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ECSA-6

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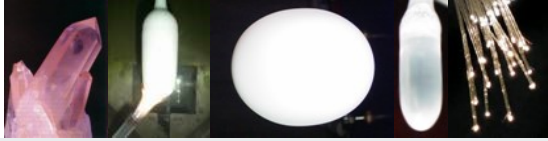
Use of Optical Fiber Sensor for Monitoring the Degradation of Ac-Dex Biopolymeric Nanoparticles

Marco César Prado Soares[1*], Gabriel Perli[2], Matheus Kauê Gomes[1], Carolyne Brustolin Braga[2], Diego Luan Bertuzzi[2], Eric Fujiwara[1] and Carlos Kenichi Suzuki[1]

[1]School of Mechanical Engineering, University of Campinas, SP, Brazil

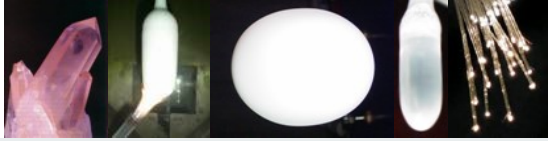
[2]Institute of Chemistry, University of Campinas, SP, Brazil



1. Introduction

Current research in nanomedicine:

- Development and application of new biocompatible and biodegradable materials;
- Nanostructures produced from degradable polymers such as polysaccharides:
  - carriers for pharmaceuticals;
  - tunability for releasing active compounds in response to pH changes;

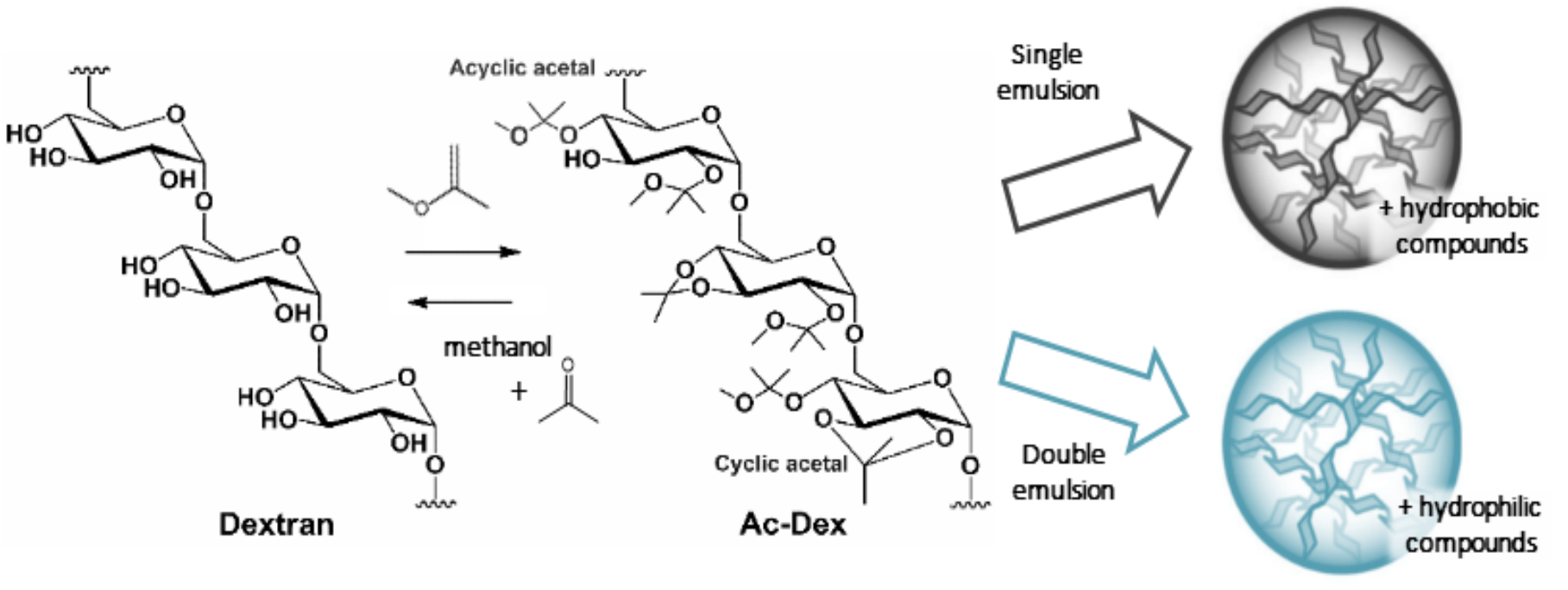


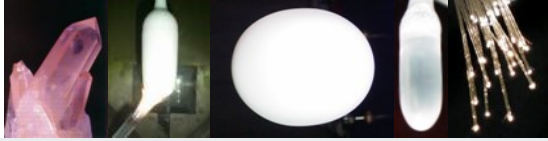
1. Introduction – Acetalated Dextran (Ac-Dex)

- Promising example of pH-responsive polymer;
- Easily processable by different emulsion techniques;
- Ac-Dex nanoparticles (NPs) present the ability to encapsulate both hydrophobic and hydrophilic molecules, depending only on the emulsion process

2. Polymer Synthesis and Nanoparticles Preparation

- Two methods applied: single-emulsion (SE) and double-emulsion (DE)





2. Optical Fiber Sensor for *in-situ* Assessment of Degradation

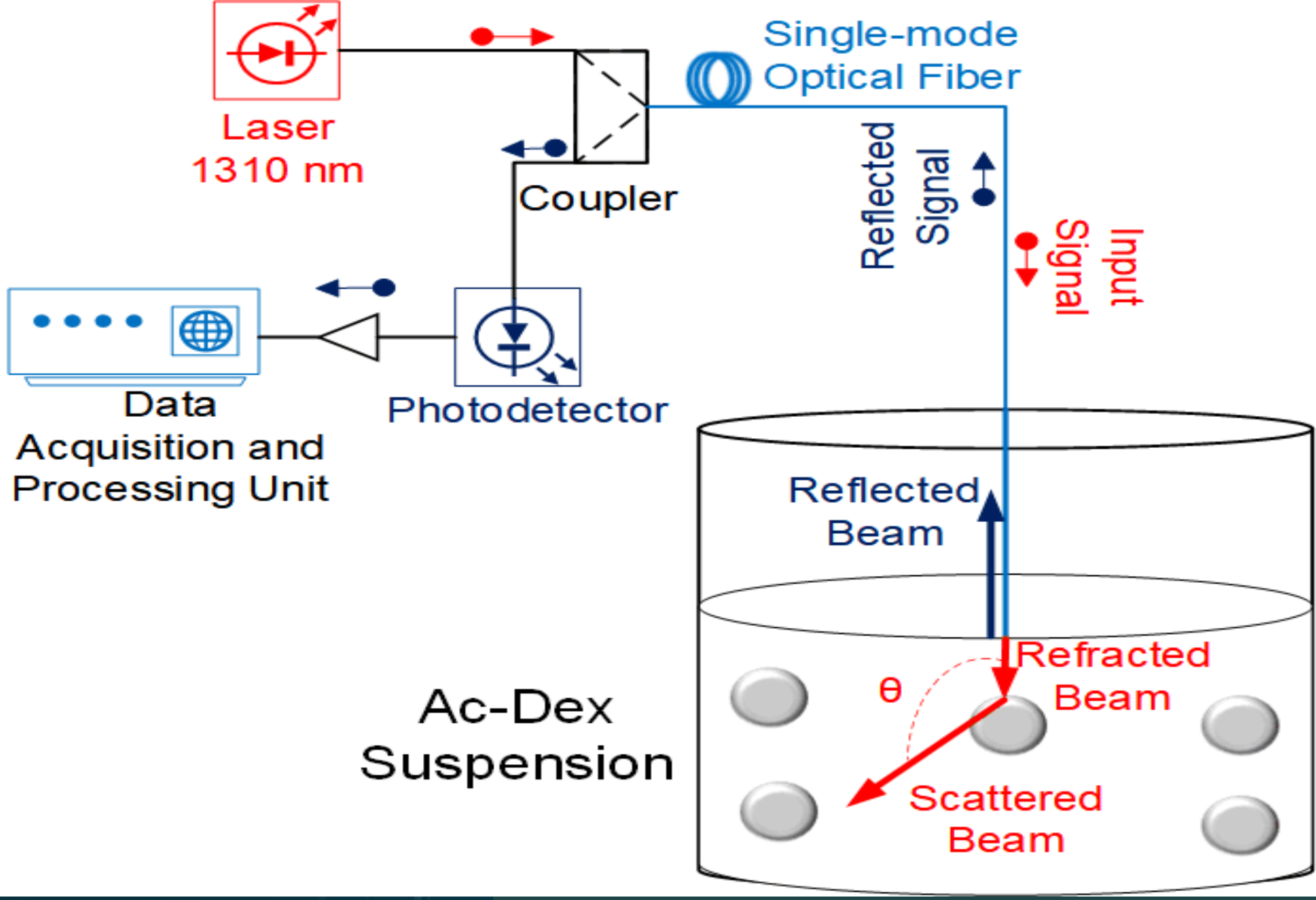
- Based on Quasi-Elastic Light Scattering (QELS);
- QELS is produced when particles are hit by light with wavelength comparable to their dimensions;
- From the I_R signal it is possible to calculate the **autocorrelation of the intensity, which is related to the concentration and dimensions** by Siegert relation:

$$G_2(\tau) = A + Be^{-2\Gamma_m \tau}$$

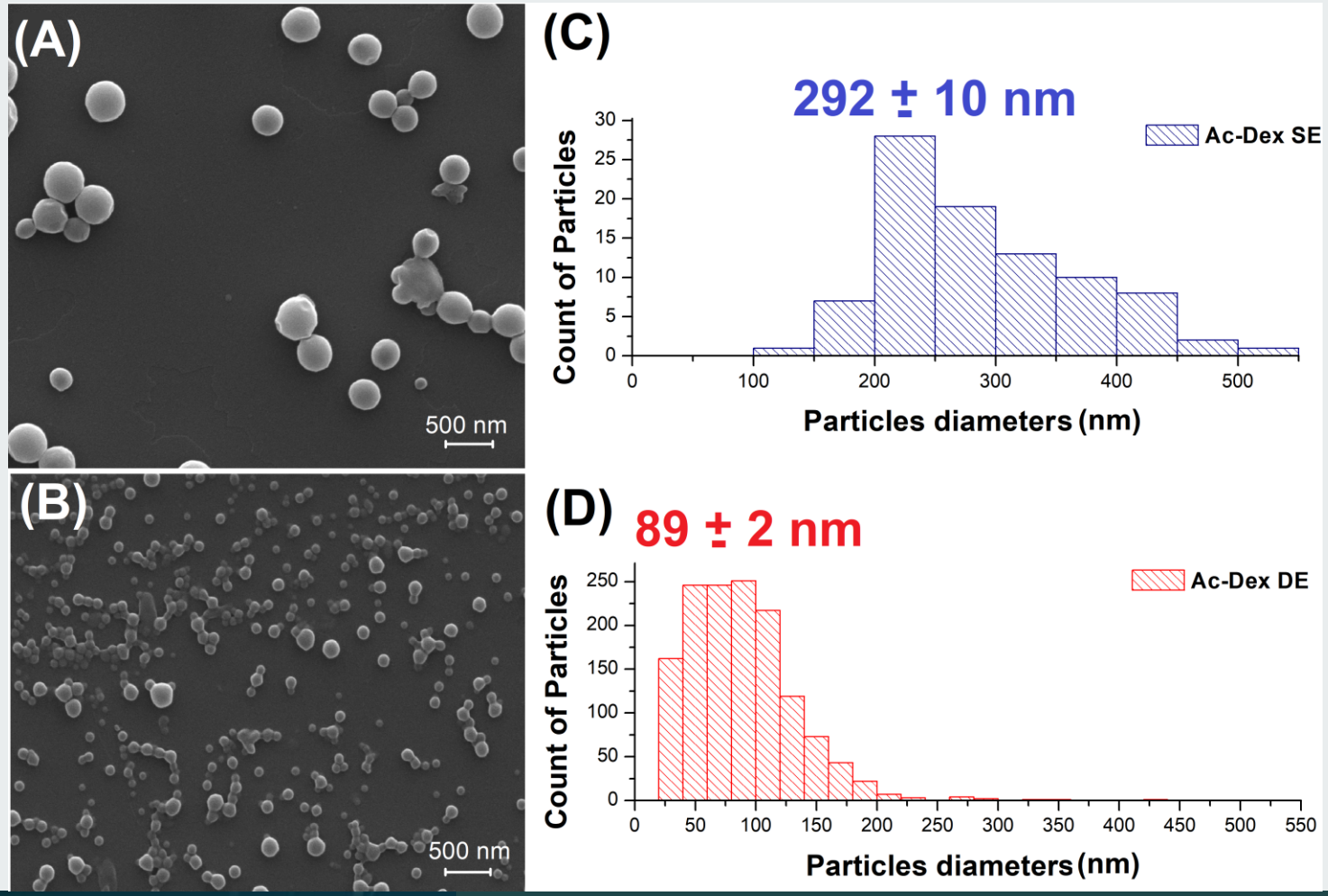
Where *A* is the baseline, *B* is the coherence factor, and Γ_m is the average decay rate. According to the **Stokes-Einstein** equation:

$$\Gamma_m = Dq^2$$

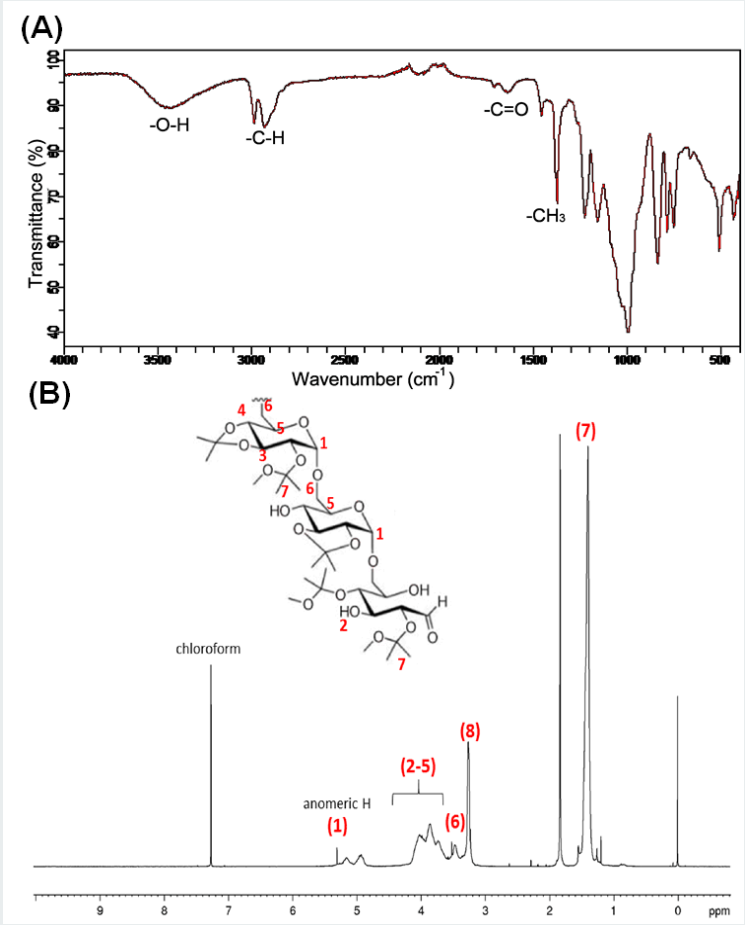
In which D is the translational diffusion coefficient and q is the magnitude of light scattering vector.


Laser
1310 nm
Coupler
Single-mode
Optical Fiber
Reflected
Signal
Input
Signal
Data
Acquisition and
Processing Unit
Photodetector
Reflected
Beam
Refracted
Beam
θ
Ac-Dex
Suspension
Scattered
Beam

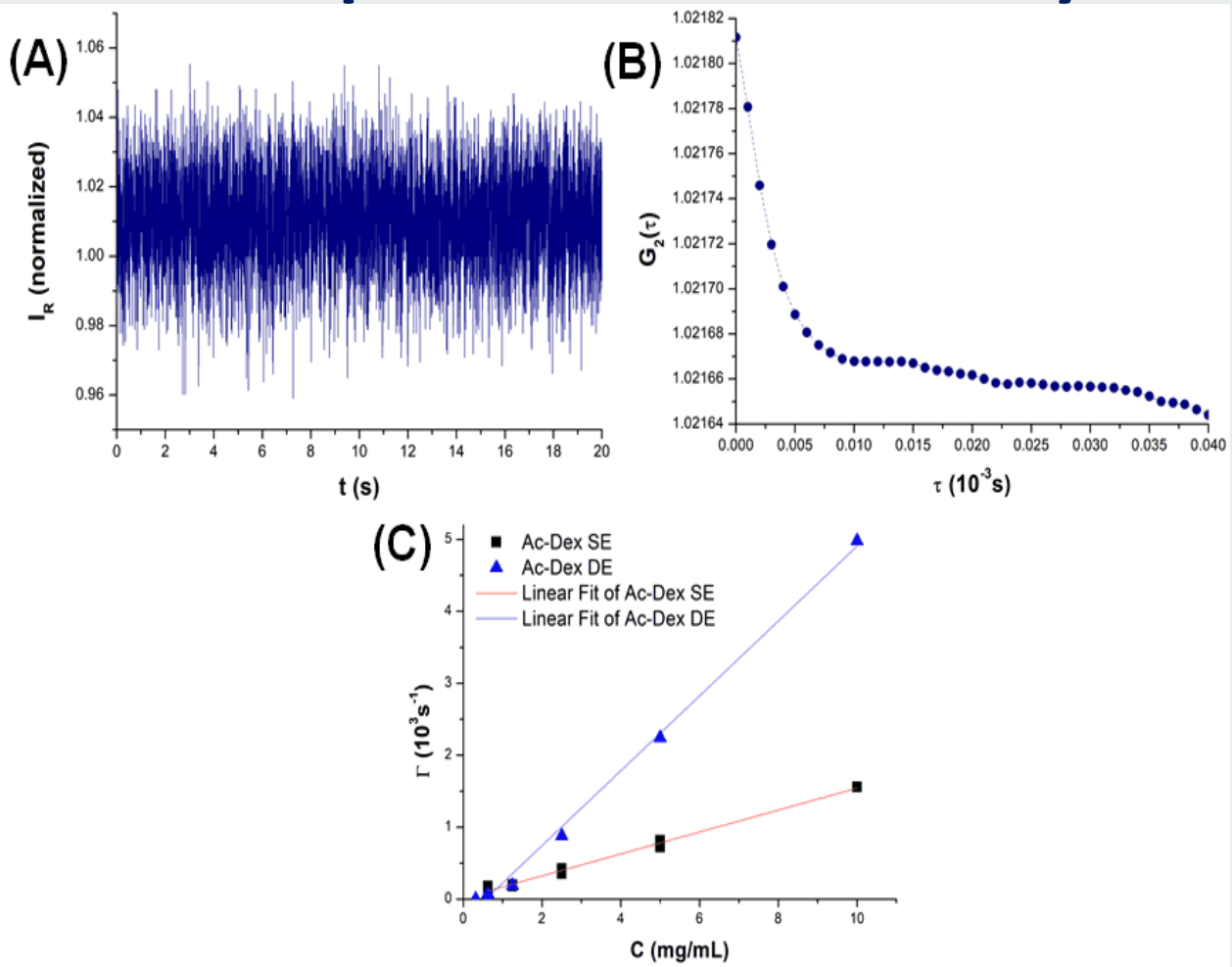
3. Nanoparticles Characterization



3. Nanoparticles Characterization



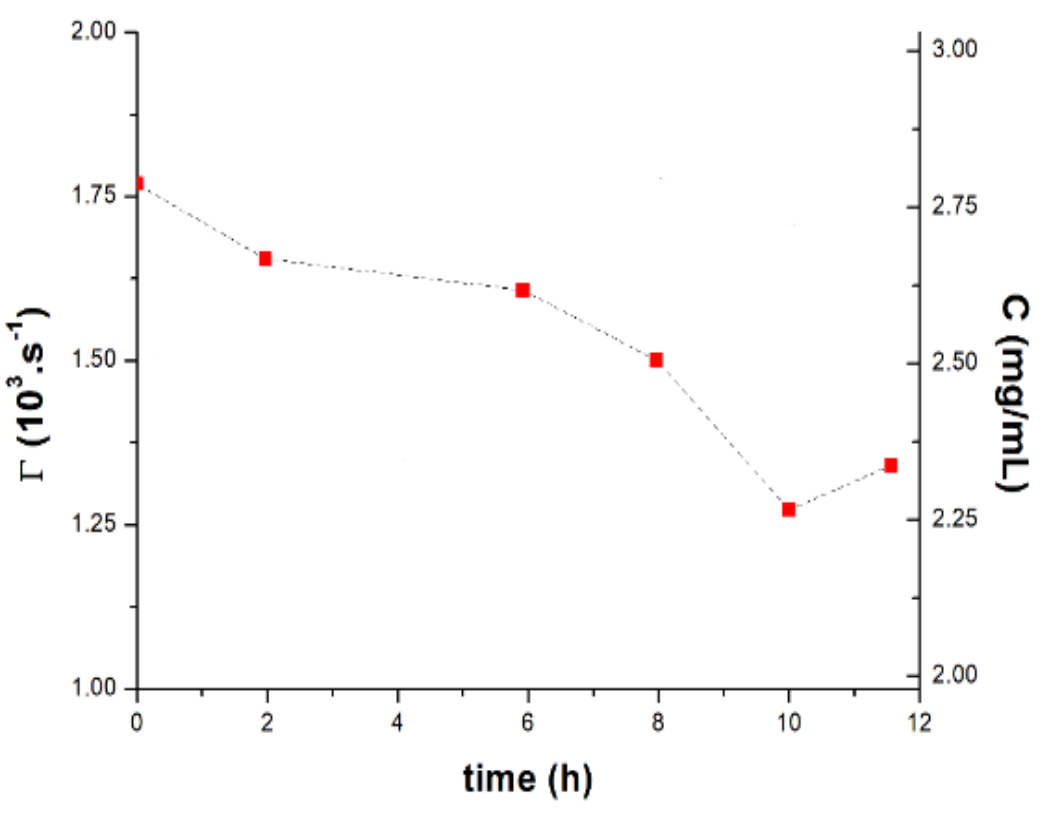
3. Optical Fiber Sensor Dynamic Evaluation

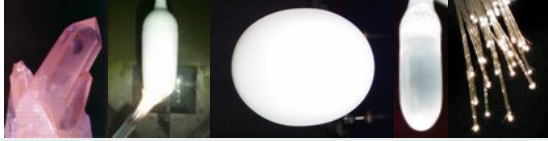


- (A) Reflected intensity I_R; and (B) G_2 (τ) obtained for 10 mg of Ac-Dex SE /mL; (C) Mean decay rates Γ_m
- $\Gamma_m = 0.152C + 0.017$ (R^2 = 0.9915, Ac-Dex SE) and $\Gamma_m = 0.520C - 0.295$ (R^2 = 0.9952, Ac-Dex DE), Γ_m in 10^3 s^{-1} and C is in mg mL^{-1}
- **Sensitivities**: 0.152 x 10^3 $s^{-1}mg^{-1}mL$ (Ac-Dex SE) and 0.520 x 10^3 $s^{-1}mg^{-1}mL$ (Ac-Dex DE)

3. Optical Fiber Sensor Dynamic Evaluation

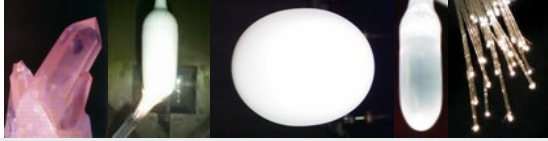
- Due to the higher sensitivity, the Ac-Dex DE particles (suspension with initial concentration of 4 mg/mL) were chosen for the **degradation test**;
- Particles degrade in the presence of the acid pH characteristic of the cancer tissues;
- **The process occurs in a tunable way**: degradation of 20.9% of the NPs after 12 h.





4. Conclusions

- **Successful synthesis of Ac-Dex nanoparticles by two different methods:** statistically significant differences on the average diameter were obtained: **292 and 89 nm for Ac-Dex SE and Ac-Dex DE**, respectively;
- **Analysis with the optical fiber sensor**: two different sensitivities (**0.152 x 10^3 and 0.520 x 10^3 $s^{-1}mg^{-1}mL$ for SE and DE, respectively**) due to the different diffusivities;
- **Continuous evaluation of Ac-Dex DE with the sensor**:
  - Nanomaterial is adequate for drug-delivery, since **it suffers a controlled degradation under conditions that simulate those in tumoral tissues**;
  - Optical fiber sensor is a feasible instrument for the *in-situ* monitoring of the colloidal system.
- **Future works:** chemical modification of the optical fiber with targeting groups to **co-evaluate the colloidal properties while the release of active compounds under tumoral acidic conditions is quantified.**



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Thank you for your attention!

Questions?

marcosoares.feq@gmail.com
fujiwara@fem.unicamp.br

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