Production and Mechanical Characterization of Electrospun Ceramic/metallic Nanofiber

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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 stress waves, radiation damage.
- Objective is to fabricate ceramic/metallic nano-fiber with high strength, thermal shock resistance using low cost electrospinning process.

Electrospinning process

- Process carried out at room temp. and atm. pressure
- Process initiates when electrostatic repulsion overcomes surface tension

In-house electrospin set up

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

Ceramic/metallic nanofiber production

- Inorganic precursor: (Zirconium Carbonate + Acetic Acid → Zirconia / Ammonium meta-tungstate + D.I. Water → WO₃)
- Polymer solution: PVP + Ethanol/Aceton
- Calcination (Heat treatment)

Single nanofiber micro-mechanical testing - Atomic Force microscopy

- Diamond tip cantilever
- Spring Constant: 450 N/m
- Resonant Freq. : 70 Hz
- Peak Force, nN
- Indentation depth
- Adhesion

Summary and Future work

- Set up a low cost, low power, safer electrospinning unit.
- Success in fabricating metallic and ceramic nanofiber.
- AFM technique to evaluate single nanofiber modulus.
- 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.

References

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