Rapid, Noninvasive, Fluorescence-Based Detection for Elevated Levels of Nitric Oxide in Exhaled Breath, as a Marker for Hazardous PM2.5 Exposure

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There is a clear correlation between prolonged exposure to ambient fine particulate matter (PM2.5) and development of lethal disease. Today, there exists no personalized, quantifiable measure to gauge an individual's exposure to PM2.5. Lung airway constriction from PM2.5 exposure leads to the production of elevated levels of Nitric Oxide to fight inflammation. Accordingly, excess concentration of NO (40+ ppb in adults, 25+ ppb in children) can be a viable breath biomarker for the indication of PM2.5-induced lung inflammation. Herein, an inexpensive, portable, rapid, and temperature-independent breath detection kit for PM2.5 exposure was developed, based on smartphone-detection of NO-induced luminescence of DAF-2 (diaminofluorescein-2). Upon exposure to NO, DAF-2 is converted to highly luminescent DAF-2T (exc/em 485/530nm), acting as a positive indicator for elevated breath NO levels due to PM2.5 exposure. To begin, 8µl of 50ug/ml DAF-2 was embedded onto a filter-paper-based detection card, which was found to be stable when stored at room temperature (via repeated FTIR-analyses). A linear relationship between 60ml of 0-1000ppb NO breath concentrations and DAF-2T sensor illumination was established, first via surface-luminescence spectroscopy, and later with Smartphone images, taken with 490/560nm bandpass filters, for the flash/camera, respectively. A newly created Smartphone application converts the detection card images to green-color values, with an algorithm determining the NO-breath concentration down to 10ppb. These results are time-stamped and shared, along with GPS coordinates, to build color-coded, live, and geographic PM2.5 exposure trends, at a per-test cost of ~$5.

Awards Won:
Fourth Award of $500