Polyaniline Nanofiber Based Inks for Security Printing Applications

Connor Holland: SWOSU

Advisors: Dr. Grant Crawford, Dr. Jeevan Meruga, Dr. Alfred Boysen

Background

Polyaniline is a common organic conducting polymer. Recently, polyaniline nanofibers have attracted a great deal of attention due to some of their unique properties. Polyanilne nanofibers are currently being used in sensors, memory devices, actuators, etc. This research project investigates polyaniline nanofiber based inks and how the unique properties of polyaniline could be applied to security printing and anti-counterfeiting technology.

Objective

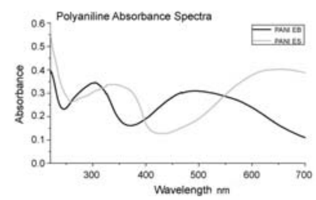
- Synthesize uniform polyaniline nanofibers and characterize morphology
- Use direct write printing technology to pattern stencils using polyaniline based inks
- Investigate difference in conductivity of flash welded regions and non flash welded regions

Experimental Procedure

Polyaniline nanofibers were synthesized using interfacial polymerization. Aniline was added to an organic phase, i.e. chloroform. Ammonium persulfate was dissolved into an aqueous phase of hydrochloric acid. The molar ratio of aniline to ammonium persulfate was kept at 4:1 respectively. After letting the reactants interact fully cleaning was accomplished by using methanol and centrifuging.

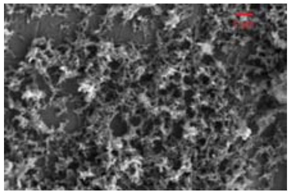
Polyaniline nanofiber based inks were printed using direct write printing technology. This was accomplished using a Hewlett Packard thermal inkjet pipette system (TIPS) printer. Varied weight percent inks were printed onto paper, kapton, and glass substrates. Different numbers of passes and speed of passes by the TIPS printer were tested in order to print uniform patterns.

Flash welding was accomplished using a camera flash from a couple inches away and also by using a 635 nanometer laser. The conductivity of flash welded portions was then compared to conductivity of non-flash welded regions. The substrates flash welding was accomplished on were also varied.



Results

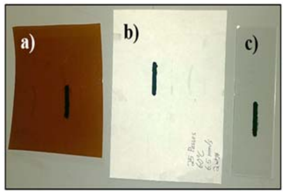
Synthesis



SEM image showing successful synthesis of polyaniline nanofibers

- Diameter of 60-90 nanometers
- Length of 700-900 nanometers
- Smaller nanofibers were found to disperse longer and more fully in water

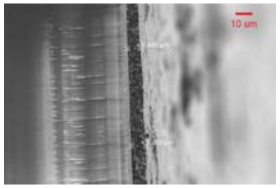
Printing



Uniform stencils printed on a) Kapton B) Paper and c) Glass

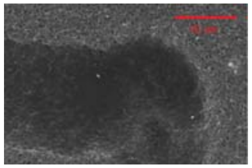
- Several number of passes tested ranging from 5 to 25
- Stencils came out best when hot plate below was held at 60°C
- 1, 2, and 5 weight percent inks were all printed succesfully

- Approximate thickness of 9 micrometers
- Thickness allows conductivity to be found

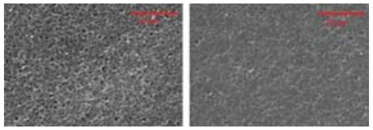


SEM image showing uniform thickness after printing

Flash Welding

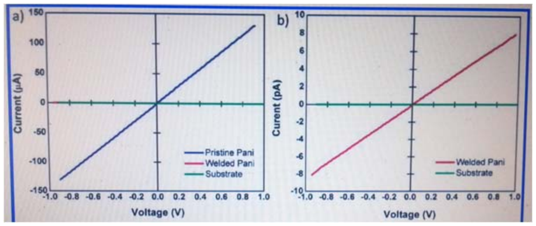


Flash welding accomplished using a 635 nm laser



SEM images showing difference before and after flash welding

- Difference between flash welded and non-flash welded portions s is apparent
- Laser flash welding allows for patterns to be etched
- Non-flash welded regions are conductive, approximately 200 S/m
- Flash welded regions are non-conductive



Graph showing difference in conductivity of flash welded regions and non-flash welded regions

Conclusions

- Polyaniline nanofibers can be uniformly synthesized with relative ease
- Direct write printing of polyaniline based inks is possible
- Flash welding causes a physical change in polyaniline that could prove useful in security printing applications

Acknowledgments

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