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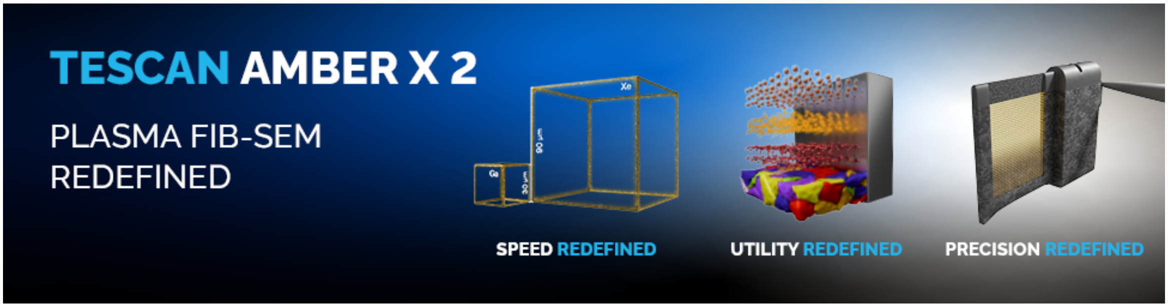

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Meeting-report

Direct-On-Filter Analysis of Airborne Engineered Nanomaterials using Correlative Microscopy and Spectroscopy

Jianqi Wang[1,2], Chen Wang[1,*], Kabir Rishi[1], and Vasileia Vogiazi[1]

[1]Health Effects Laboratory Division (HELD), National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC), Cincinnati, OH, United States
[2]Chemical & Materials Engineering, University of Cincinnati, Cincinnati, OH, United States

*Corresponding author: xli7@cdc.gov

Engineered nanomaterials (ENMs) are used in a wide variety of applications especially high-performance products for aerospace, automobiles, sports equipment, and construction. The toxicity and adverse health effects of ENMs are likely a multifaceted function of their particle physical, chemical, and surface properties. Specific morphologies and spectroscopic features of airborne ENMs have been used as fingerprints for identifying materials and quantifying their exposures in occupational settings [1, 2]. Scanning Electron microscopy (SEM) is known for its capabilities for conducting size-specific measurements in micro and nanoscales and elemental determination by using Energy Dispersive Spectroscopy (EDS). With Raman becoming an important analytical tool for aerosol characterization [1] and recent development of Optical Photothermal Infrared (O-PTIR) spectroscopy [3], there's a growing need to combine these structural and micro-molecular techniques with conventional surface imaging and elemental analysis performed by using SEM-EDS. Images and spectroscopic information obtained from different scales across multiple instruments are often very complementary for correlative measurements of the same regions of interest (ROI). However, achieving high accuracy and simplicity of co-localized observation across different instruments has been a key challenge.

There have been reports of using machine-readable position scales to achieve in-plane positioning for microscopes [4, 5]. In this study, commercially available NanoGPS tags [4, 5] were used for coordinate transfer in correlative microscopy. The goal is to develop a direct-on-filter correlative microscopy method that can selectively and specifically analyze a wide range of ENMs and other emerging materials in workplace atmospheres. The study investigates preparation methods for filter-based and bulk samples (see Fig. 1) and analysis methodologies using SEM-EDS, Raman, and O-PTIR, to quantify airborne concentration of target analytes. The method involves collecting aerosols on a compatible media, followed by sequential analysis of the collected particles using multiple spectroscopy and microscopy techniques.

We have presented a workflow for analyzing field and bulk samples collected in workplaces (see Fig.2). The workflow involves the following steps: 1) collect the samples on compatible media, 2) position the samples in the instrument, 3) define and relocate sample ROIs, 4) collect and process data, and 5) quantify the analyte. The proposed method focuses on the quantification of aerosols by combining physical and chemical hyperspectral imaging of collected particles. The validated workflow and tools from the correlative studies can be adopted for analyzing various nanoscale aerosols such as graphene, nanoclay, and other emerging materials in workplace environment [6].

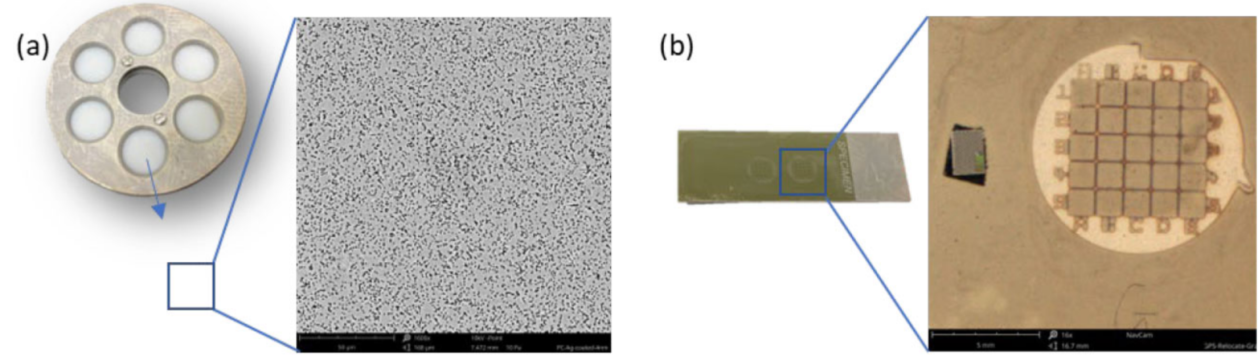

Fig. 1. Illustration of two proposed preparation methods for (a) filter-based and (b) bulk samples.

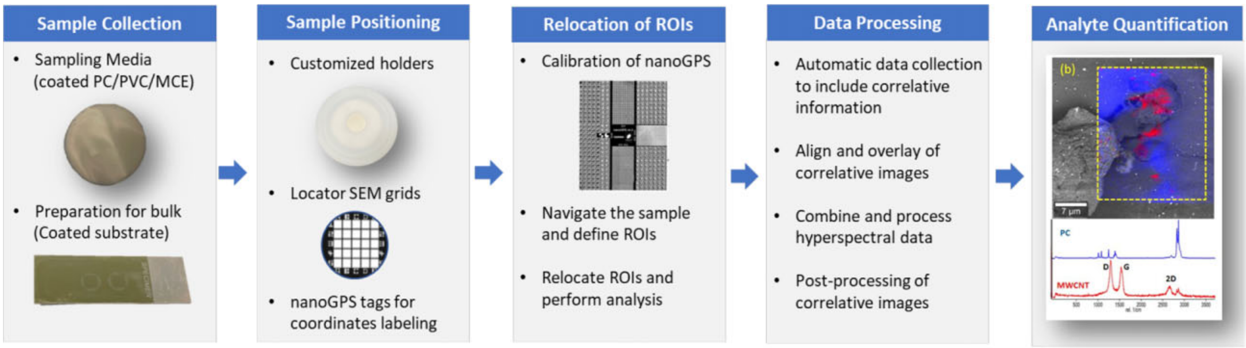

Fig. 2. The workflow of correlative microscopy method for airborne samples.

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6. Disclaimer: The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention