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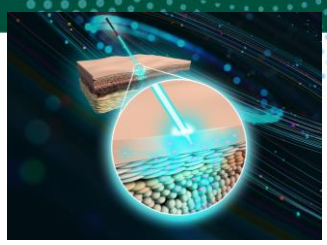


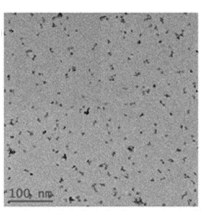
Sensing the penetration of nanodiamond along different skin layers according to their optical properties

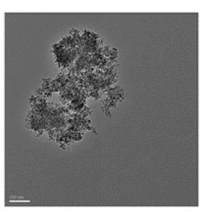
Channa Shapira[1,3], Daniel Itshak[2,3], Hamootal Duadi[1,3] and Dror Fixler[1,3,*]

[1] Faculty of Engineering, Bar Ilan University, Ramat Gan 5290002, Israel
[2]Department of Chemistry, Bar Ilan University, Ramat Gan 5290002, Israel
[3]The Institute of Nanotechnology and Advanced Materials, Bar Ilan University, Ramat Gan 5290002, Israel

INTRODUCTION

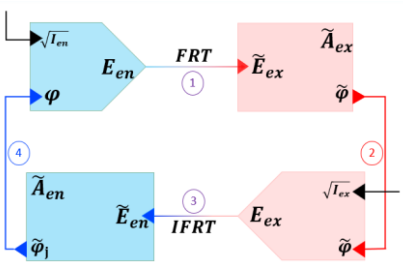
- Human tissues are highly nonhomogeneous scattering and absorbing media, and their optical properties are wavelength dependent.
- Carbon-based nanoparticles (NPs) are widely used in nanotechnology. They can act as a drug reservoir with a tuneable release. To be able to cross the skin barrier, the NP's diameter must be smaller than 100nm. Therefore, non-invasive detection of NP and profiling its permeation along the skin depth (>100μm in human skin) are challenging tasks.
- Nanodiamond (ND) are carbon-based NPs. They can be coated by an anti aggregation Cerium coating. With this coating the ND is anti-oxidant, which makes it appropriate as drug delivers.



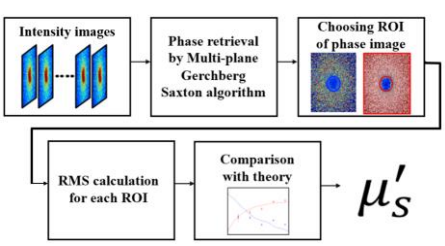


METHODS

- The multiplane version of the Gerchberg-Saxton algorithm is used to reconstruct the phase of the diffusion reflection.

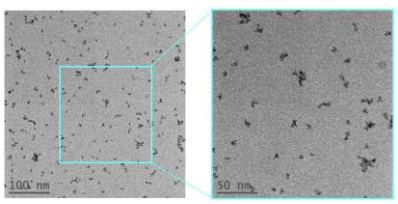


- The IMOPE technique: the iterative multiplane optical properties extraction technique is used to extract μ_s' of turbid media, including tissues[1-3].



MATERIALS

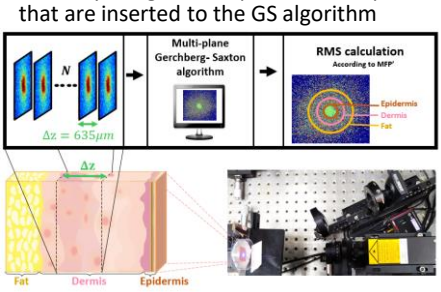
- Cerium coated ND:



- Liquid and solid optical phantoms containing varying ND concentration.
- Porcine skin samples, to be measured before and 3h after applying the ND.

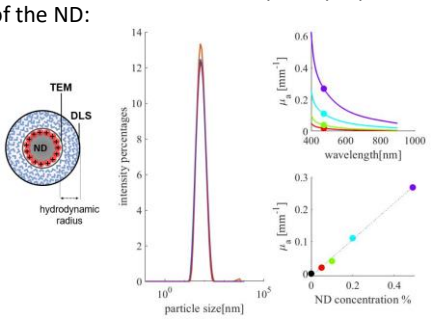
OPTICAL SETUP

- The optical setup contains a laser source, a set of two perpendicular linear polarizers, a camera and a lens.
- The optical setup is used to capture intensity images at sequential focal planes that are inserted to the GS algorithm

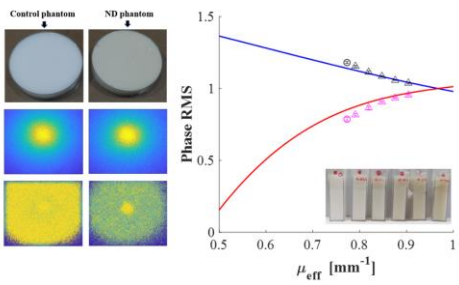


RESULTS

First, we characterized the optical properties of the ND:

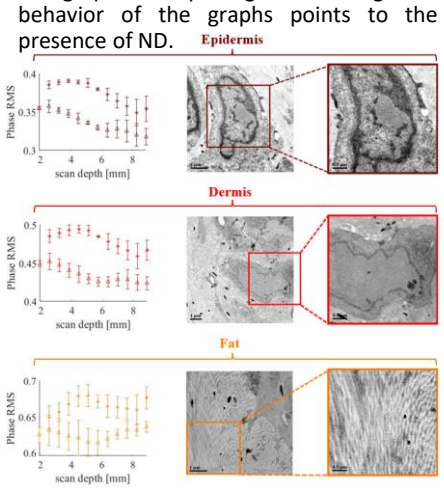


We saw that the presence of ND affects the phase image, and that for known μ_s' the IMOPE can detect the absorption



We saw that the IMOPE can detect the ND within the skin. These results were corroborated by TEM images.

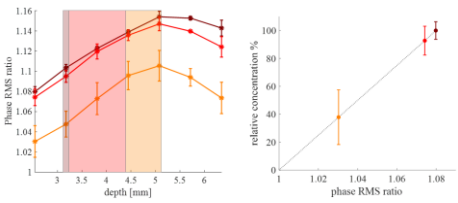
- The graphs are opening then closing. This behavior of the graphs points to the presence of ND.



For the graphs of the epidermis, dermis, and fat layers a T-test results in p values smaller than $10^{-4}, 10^{-3}$ and 10^{-2} respectively;
Meaning that ND presence within the epidermis and dermis is highly significant, and within the fat- significant.

DISCUSSION

- Presenting the phase RMS ratio on a graph may reveal the position of the sample along the scanning axis.
- Relative NDs concentration at each layer was calculated from the surface phase RMS ratio values.



CONCLUSIONS

- The IMOPE technique can sense absorbing NP with negligible scattering in turbid conditions by analyzing the reflectance phase.
- The IMOPE technique can sense concentration variations in a multilayer structured tissue, noninvasively.

REFRENCES

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