Detection and quantification of combustion-derived particles in aqueous media: towards the development of a diagnostic biomedical assay

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Abstract:

The detection and quantification of combustion-derived particles (CDPs) such as carbonaceous particulate matter (PM) in biological samples is important to understand their toxicity. Different techniques, such as absorption photometry and laser-induced incandescence, used for measuring CDP concentrations in gaseous environments, cannot be employed for the label-free detection of CDPs in biological samples. Hence, there is a need for the development of diagnostic tools for selective and label-free detection of CDPs to evaluate the exposure at the level of individual persons. Recently, we have shown that CDPs could be detected in biological samples based on non-incandescence-related white light (WL) emission under illumination with femtosecond (fs) pulsed near-infrared (NIR) lasers using a multiphoton microscope.[1-4]

In this work, we study the effects of stirring and concentrations of suspensions on the label-free detection and quantification of particles under illumination with fs pulsed NIR laser. We performed measurements on CDP suspensions with different concentrations in ultrapure water and buffered medium as exemplary conditions for wet biomedical samples. We observe that the number of detected particles increases linearly with the concentration of the suspension. This opens the ways for label-free quantification of CDPs in liquid biopsies.

In addition to CDPs, ambient PM also includes other types of nanoparticles such as silica and metal oxides. This increases the likelihood of interference from other common nanoparticles in the detection of CDPs based on WL emission. In our recent study[5], we could observe that the WL emitted by the CDPs under illumination with fs pulsed NIR lasers is unique and was not observed for other common nanoparticles. Hence, interference from other types of common nanoparticles based on WL emission is not expected when detecting CDPs in aqueous media.

We believe that these results are a step towards the development of diagnostic biomedical assays for direct and label-free detection of CDPs at the level of individual persons.

Keywords: particulate matter, combustion-derived particles, nanoparticles, femtosecond pulsed laser, white light emission

References

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