

# Optical Studies of Nanodiamond-Tissue Interaction: Skin Penetration and Localization

**Elena Perevedentseva**<sup>1,2,3</sup>, **Nsrein Ali**<sup>4</sup>, **Artashes Karmenyan**<sup>1,3</sup>, **Ilya Skovorodkin**<sup>4</sup>, **Renata Prunskaitė-Hyyryläinen**<sup>4</sup>, **Seppo Vainio**<sup>4,5</sup>, **Chia-Liang Cheng**<sup>1,\*</sup> and **Matti Kinnunen**<sup>3,\*</sup>

<sup>1</sup> Department of Physics, National Dong Hwa University, Hualien 97401, Taiwan; elena@gms.ndhu.edu.tw (E.P.); artashes@gms.ndhu.edu.tw (A.K.)

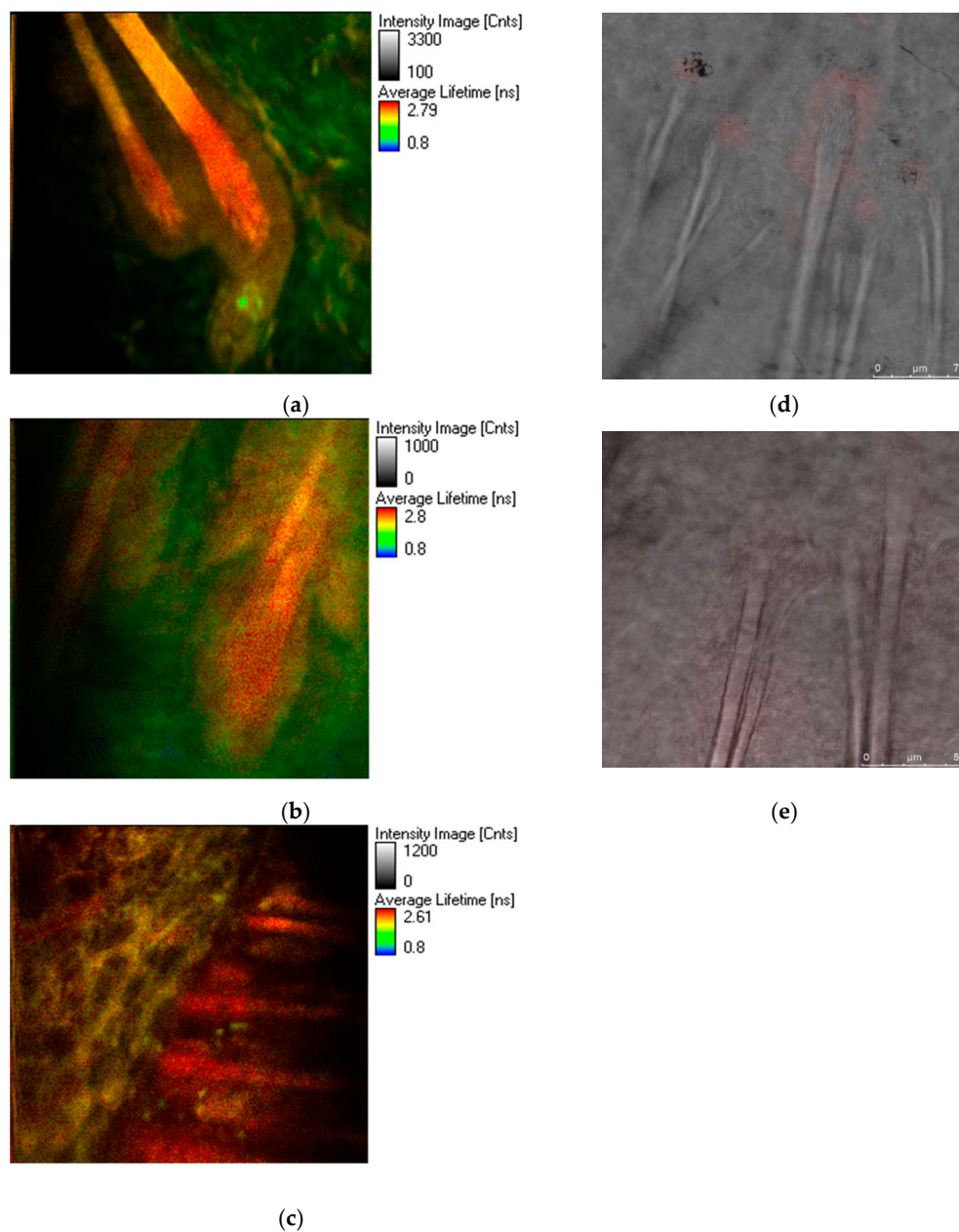
<sup>2</sup> P.N. Lebedev Physics Institute of Rus. Acad. Sci., Moscow 119991, Russia

<sup>3</sup> Faculty of Information Technology and Electrical Engineering, University of Oulu, Oulu 90570, Finland

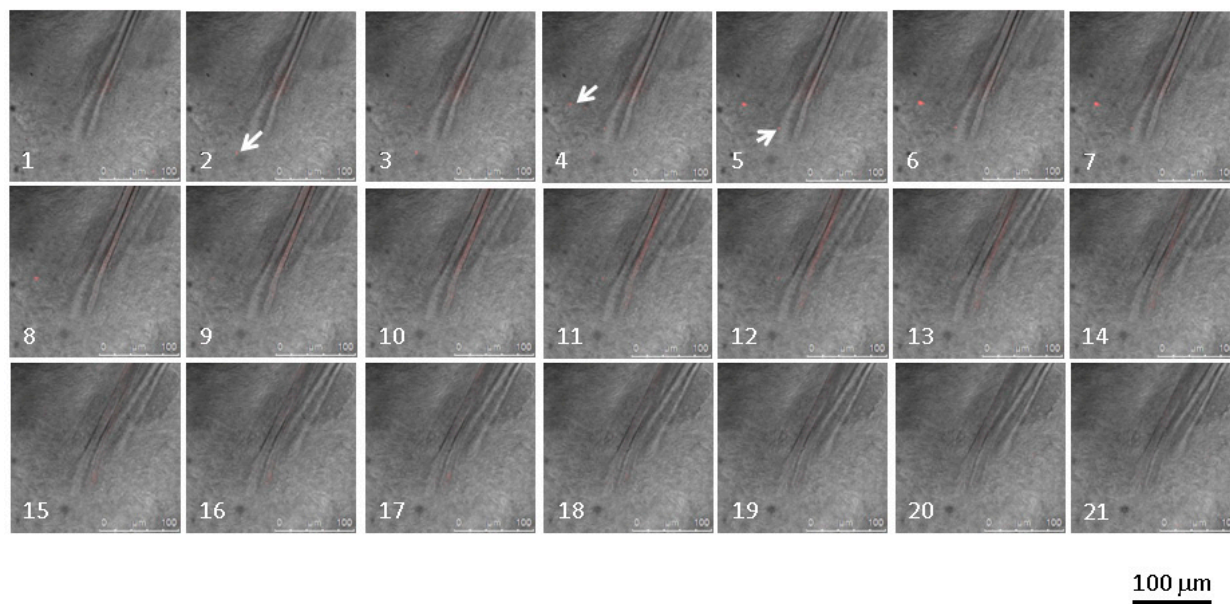
<sup>4</sup> Faculty of Biochemistry and Molecular Medicine, Biocenter Oulu, University of Oulu, Oulu 90220, Finland; nsrein.ali@oulu.fi (N.A.); ilya.skovorodkin@oulu.fi (I.S.); renata.prunskaitė@oulu.fi (R.P.H.); seppo.vainio@oulu.fi (S.V.)

<sup>5</sup> Borealis Biobank of Northern Finland, University of Oulu, Oulu University Hospital, Oulu 90220, Finland

\* Correspondence: mattitapanikinnunen@hotmail.com (M.K.); clcheng@gms.ndhu.edu.tw (C.L.C.); Tel.: +358-40-688-6156 (M.K.); Tel.: +886-3-890-3696 (C.L.C.)



**Figure 1.** An FLIM of skin autofluorescence. The fluorescence is due to a two-photon excitation with an 800 nm femtosecond laser, and the signal was detected in the spectral range of 450-650 nm. The FLIM reveals the hair follicle structure (with stem cells in the dermal papilla niche (red arrow; **(a)**), sebaceous glandes (cyan arrows; **(b)**); as well as the different skin layers (**(c)**). Analogous structures can be distinguished in bright field images (**(d)** and **(e)**).



**Figure 2.** Example of Z-scans of 100ND-treated skin (images from 1 to 21 were obtained with a step on the z-axis of 0.65 μm). The signal attributed to NDs is marked by white arrows when seen for the first time.