LABEL-FREE OPTICAL DETECTION OF CARBON NANOPARTICLES IN BIOMEDICAL SETTING

Christian Steuwe[1], Hannelore Bové[1,2], Marcel Ameloot[2], Maarten Roeffaers[1*]
[1]Department of Microbial and Molecular Systems, KU Leuven, Belgium
[2]Biomedical Research Institute, Hasselt University, Belgium
E-mail: maarten.roeffaers@kuleuven.be

KEY WORDS: label-free imaging, pico- and femtosecond pulsed illumination, white light generation, pump-probe microscopy, carbon nanoparticles

While adverse health effects of particulate matter exposure are a generally accepted concern, locating and tracking these nanometer sized particles is not straightforward. Measurements in polluted air such as absorption photometry and laser induced incandescence (LII) [1,2] have so far been used to determine particle concentrations; alternatively labeling methods [3,4] have been applied in epidemiological and toxicology research such as the technetium-99-m radionuclide marker.

In our work we have developed two novel contrast mechanisms that allow direct, label-free optical imaging to detect carbon nanoparticles in fluids and cells (Figure 1).[5,6] The first technique is non-incandescence related white-light generation by illumination with femtosecond pulsed near-infrared light (150 fs, 80 MHz) of dry and suspended carbon black particles (CB), a widely used model compound for soot.[5] Four different, strongly absorbing CB species with diameters ranging from 13 to 500 nm have been scrutinized, all showing similar detection possibilities. Consequently, the described white-light emission allows optical detection and unequivocal localization of CB particles in fluids and in cellular environments. The experiments are performed on a typical multiphoton laser-scanning microscopy platform, a system commonly available in research laboratories. In the second technique,[6] carbon nanoparticulates are detected using photothermal pump-probe microscopy, which directly probes the strong light absorption. Two different laser pulses with a repetition frequency of 80 MHz and 7 ps duration were employed. Pump pulses fixed at 1064 nm and probe pulses (blue) of 800 nm up to 950 nm were tested. The method is evaluated on the detection of carbonaceous particles in cells and human urine, and the versatility is shown by microfluidic analysis of CB-spiked urine samples.

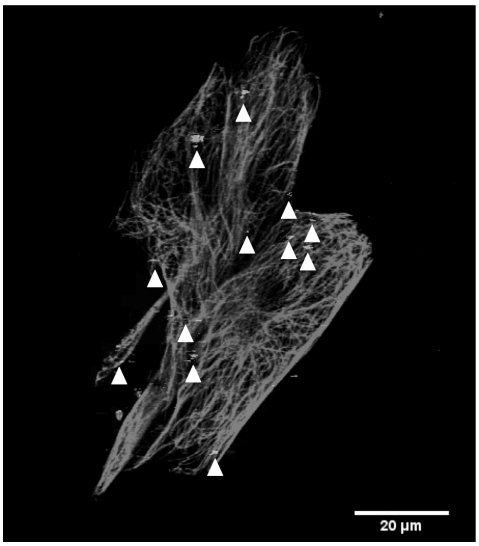

Fig. 1 Optical imaging of CB nanoparticles (arrow heads) in human lung fibroblasts .

REFERENCES

[1] J.C. Chow *et al.*, Atmos. Res. 2009, 93(4), 874-887.
[2] C. Schulz *et al.*, Appl. Phys. B 2006, 83(3), 333-354.
[3] A. Nemmar *et al.*, Circulation 2002**,** 105(4), 411-414.
[4] H. Kong, *et al.*, Int. J. Mol. Sci. 2013, 14, (11), 22529-22543.
[5] H. Bové, C. Steuwe *et al.*, Nano Lett. 2016, 16(5), 3173-3178.
[6] C. Steuwe, H. Bové *et al.*, J. Biophotonics. Just accepted.