Multiphoton imaging of skin morphology, physiology and transport processes

M.S. Roberts[1], A.M. Homes[1], L.Sandiford[1], S. Mangion[1], I. Haridass[1,2], Y. Mohammed[2], V. Leite[2], W.Sanchez[2], J.E. Grice[2]

[1] The University of South Australia, School of Pharmacy and Medical Science, Adelaide, SA, 5001, [2] The University of Queensland, Diamantina Institute, Princess Alexandra Hospital, Brisbane, QLD, 4102, Australia
Corresponding Author m.roberts@uq.edu.au and URL: http://people.unisa.edu.au/Michael.Roberts

KEY WORDS: multiphoton, fluorescence lifetime imaging, pharmacokinetics

The United States Food & Drug Administration has recently made a call for non-invasive imaging of the skin using spectroscopy and imaging tomography to describe the levels of pharmaceuticals in the viable epidermis and upper dermis over time after topical application. Their hope is that non-invasive imaging of topical product absorption in volunteers may eventually support the development of an alternative, scientifically valid, cutaneous pharmacokinetics approach to efficiently evaluate different products from a regulatory perspective. Multimodal imaging with multiphoton microscopy, fluorescence lifetime imaging (FLIM), confocal reflectance and confocal Raman may meet that that call as they each enable the imaging of the skin morphology, active ingredients and excipients in the skin.

We describe here some of our recent experiences in characterizing skin morphology, physiology and transport processes in skin. We highlight the use of FLIM to describe the fate of zinc pyrithione (ZnPT), the primary active antifungal ingredient in most antidandruff shampoos. In particular, we examine the effective follicular delivery of ZnPT as hair follicles are deep skin structures that provide ideal microenvironments for yeast colonization.

A key finding was the ZnPT luminescent properties and a characteristic short average time-weighted lifetime of ZnPT. We demonstrated that ZnPT can be deposited up to a depth of 350 μm into follicles but that the extent of delivery was formulation dependent. We concluded that FLIM offers an opportunity to assess the topical delivery of therapeutically active solutes in cosmetics in a manner not previously possible. The results are especially relevant to all who have had dandruff, estimated to be 1 in 2 people at some stage in their life.[1,2]

Supported by an Australian National Health & Medical Research Council (NHMRC) grant

1. Elewski BE. 2005. J. Invest. Dermatol. Symp. Proc. 10:190-193.
2. Turner GA, Hoptroff M, Harding CR. 2012. Int. J. Cosmet. Sci. 34:298-306.