High-Throughput, Scalable Nanomanufacturing of Nanocomposites via Micellular Electrospray

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http://nano4neuro.com/
Nanocomposite Particles

Quantum Dots
- Broad Excitation
- Narrow Emission Bandwidths
- Low photobleaching
- High Quantum Yield

Magnetic Nanoparticles
- Reduce T2 relaxation (MRI)
- Biocompatible
- Biodegradable
- Exert force in magnetic field

Core-Shell
Gu et al., JACS, 2004, 5664

Interfacial Doping
Deng et al., Nanotech., 2010, 145605.
Self-Assembled Micellar Nanocomposites

Interfacial Instability

Animation by A. Duong
Introduction to Electrospray
Collaboration with Barbara Wyslouzil, ChBE, OSU

Organic Solvent, Polymer, Nanoparticles

High Positive Voltage Applied

Aqueous Solution: Water, Surfactant

Ground

Collection Dish (Water)

Manuscript in Preparation
Process Optimization

Q = 3, Q/o/Q(i) = 14

Q = 3.5, Q/o/Q(i) = 2.5

Collection Temperature (°C)
PS-PEO Concentration in Organic (mg/ml)

Spheres
Mix Worms & Spheres
Not Viable
Spheres Batch 2
Mix Worms & Spheres
Batch 2

40°C
30°C
2°C
5mg/ml
10mg/ml
Wormlike Micelles

Worms with QDs concentrated in globular regions

Spherical micelles
Yield and Size Distribution

30 fold increase in yield
15% size distribution
Particles Produced and Uses

**MultiDot: QDs**
- QDs
- Amphilphilic polymer
- Imaging
- 25 nm

**MagDot: Magnetic QDs**
- QDs
- SPION
- Amphiphilic Block Copolymer
- Micelle
- Nanocrystal
- Separations
- 50 nm

**PolyDot: Polymer NPs**
- Polymer NPs
- Drug Delivery
- 47 nm
- 48 nm
- 100 nm

Drug Delivery
- 10% loading (Conventional)
- 10% DEX loading (Polydot)
Conclusions

• Micellar nanocomposites can be synthesized by interfacial instability.
• Nanocomposites can be synthesized by electrospray increasing yield and with potential for continuous fabrication.

• Synthesis is robust, with little change in particles produced over a wide range of process parameters.
• Alternative structures can be created by altering polymer characteristics.

• Several types of particles can be produced using this approach.
• Particles have applications in several fields.
The Winter Group

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