Undergraduate Research Posters   Undergraduate Research Opportunities Program

2016

Smart Fabrics for Colorimetric Detection

Breland Edwards

Follow this and additional works at: https://scholarscompass.vcu.edu/uresposters

Part of the Polymer Science Commons

Downloaded from

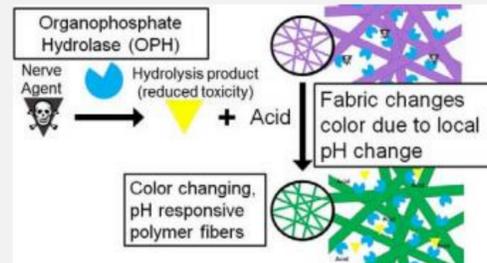**VCU** School of Engineering

VIRGINIA COMMONWEALTH UNIVERSITY

Smart Fabrics for Colorimetric Chemical Detection

Breland Edwards, Dr. Christina Tang, Virginia Commonwealth University Department of Chemical and Life Science Engineering

Introduction

Chemical warfare with nerve agents that bind to neuro-transmitters is prevalent.

- Tabun
- Sarin
- Soman
- VX

Soldiers must carry cumbersome chemical sensing devices.

An alternative would be to use chemical sensing nanofabrics as outer layer of clothing to detect and degrade nerve agents.

The enzyme organophosphate hydrolase degrades agents and releases an acidic byproduct.

Polyaniline (PANI) changes color when exposed to acid due to change in polymer backbone; converts from emeraldine base to emeraldine salt.

Both components can be added to nanofibers to create fabrics.

Approach

A polyaniline solution was polymerized to show that the polymer changed color in response to changes in pH.

Emeraldine Salt — 2.3 3.1 3.5 4.3 5.3 5.7 6.6 7.1 10.3 — Emeraldine Base
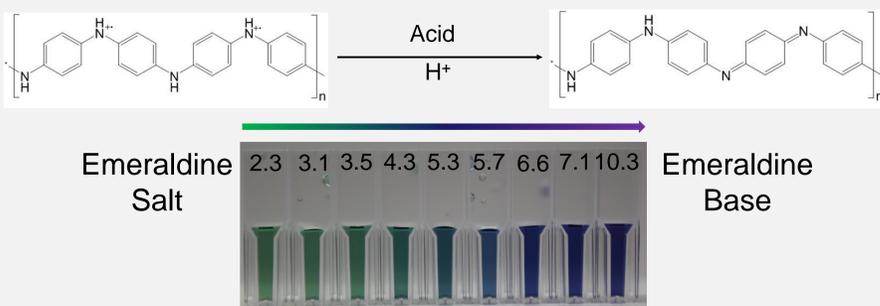
Polyaniline was grafted to the surface of electrospun nylon nanofibers. The nylon was previously acid treated to add more amine groups to the surface.

PANI coating

Nylon nanofiber
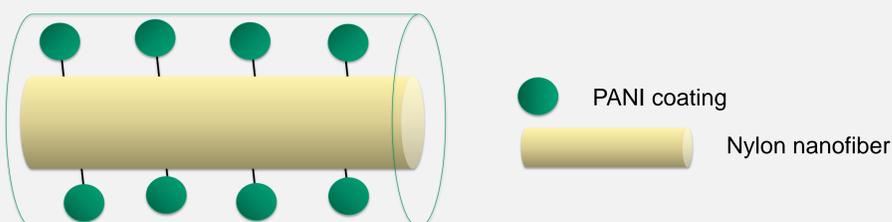
Methods

Electrospinning:

- A high voltage is applied to a system, making the polymer "spin" onto a collecting plate.

- Creates nanofibers many times thinner than human hair.
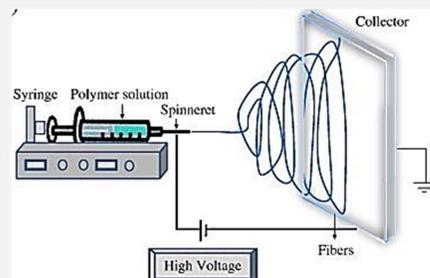
Sensitivity testing:

- Blue fabric is placed on glass slide and inserted into conical tube with vapor of low concentration acid.

- If color changes to green within five minutes, fabric is taken out and "reset" in 0.1M NH_4OH for one minute.

- If no color change, fabric is inserted in new tube with higher concentration acid. Repeated until color changes.

Results

Graft Polymerization

Nylon

in situ polymerization

Substrate

Before acid exposure   After exposure
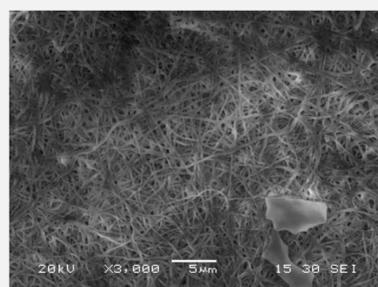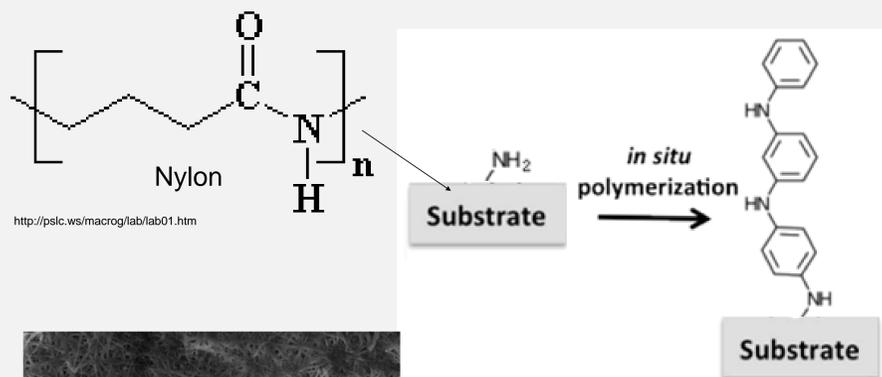
SEM Image of Grafted Nylon Fibers ~300nm in diameter

Deprotonated (left) and protonated (right) grafted nylon fabrics

Results Cont.

Average Sensing Capability of Fabrics After Resetting in Ammonium Hydroxide

- The average sensing capability of all fabrics combined at each reset was found and ranged from 6.2µM before resetting to 21.2µM at 10 resets and beyond.

- The standard deviations were larger in the middle due to some fabrics' sensitivities decreasing faster than others.

Discussion

The sensitivity to HCl vapor decreases with multiple uses. One explanation under investigation is that residual ammonium hydroxide could prevent protonation of PANI upon reuses. Once PANI and residual ammonium hydroxide reach equilibrium, i.e. ~10 resets, no further decrease in sensitivity is observed.

Future Work

- Repeat sensitivity measurements using a different base to reset the fabrics.

- Incorporate the enzyme, atrazine hydrolase, as a model system to demonstrate proof of concept. This enzyme degrades a common herbicide and releases an acidic byproduct.

References

Mikhaylov, S., Ogurtsov, N., Noskov, Y., Redon, N., Coddeville, P., & Wojkiewicz, J. L. (2015). Ammonia/amine electronic gas sensors based on hybrid polyaniline–TiO2 nanocomposites. The effects of titania and the surface active doping acid. *RSC Advances 5*(26). doi:10.1039/C4RA16121A

Acknowledgements