Quick Silver 47
IPRO 317

Silver Nanorods as Thermal Indicators
Project Introduction

- Incidence rate for food poisoning - **76 million cases** annually in USA

- Average yearly U.S. beef consumption:
  - 28.1 billion pounds
  - $74 billion

- Food wasted:
  - 195 lb/capita/year
  - 33.7% red meat
  (Producer – Consumer)

http://www.micron.ac.uk/organisms/images/yeast4a.jpg
Objectives

- Universal marketability
- Broader temperature range
- Improved efficiency in temperature monitoring
- Ethical concerns
  - Inconclusive health and environmental effects
Agenda

- Project Introduction
- Background

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Background

• What are nanoparticles?

• Nanorod-based thermal indicators

• Technology
Team Organization (Initial)

- **Advisor**: Prof. Victor Perez-Luna
- **Team Leader**: Riju Konwar
- **Archivist Team**: Marisa De Nicolo
- **Lab Team**: Jennifer Peavor
- **Research & Development**: Christian Arnoux
  - **Lab Sub-Team 1**: Jennifer Peavor
  - **Lab Sub-Team 2**: Farouk Yaker
  - **Lab Sub-Team 3**: Katherine Hammes
Team Management

**Challenges**

- Communication
- Monitoring Tasks
- Deadlines

**Resolution**

- Igroups
- Ram chart
- Gantt Chart

**Impact**

- Improved task efficiency
- Individual performance improved
- Time efficiency improved

**Timeline**

- 1/26/2009: Team Structure (Phase I)
- 2/1/2009: Reaction Kinetics Examined
- 2/17/2009: 1st Nanorod Batch
- 2/6/2009: 1st Microreactor Model
- 3/1/2009: Kinetic Parameters Determined
- 3/26/2009: Team Structure (Phase II)
- 3/5/2009: Isolated Adequate Batch Conditions
- 4/10/2009: 1st Microreactor Model
- 4/14/2009: Isolated Adequate Batch Conditions
- 4/24/2009: Testing of Microreactor Began
Agenda

- Project Introduction
- Background
- Team Organization
- Research & Development

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Research Team

- Research nanorod background
- Computer simulation
- Conduct kinetic experiments
- Scale-up to continuous process

Continuous Flow Synthesis

- Microreactors most promising
- Control size distribution of particles
- Diffusion can be slow
  - Micromixers often used

Computer Simulation

- Shape dependent optical properties
  - Spherical – 400nm peak
  - Rods – 600nm peak
- Provides correlation between wavelength and concentration
Kinetics

- Monitored the growth of nanorods over time
- Most growth achieved within 5 minutes

- More experiments needed to obtain reliability in results
Purpose
- Can silver nanorods be used as thermal indicators?

Experiments
- Time dependent
- Temperature dependent
Temperature dependent results

- Does temperature effect color?
- Stored at three temperatures
- Noticeable color change
Time dependent results

- Sample was submerged into a water bath
- Temperature was held at 55°C
- Photographs were taken periodically
Nanorods customized to 15°C

Several sizes of nanorods detect temperature

Time (min) 0 5 10 15 20 30 40
Temp (°C) 0 10 20 30 40 50 60
Continuous Flow Microreactor

Batch to continuous process transition
Agenda

- Project Introduction
- Background
- Team Organization
- Laboratory Achievements
- Research & Development
- Market Analysis
Market Analysis

Current Commercial Applications of Silver Nanoparticles

- Hybrid Materials
- Other
- Medical/Healthcare
- Nano MEMS
- Semiconductor
- Information Technology

Market Analysis

Potential market for thermal indicators:

- Food
- Pharmaceutical drugs
- Electronics

Data from the US Department of Agriculture
• 0.8 cents / label

• It is over 3 times cheaper than the closest competitor

The price is on a logarithmic scale of base 10
Competitive Advantage

Value Analysis

- Cost
- Color Spectrum
- Shelf Life
- Temperature Range

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Thermax
Fresh Check
Conclusion

- Successful batch process produced
- Color spectrum validation
- Continuous flow process designed
- Testing in progress

http://www.flickr.com/photos/48372717@N00/435479522
Future Work

• Further develop the microfluidics model

• Optimize reaction conditions

• Explore other possible markets
  – Surface Enhanced Raman Scattering (SERS)
  – Antimicrobial application (Healthcare)

Questions?

Hi Ho Silver!