CARS microscopy for studies in skin physiology and pharmacology

Professor Jonathan Brewer[1], PhD Irina Iachina[1], MA Lomholt[1], Kim Nielsen[2], Morten Ebbesen[1]
[1]University of Southern Denmark, Odense, Denmark, [2]Leo Pharma, Ballerup, Denmark

The application of Coherent anti-Stokes Raman Scattering (CARS) microscopy in biomedical research represents an extension in our ability to study complex biological systems with unique resolution and specificity. This presentation highlights the use of CARS microscopy to explore various aspects of skin physiology and pharmacology, demonstrating the technique's versatility and its potential to extend our understanding of biological tissues and treatment efficacy.

Firstly, utilizing CARS microscopy enabled the direct observation of time-dependent, spatially resolved diffusion of water (D2O) within human skin tissue, unveiling significant variations in diffusion coefficients across different strata of the Stratum Corneum (SC). This heterogeneity challenges the prevailing notion of the SC as a monolithic barrier, instead positing it as a complex, layered defense mechanism. This study show CARS microscopy's ability to quantitatively measure diffusion coefficients at varying tissue depths and locations.

Further, the examination of dissolvable microneedles for transdermal drug delivery underlines CARS microscopy's unique ability to visualize penetration of the microneedles and follow their morphology within the skin. By providing detailed images of microneedle degradation and drug dispersion, CARS microscopy offers valuable insights into the mechanisms of drug release and absorption, supporting the development of more effective transdermal therapeutics.

Additionally, employing CARS microscopy in conjunction with a perspiring skin simulator to assess sunscreen substantivity offers a novel approach to studying the interaction between topical formulations and physiological processes like sweating. This application highlights the technique's potential to dynamically follow the redistribution of specific active ingredients in the sunscreen during perspiration. Thus, evaluate product performance under realistic conditions, informing the design of more resilient and effective sunscreens.

Overall, these studies exemplify the power of CARS microscopy to provide detailed, molecule-specific insights into complex molecular interactions in tissue.

Keywords:

CARS, Drug delivery, Micro needles

Reference:

les for transdermal drug delivery showing skin pentation and modified drug release. European Journal of Pharmaceutical Sciences. 2023;182.
2. Iachina I, Lomholt MA, Eriksen JH, Brewer JR. Multilayer diffusion modeling and coherent anti-Stokes Raman scattering microscopy for spatially resolved water diffusion measurements in human skin. Journal of Biophotonics. 2022;15(10).
3. Keshavarzi F, Østergaard Knudsen N, Brewer JR, Ebbesen MF, Mirmahdi Komjani N, Zajforoushan Moghaddam S, et al. In vitro skin model for characterization of sunscreen substantivity upon perspiration. International Journal of Cosmetic Science. 2021;43(3):359-71.