanofiber production

Inorganic precursor:

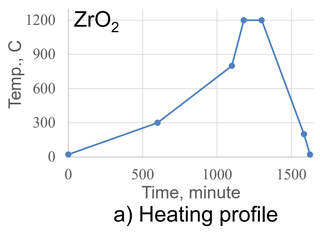
(Zirconium Carbonate +Acetic Acid → Zirconia)

+

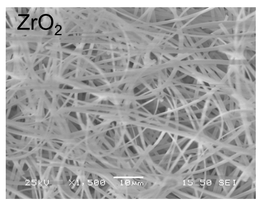
Polymer solution : PVP+Ethanol/Aceton

↓

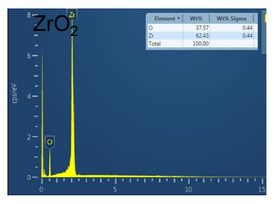
Calcination (Heat treatment)



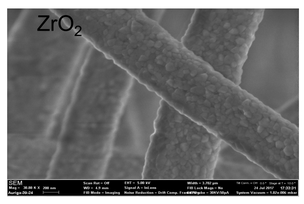
a) Heating profile



b)After calcination



c) EDS mapping



d)High resolution SEM image

Summary and Future work

- Set up a low cost, low power, safer electrospinning unit.
- Success in fabricating metallic and ceramic nanofiber.
- Thicker nanofiber production using dual polarity spinning.
- Ceramic nanofiber looks promising as future candidate target material.

Future work

- Single fiber bending test for tensile strength.
- Single fiber thermal properties evaluation.
- Radiation damage studies using ion irradiation.

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