Synthesis of Zinc Oxide (ZnO) Nanofibers for Thermoelectric and Piezoelectric Applications

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OUTLINE

1. Problem/Need
2. Piezoelectricity and Thermoelectricity
3. What is Electrospinning?
4. Production Process
5. Applications
6. Issues
7. Regulation and Environment
PROBLEM/NEED

• There is a need for new materials for clean alternative energy devices.

• Nanofibers were previously difficult to fabricate cheaply.
PIEZOELECTRICITY AND THERMOELECTRICITY

• “Piezo” - to press or to squeeze in Greek
• The process of converting mechanical energy into electrical current flow.
• Optimal materials: quartz, zinc oxide, ceramic lead zirconate titanate (PZT), groups 3 and 5 elements paired together, sucrose
• Discovered by Jacques and Pierre Curie

• A Thermoelectric material can turn a temperature change into a voltage change
• Currently silicon semiconductors are used
• ZnO nanofibers are cheaper to manufacture than silicon semiconductor pellets
WHAT IS ELECTROSPINNING?

• Cost-effective and simple way to fabricate nanofibers
• A high voltage is applied to a solution (ZnO) and pushed through a syringe onto a spinning drum or grounding plate
• Individual nanofibers can be used to create “nanoscale fibrous membranes” [2]
1. Created a Zinc Oxide Solution.
2. Solution is charged
3. The ZnO solution is slowly dispensed as nanofibers
4. Nanofibers attach to steel substrate
APPLICATIONS

• Piezoelectric
  • Current - barbecue lighters, computer keyboards, printer cartridge
  • Future - pacemakers, Fitbit batteries, bridge sensors, artificial organs

• Thermoelectric
  • Current - Used in basic heaters and coolers
  • Future - windows in houses, waste heat from car to power radio, wasted coal plant heat
ISSUES

- Optimal solution viscosity
- Distance and speed of syringe from substrate below
- Durability of nanofibers
- Optimal voltage
- Shifting frequency because piezoelectricity is AC
- Difficult to integrate into small devices
REGULATION AND ENVIRONMENT

• Relatively new research, so no policies exist yet.
• Possible issues:
  • Disposal of nanofibers
  • Possible respiratory problems and cancer [3]
CONCLUSION

• Electrospinning and Nanofibers are a new technology
• Possibility of life changing use in Piezoelectric and Thermoelectric devices
• As this new process grows and changes, policies and health concerns will have to be considered.
QUESTIONS?
SOURCES


