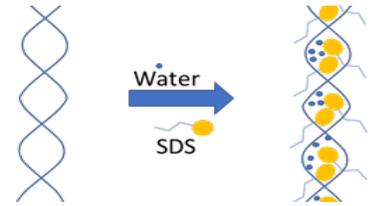


Biomedical Colloid and Interface Lab

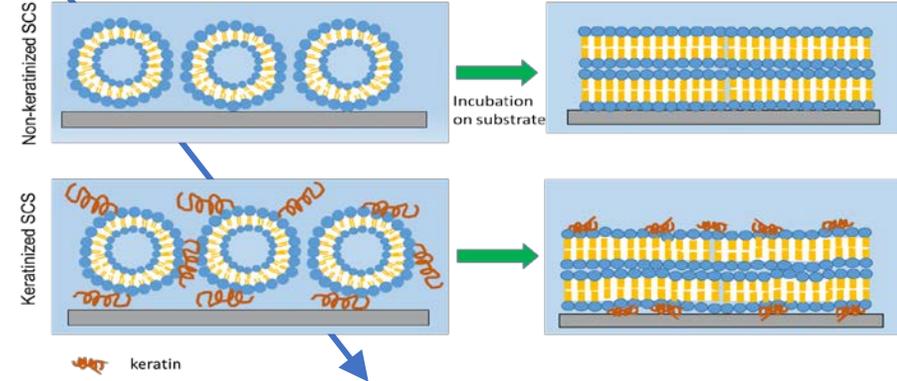
Yoonjee Park, Ph.D.

Smart Colloid Systems
For Drug Delivery
Applications

Dehydration on the skin
surface
(stratum corneum)?



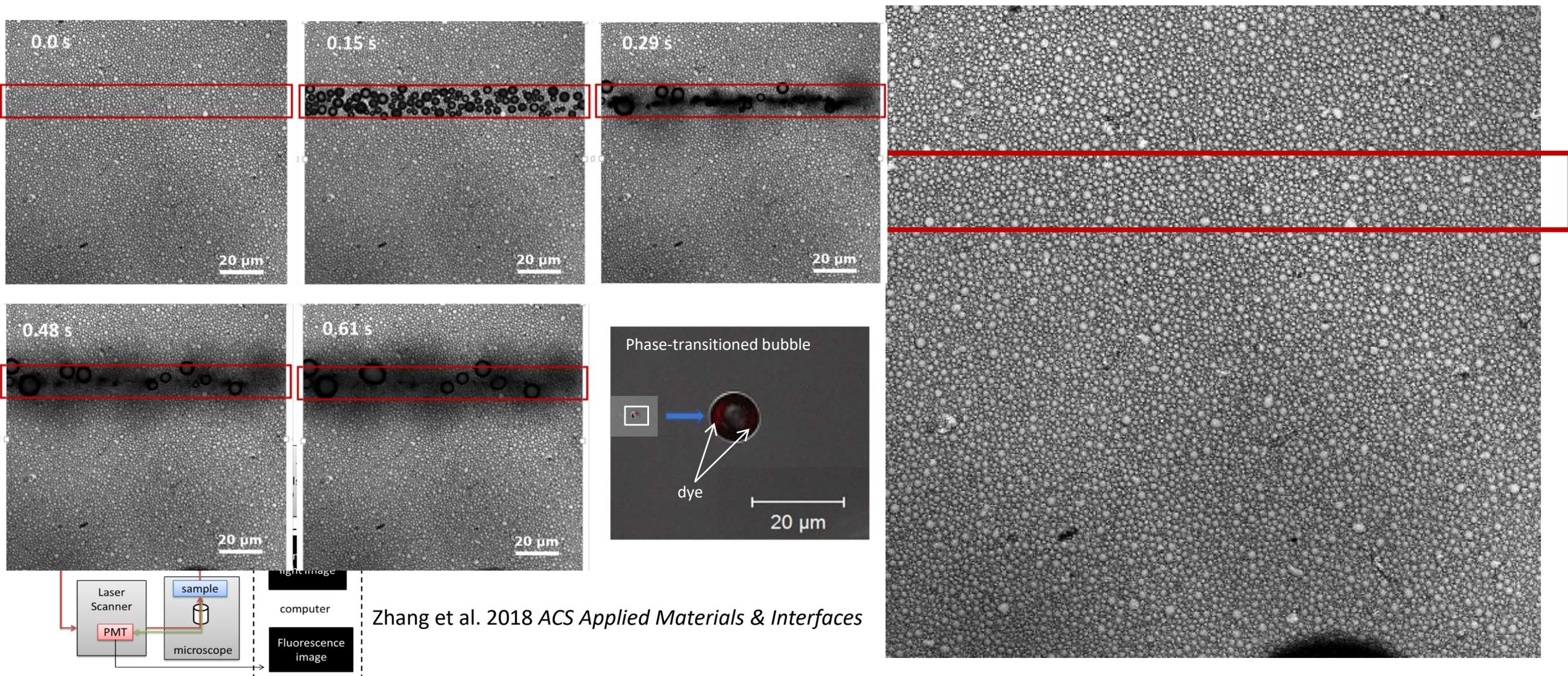
Stratum Corneum Substitute (SCS)



Biocompatible Polymer
For Controlled Release

In Vitro Skin Surface
Model

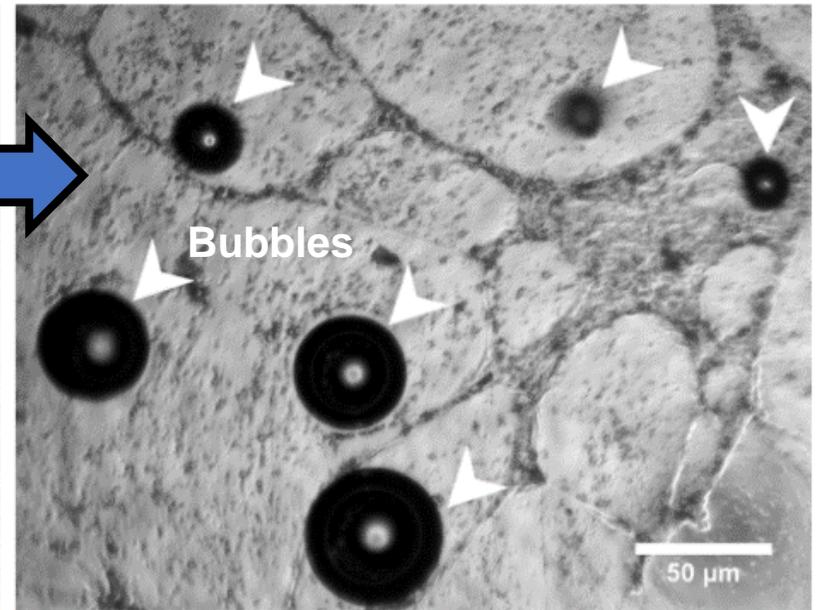
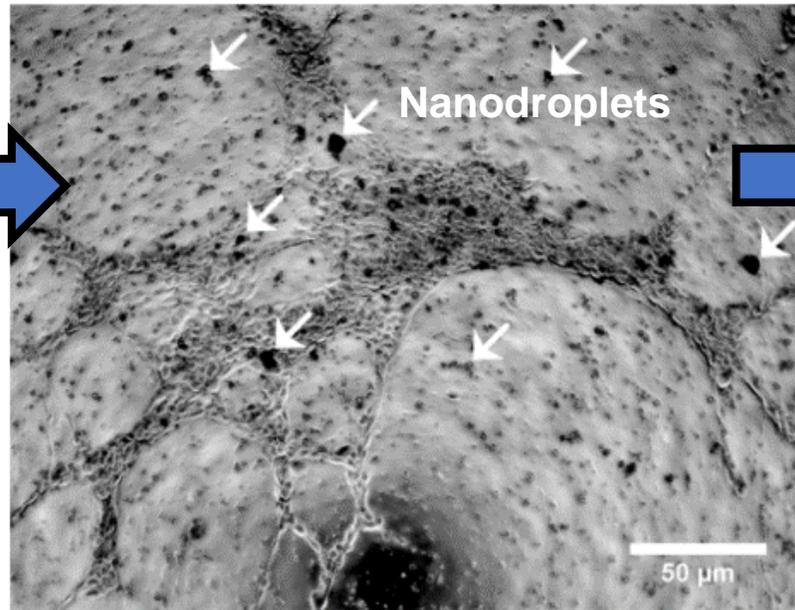
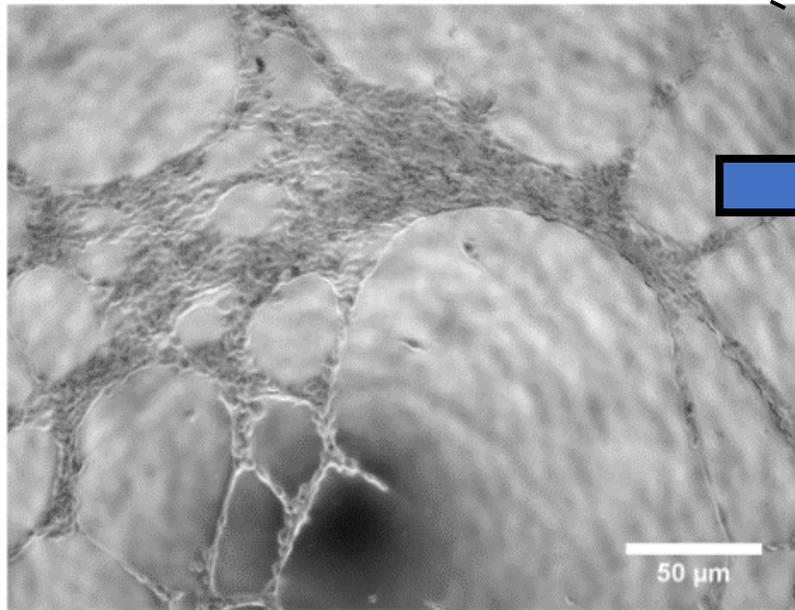
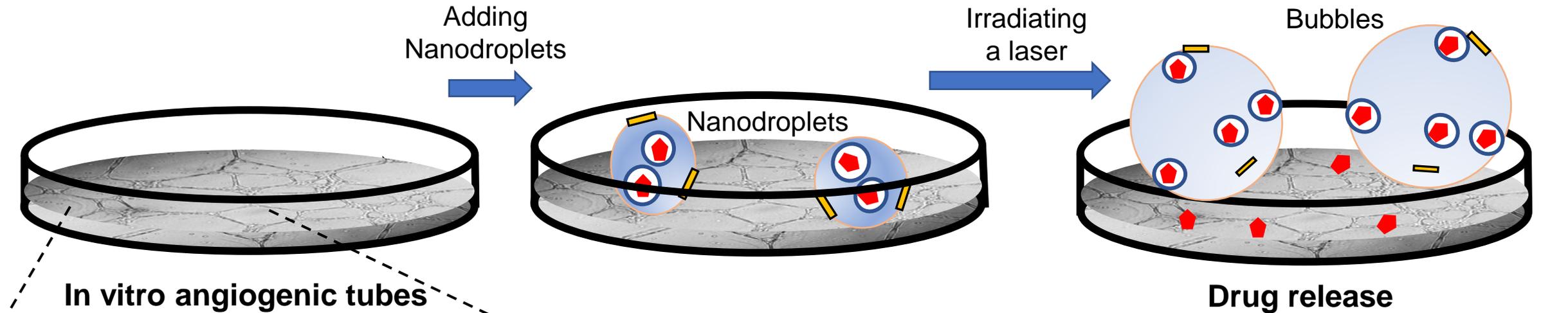
Phase-transition of the nanodroplets by pulsed laser



Phase-transition of the nanodroplets observed with an inverted microscope. The schematic is the optical setup (AOM: acousto-optic modulator; PMT: photomultiplier detector).

Fs laser: 980 nm, 80 mW, single shot 100 fs (DIC/Fluorescence)

Drug delivery in in vitro angiogenesis model



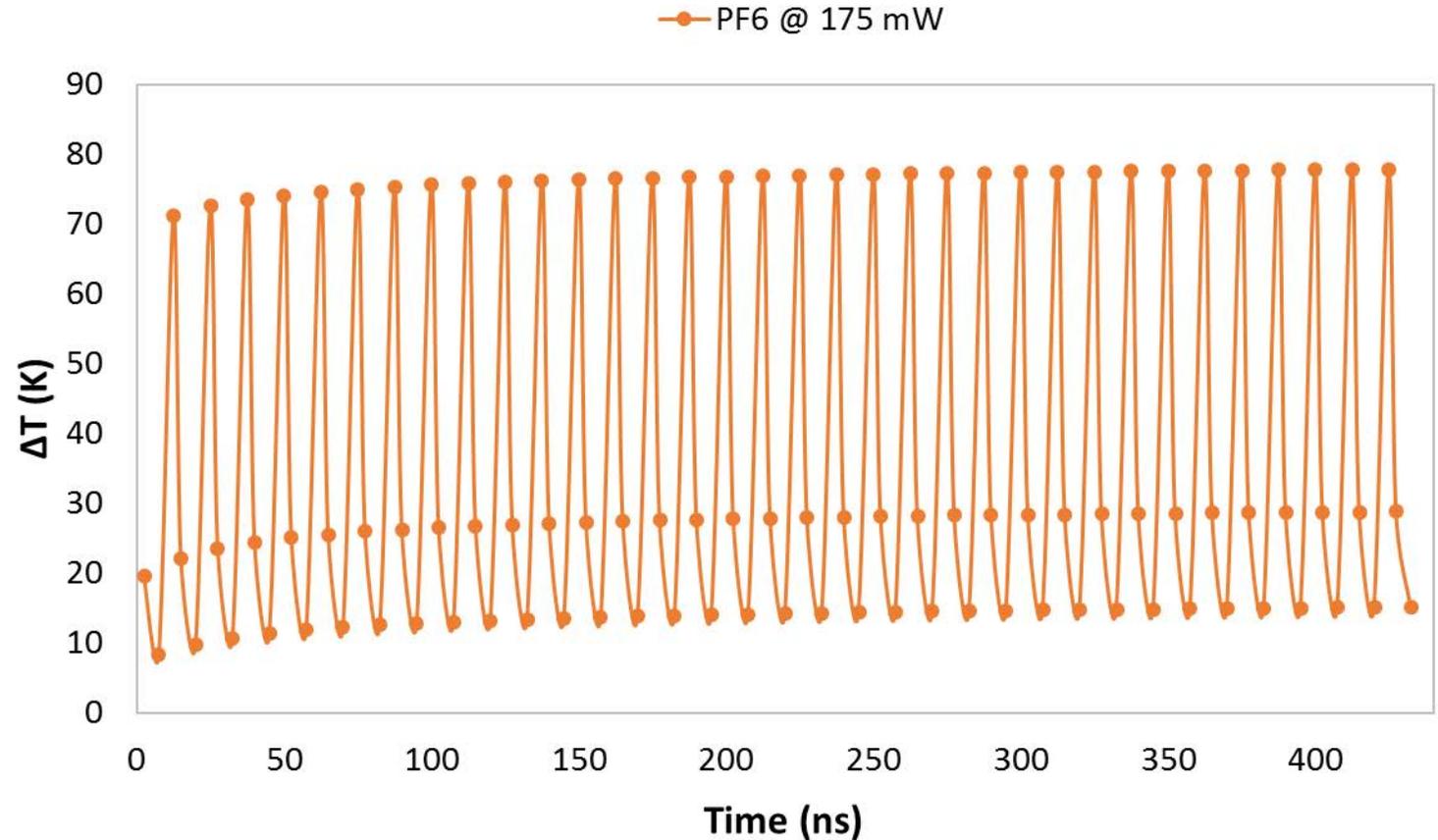
Theoretical T_{ph} from heat transfer model considering **Peak intensity**

$$\alpha \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial T}{\partial r} \right) = \frac{\partial T}{\partial t}$$

$$T(r, t) = \frac{H_0}{(4\pi\alpha t)^{3/2} \rho C_p} \exp\left(\frac{-r^2}{4\alpha t}\right)$$

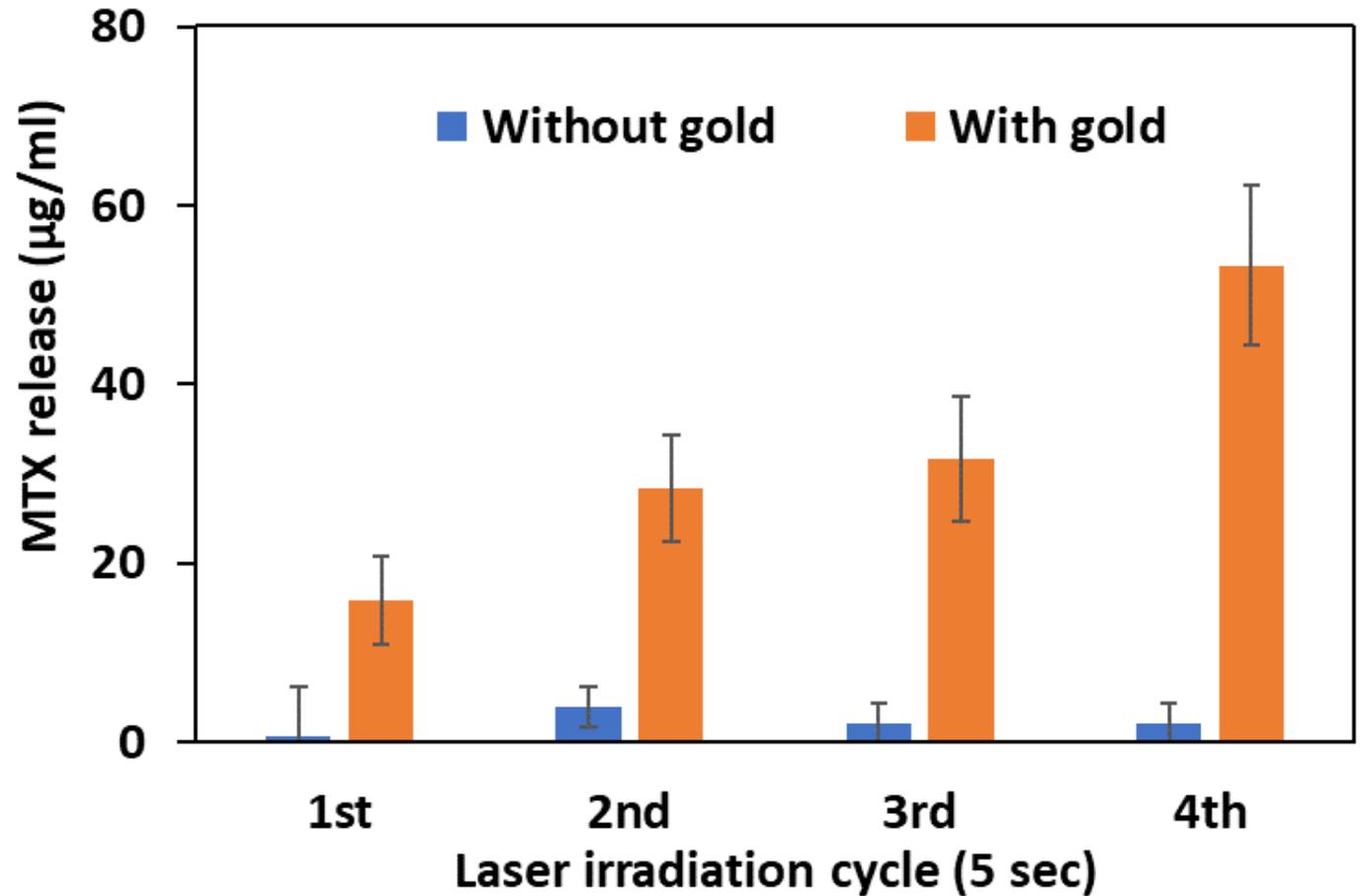
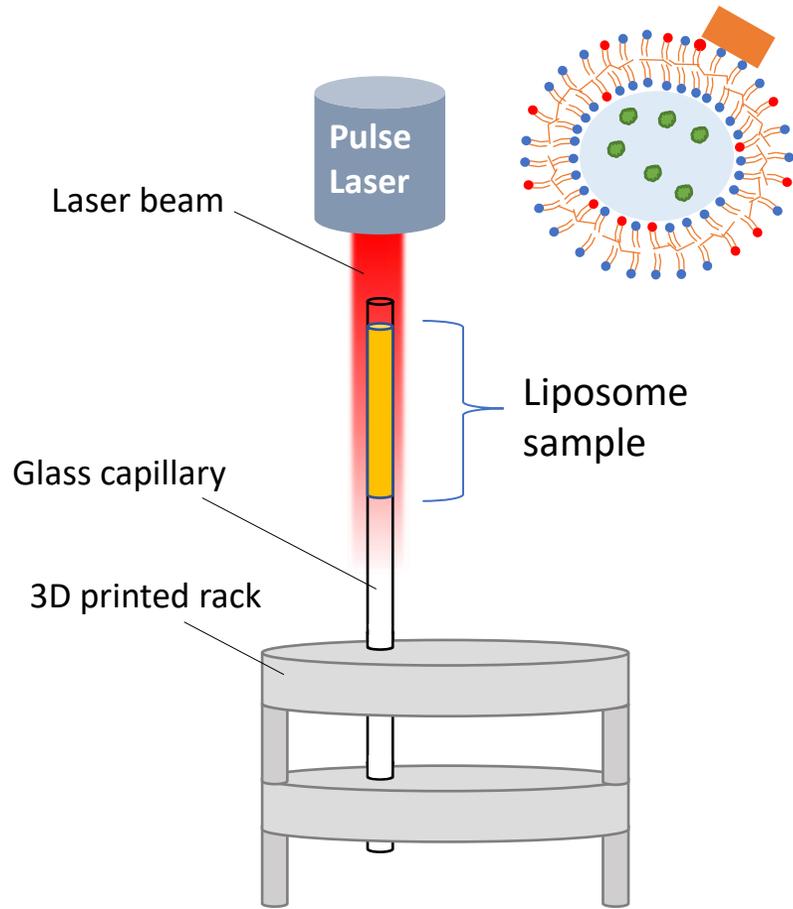
Peak intensity considering pulse duration
coefficient of gold nanorods

$$T_{NP}(t) = \sum_{j=0}^{N-1} G_{R,g}\left(t - \frac{j}{f}\right)$$



- Initial temperature rise is governed by peak intensity.
- Predicted the threshold ΔT for vaporization: PF5 \approx 30 K, PF6 \approx 60 K
- At 80 MHz, heat accumulation is not significant.

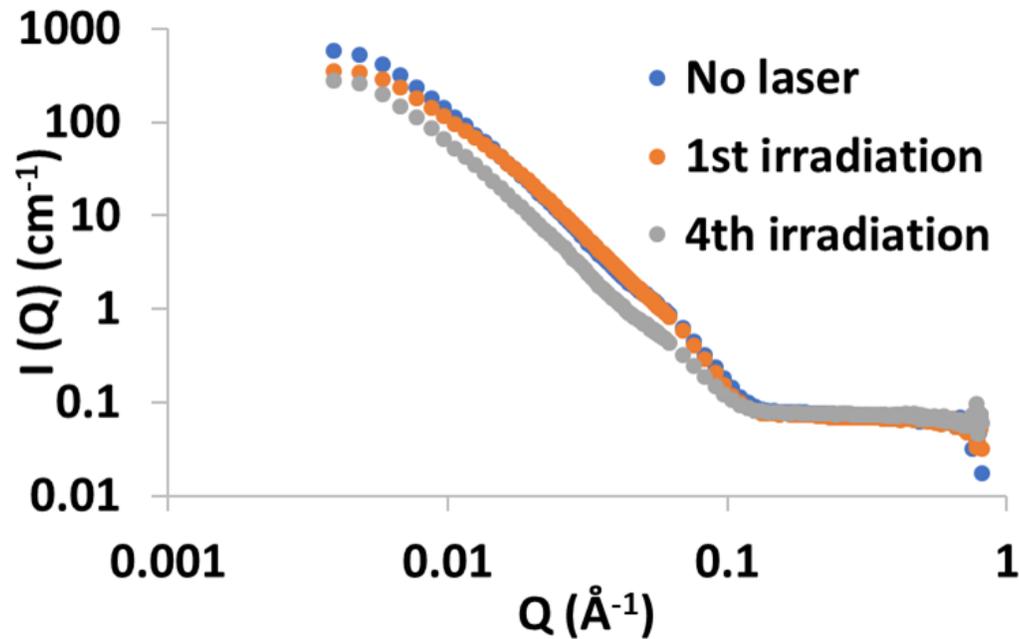
Light-Activatable Liposomes as a Drug Release System



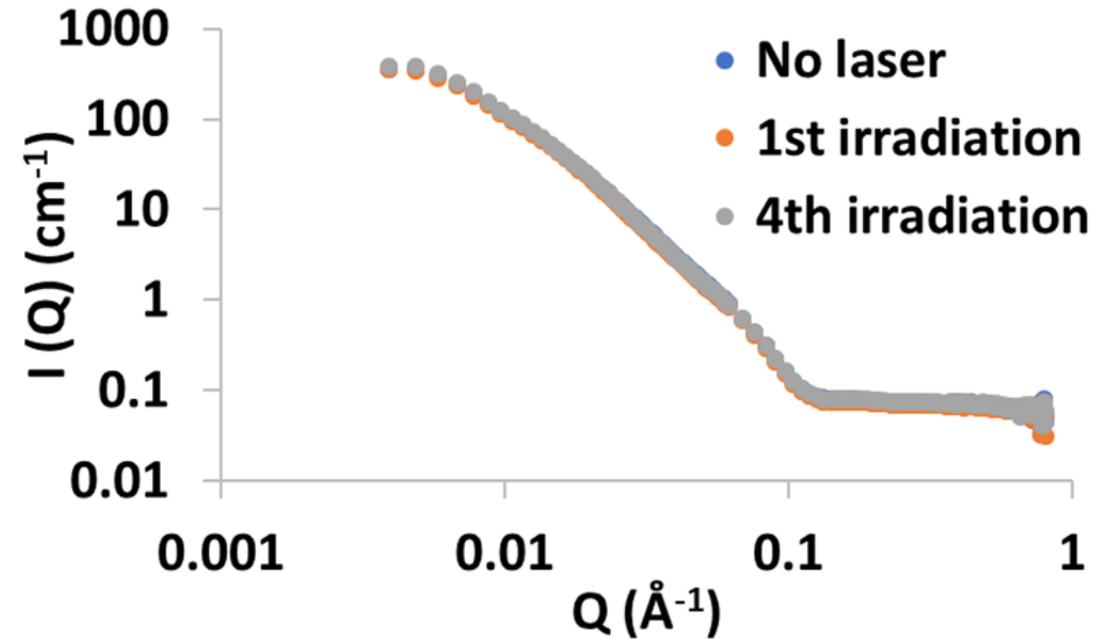
- Drug release is proportional to the number of irradiation cycles.

Effect of liposomes composition on nano-structural alteration

With Cholesterol



Without Cholesterol



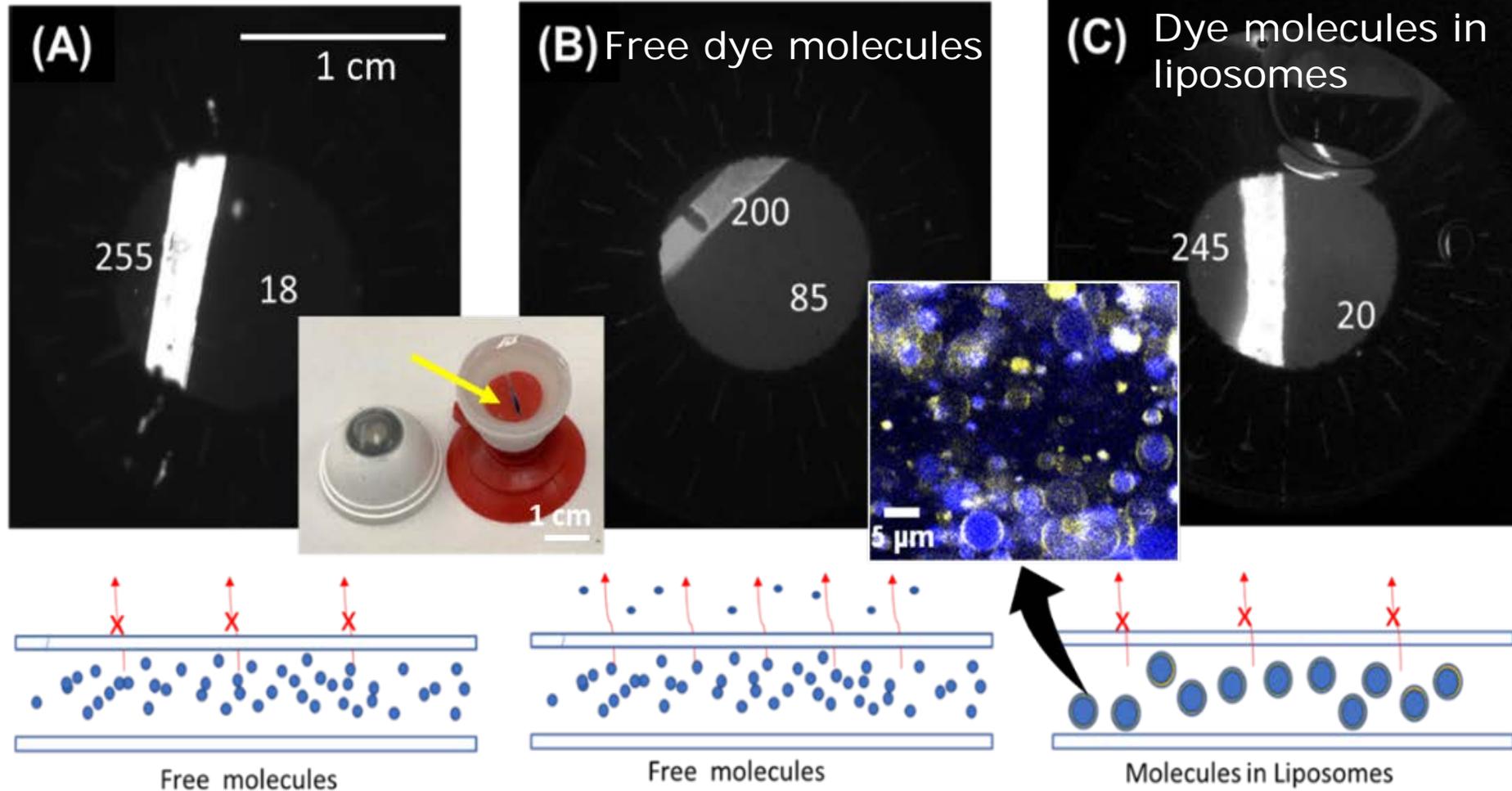
- With cholesterol liposomes : irreversible change in nano structure after laser irradiation: fluidic liposomes bi-layer
- Without cholesterol liposomes: No change in nano-structure: rigid liposomes bi-layer

Size-Exclusive Nanoporous Dose-Controllable Drug Implant

24 hr-passive release test

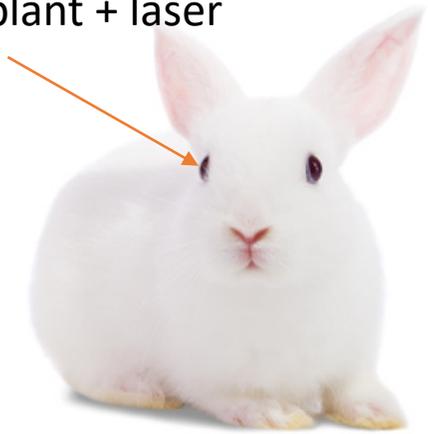
Free dye molecules in **non-porous** PLGA

size-exclusive nanoporous PLGA

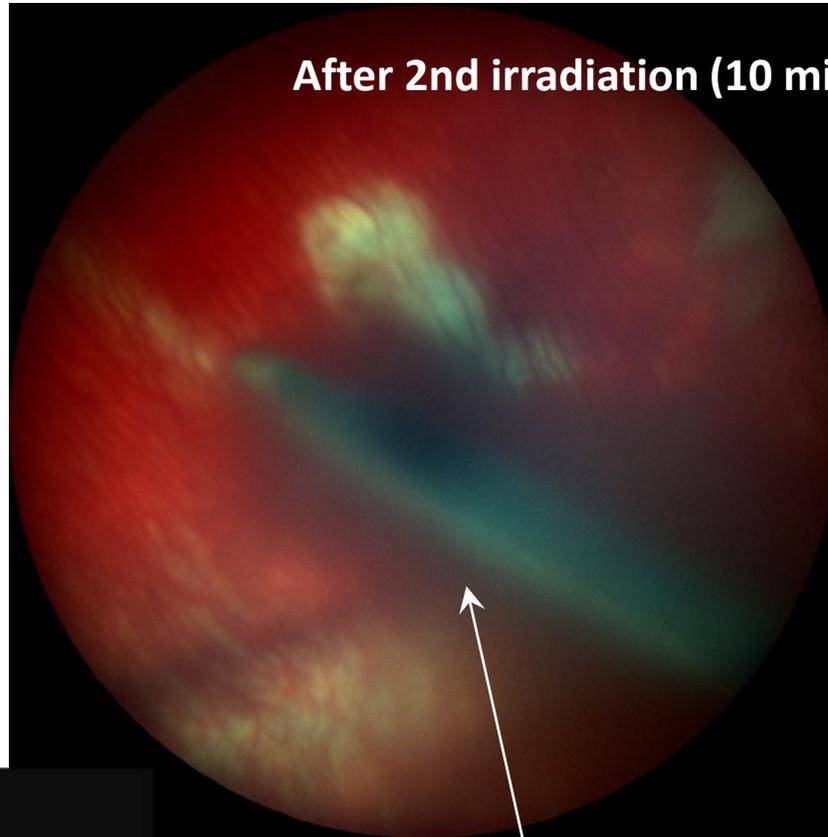


In vivo drug release by laser

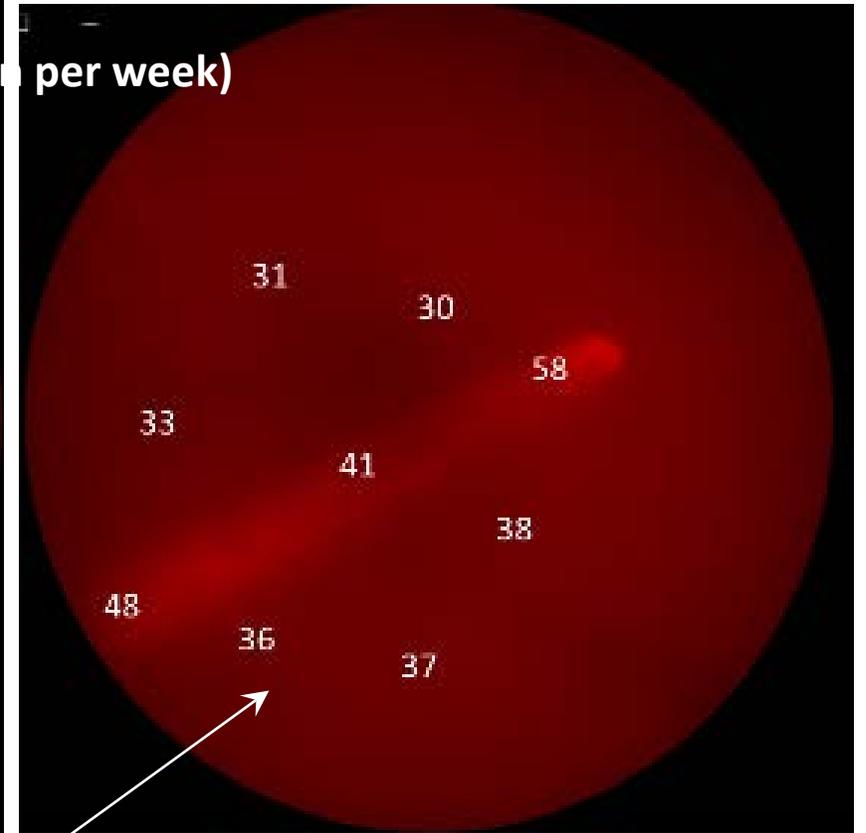
Implant + laser



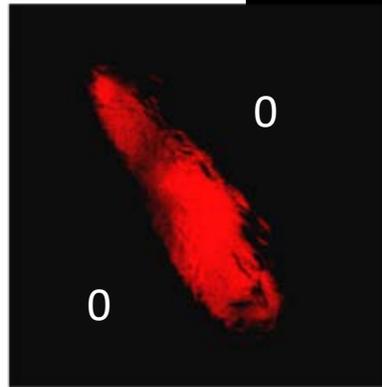
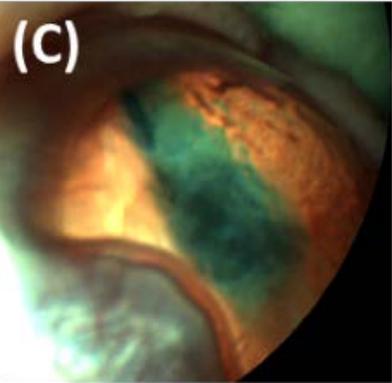
No laser



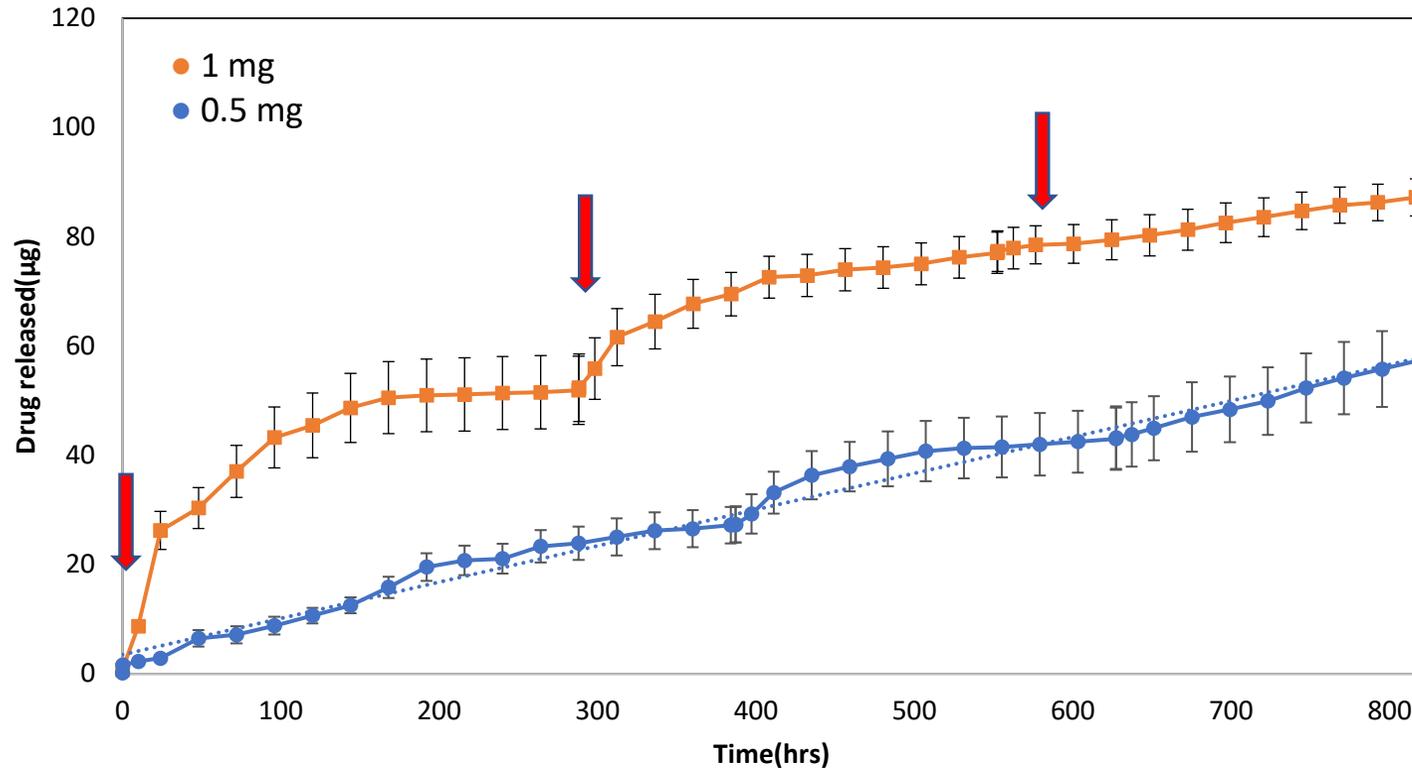
After 2nd irradiation (10 min per week)



Dye/drug released



Drug Release Kinetics of Our Implant

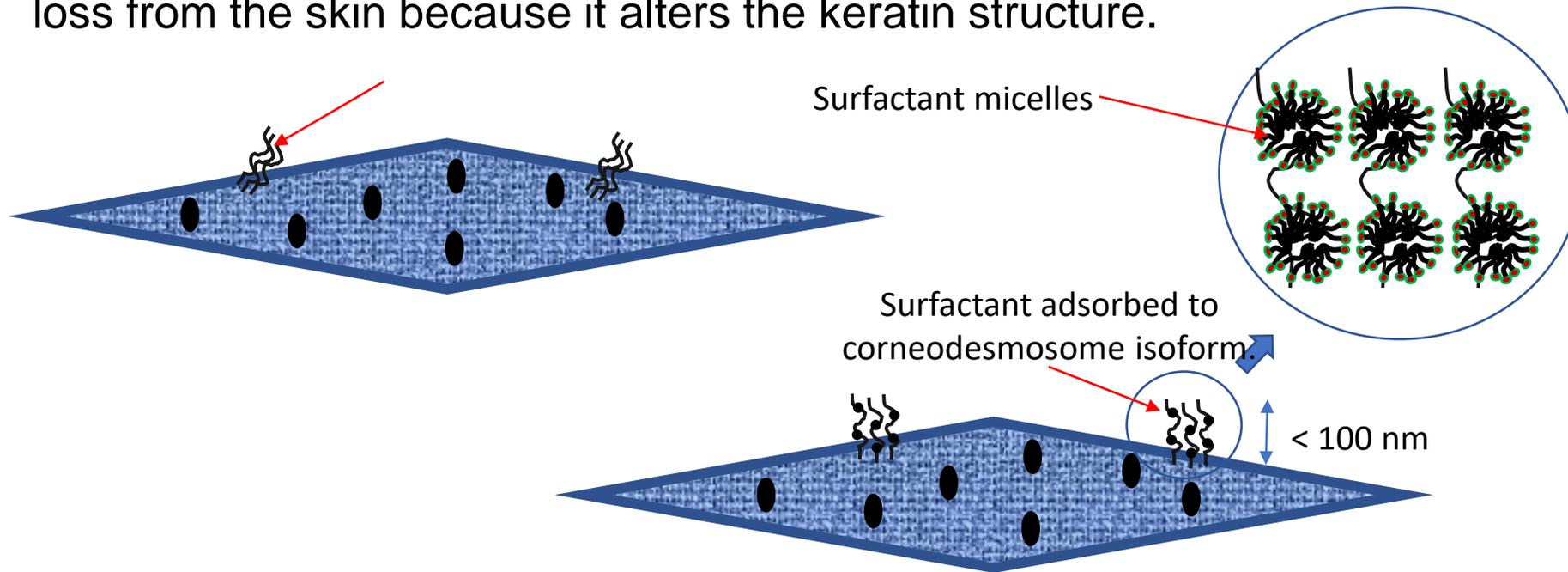


- 1 mg: first-order kinetics
- 0.5 mg: zero-order kinetics

- Improve the kinetics by using a different laser source and avoid excess heat affecting the surrounding temperature.

In vitro Skin Stratum Corneum Model

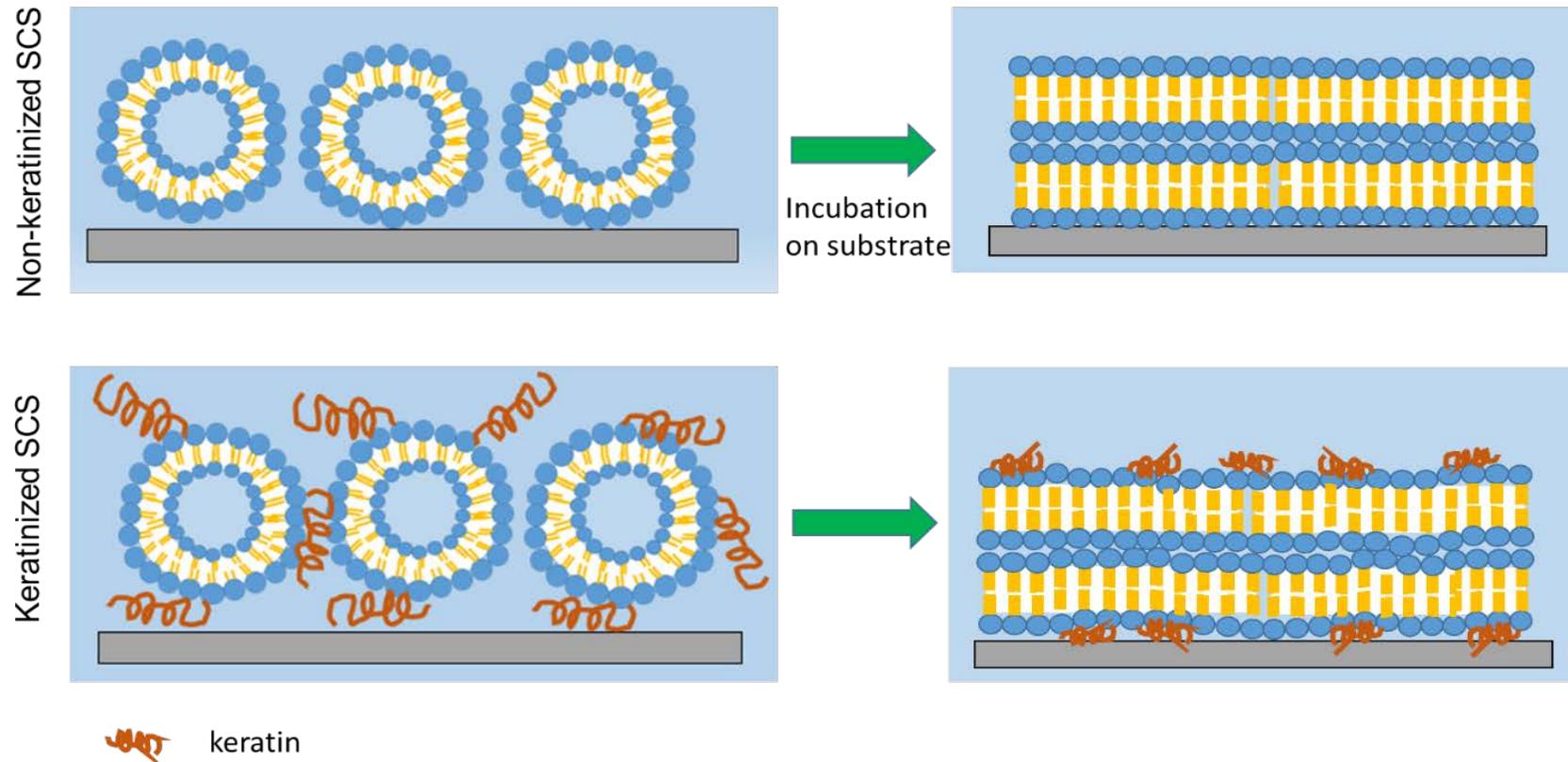
- After washing with cleansers which contain surfactants, our skin 'feels' hydration (or dehydration), or smoothness (or tightness).³
- The underlying mechanisms of action of various cosmetic chemicals at the molecular level are seldom clearly defined.
- We hypothesize that surfactant adsorbs on SC, especially keratin filaments, and accelerates water loss from the skin because it alters the keratin structure.



- It has been challenging to decouple the effect of keratin from the SC (lipid + keratin).

SCS liposomes and bilayer formation

- More than 50 kinds of lipid molecules are present in human stratum corneum.

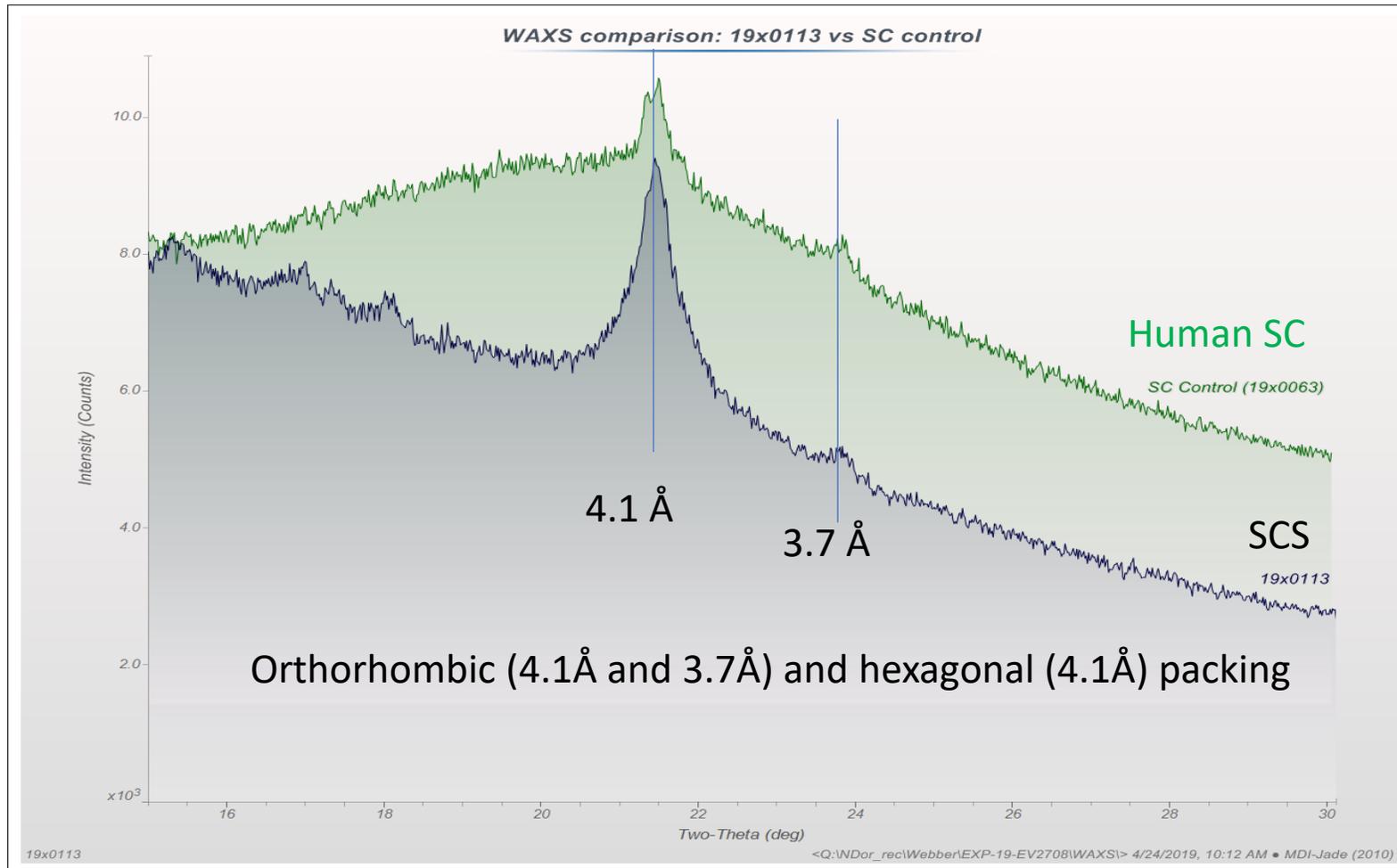


Dynamic Light Scattering data

Non-keratinized and keratinized SCS liposomes	keratinized SCS liposomes
93.7±1.5 nm	122.9±0.8 nm

Molecular Structure of SCS: X-ray Scattering Data

Lateral Packing: GIWAXS (Grazing-Incidence Wide-Angle X-ray Scattering)



SCS liposomes and bilayer formation

Enhanced dark field images



0 min



2 min

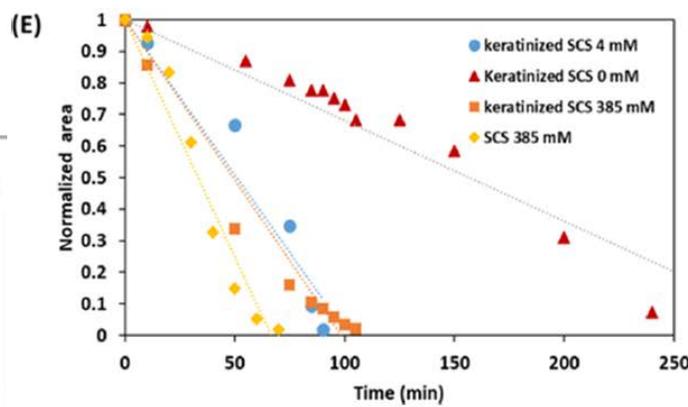
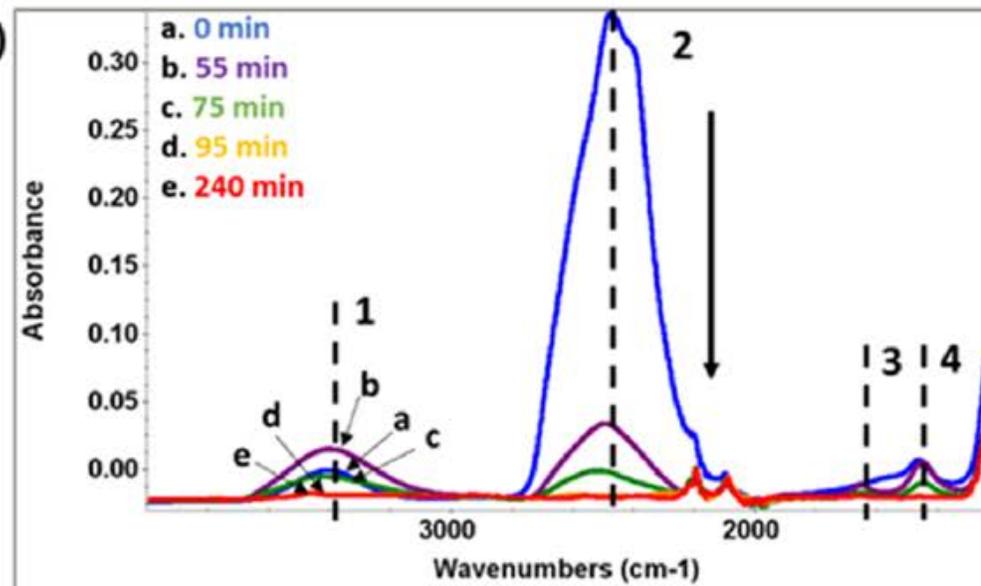
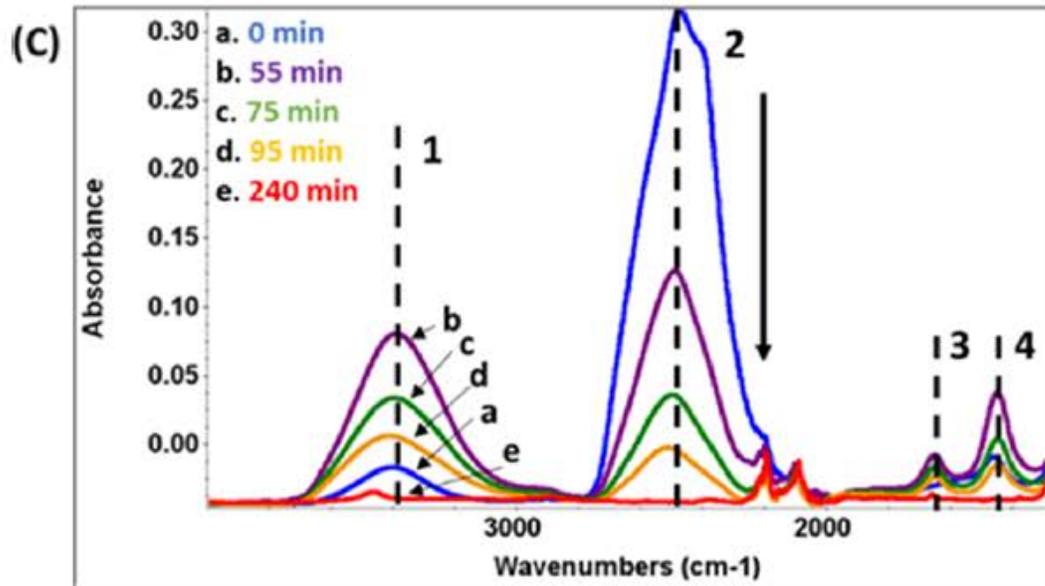
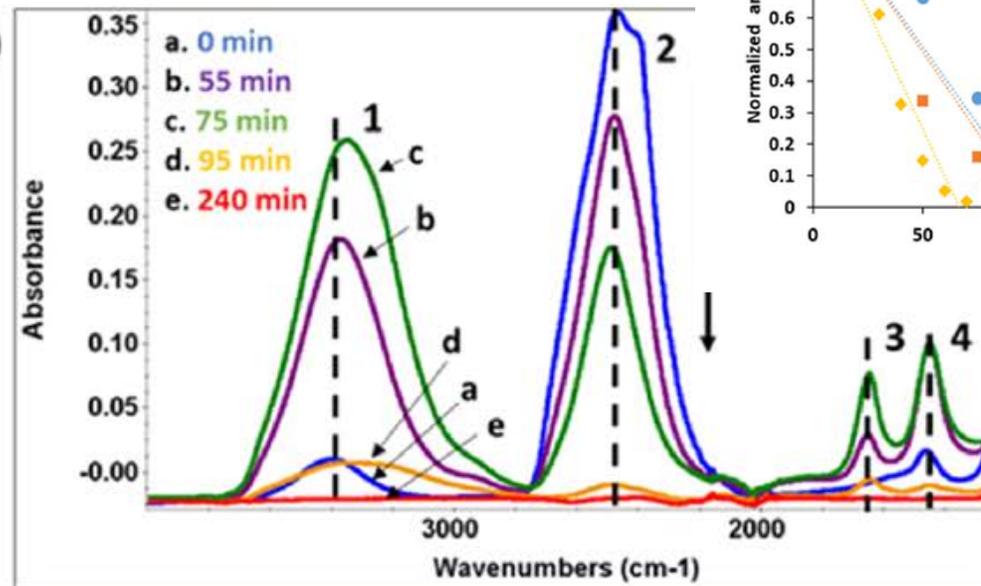
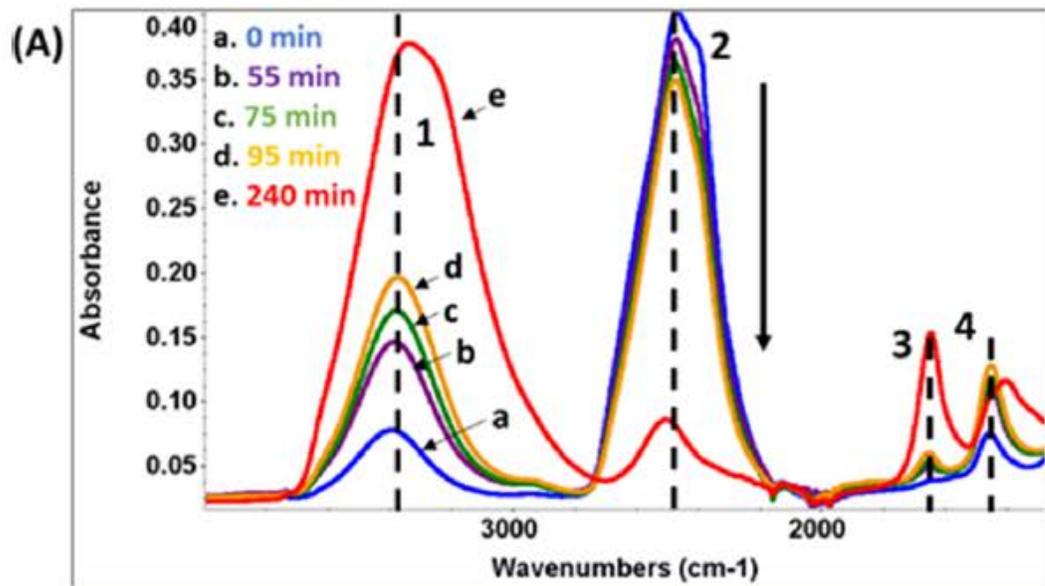


4 min

Thickness of SCS bilayer: *Ellipsometry data*

Non-keratinized and keratinized SCS liposomes	keratinized SCS liposomes
12.7 ± 0.8 nm	22.2 ± 3.6 nm

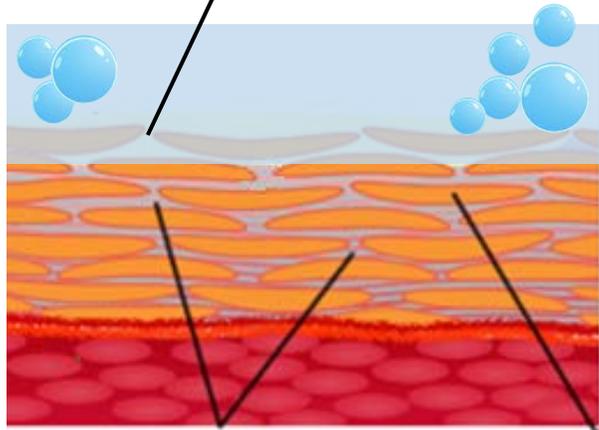
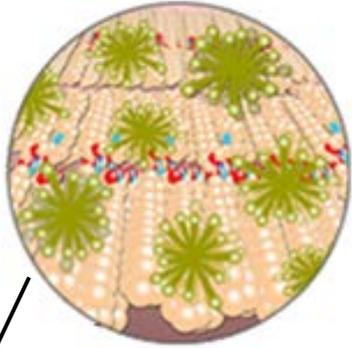
Dehydration Rate for the Short-term and Long-term



For the short-term, keratin accelerates evaporation, whereas for the long-term, keratin protect water from evaporating.

Summary

Skin-Product interactions



lipid lamellae

corneocyte

- Dehydration
- Penetration
- Deposition

Of surfactants and moisturizers on and into the skin at the molecular level.



Summary

- Keratin plays an important role on dehydration rate, both from the surface and the stratum corneum lipid layers, likely due to water binding sites in keratin coil structures.
- Surfactant accelerates water loss from the skin because it changes hydrophilicity/hydrophobicity.
- The SCS model can be used as a convenient tool to screen various chemicals.

