Controlled Release from Solid Polymer Nanofibers

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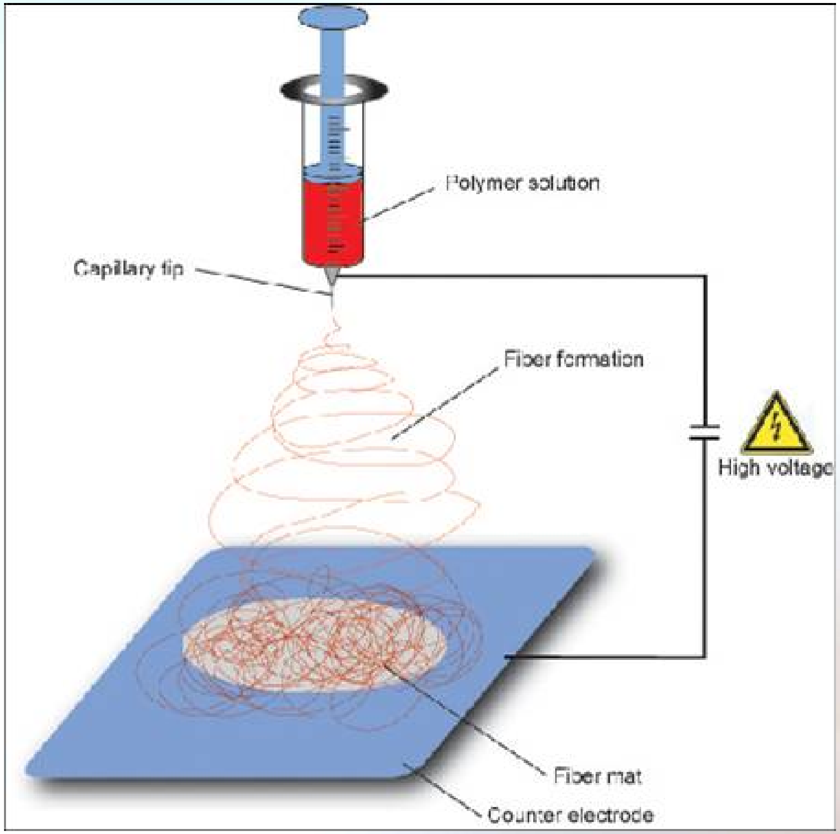
An Overview of Nanofibers

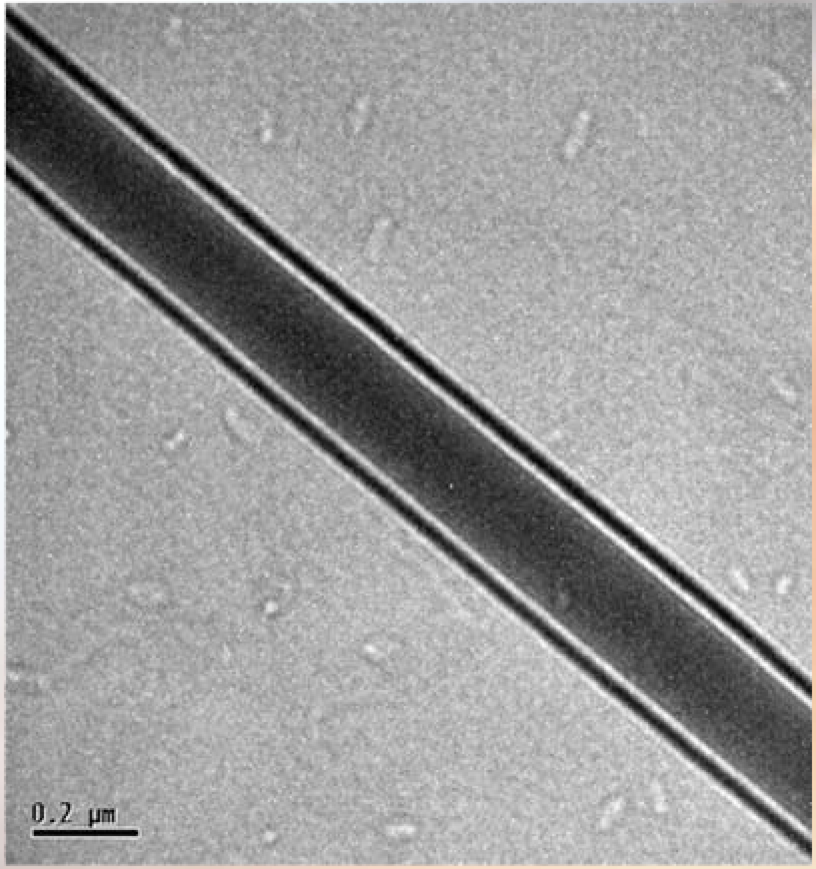


- **Continuous fiber**
- **Diameter ranges from 10 – 500nm**
  - **High Surface Area- to-Volume ratio**
  - **High Mechanical Strength**
- **Created from polymer solutions using electrospinning process**

http://www.chemie.uni-marburg.de/ag-wendorff/Forschung/F1-Elektrospinning_e.html

Applications of Nanofibers

- Filter media
- Fiber – reinforced plastics
- Solar and light sails
- Protective clothing
- Electronics
- Several biomedical applications
  - **<u>Drug delivery systems</u>**
  - Scaffolds for tissue engineering
  - Wound dressings



Drug Delivery Systems

Systems designed to dispense a drug in effective dosages with minimal exposure to the host

Conventional Drug Delivery Systems	Polymeric Drug Delivery Systems
Rapidly absorbed into body	Controlled diffusion rates
Drug travels through body	Localized diffusion at targeted sites
Several side effects	Low toxicity

Why Polymer Nanofibers?

- Reduced diameter gives rise to favorable properties for diffusion
  - **Small diffusion distance**
  - **High surface area aids mass transfer**

- Convenient means of incorporating therapeutic compounds into polymer carriers

- Promising method of controlling diffusion rates
  - **Polymer Concentration**
  - **Core – Shell fibers**

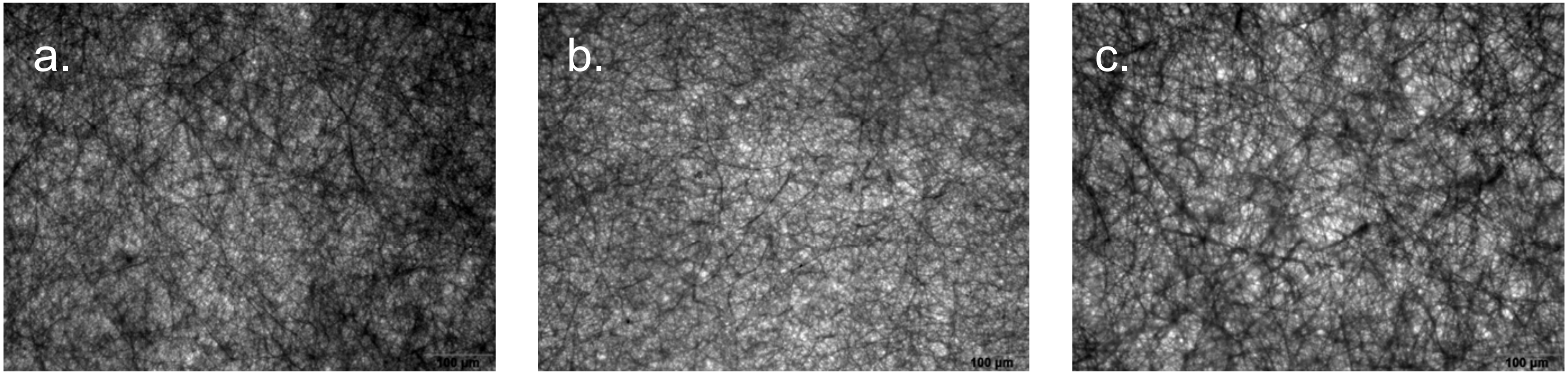
Characterizing Release

- **Fluorescent dye is added to polymer solutions**
    - **11%, 13% and 15% Polycaprolactone (PCL) in 3:2 DMF:MC solvent mixture**
- **Polymer solution is spun into nanofibers**
- **Known mass of fibers is placed in water and swirled at ambient temperature**
- **Samples of solvent are removed and analyzed using spectrofluorometer at predetermined time intervals**
- **Cumulative release is calculated**

Electrospinning Results

sample	distance (cm)	voltage (kV)	flow rate (mL/hr)	diameter range (μm)	average diameter (μm)
11% PCL	17	15.7	2	0.66-1.2	0.84±0.13
13% PCL	17	13.7	1.75	0.62-1.5	0.98±0.25
15% PCL	17	15.2	2	0.64-2.3	0.99±0.36
11% PCL with dye	17	18.7	2	0.60-1.4	0.84±0.17
13% PCL with dye	17	18.3	1.75	0.79-1.8	0.96±0.23
15% PCL with dye	17	16.0	2	0.53-1.3	1.0±0.19

Porosity

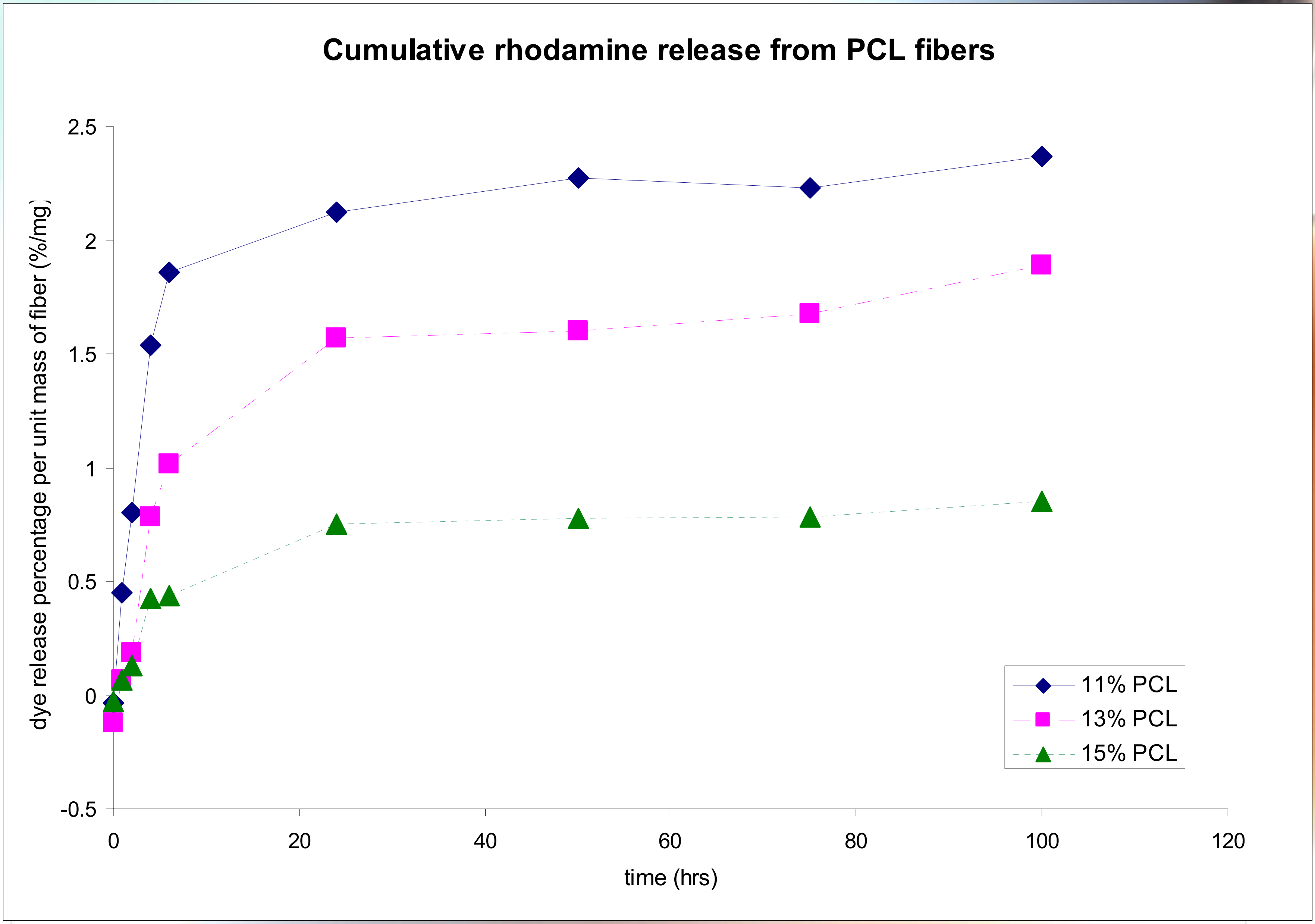


	11% PCL[a]	13% PCL[b]	15% PCL[c]
Surface Porosity	2.68%	3.57%	3.39%
Bulk Porosity	86.4%	84.3%	83.5%

$$\varepsilon = 1 - \frac{M}{\rho h S}$$

Where:
ε = porosity
M = mass of fiber sample
ρ = density of PCL
h = thickness of fiber sample
S = surface area of fiber sample

Controlled Release Measurements



Future Directions

- **Characterize radial diffusion from Solid Polymer Nanofibers**
- **Continue to investigate methods of controlling release from nanofibers**
- **Model diffusion of organic compounds for clinical applications**

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