and their attachment on the equipment chambers and parts during the ongoing semiconductor process, may result in workers' exposure during maintenance. Little is known about detailed physicochemical characterization of powder by-products generated from semiconductor processes. The aim of this study is to identify the physicochemical properties such as chemical composition, size, shape and crystal structure of powder by-products generated from a metallization process and its 1st scrubber in the semiconductor industry.

Methods: This study was conducted in three 200 mm semiconductor wafer fabrication facilities. The powder samples were collected from their inner chamber during maintenance of W-plug process equipment using tungsten hexafluoride (WF_6) and silane (SiH_4) as precursor materials and its 1st scrubber. The chemical composition, size and shape of the powder particles were determined by field emission scanning electron microscopy (SEM) and transmission electron microscopy (TEM) equipped with energy dispersive spectroscopy (EDS), respectively. The crystal structure of the powders was analyzed by X-ray diffraction (XRD).

Results: From the SEM-EDS and TEM-EDS analyses, the O and W were mainly detected which indicates the powder by-products are tungsten trioxide (WO_3), whereas Al, F and Ti were detected as low peaks. The powder particles are spherical and nearly spherical. The particle size collected from process equipment and its 1st scrubber showed 10-20 nm (aggregates: 55-90 nm) and 16-20 nm (aggregates: 80-120 nm) as primary particles, respectively. The XRD patterns of the yellow powder by-products exhibit five peaks at 23.80˚, 33.90˚, 41.74˚, 48.86˚ and 54.78˚, which correspond to the (200), (220), (222), (400) planes of a cubic WO_3.

Conclusions: This study should provide useful information for the development of alternative strategies to improve the work environment and workers' health.

SR-401-13

Experimental Study of Surgical Smoke and Its Control

T. Lee, J. Soo, R. LeBouf, D. Burns, and M. Harper, CDC/NIOSH, Morgantown, WV; D. Novak, CDC/NIOSH, Pittsburgh, PA; J. Bowers, Ruby Memorial Hospital, Morgantown, WV

Objective: To evaluate airborne particulates and volatile organic compounds (VOCs) from surgical smoke in an experimental settings when the local exhaust ventilation (LEV) system is present or absent.

Methods: Airborne particles and VOCs were collected for 45 minutes in four different experimental settings: 1) background (without any activity), 2) smoke generation without LEV utilization, 3) smoke generation with LEV control (wall irrigation suction unit with an in-line ultra-low penetration air (ULPA) filter positioned between the wall suction and suction canisters), and 4) smoke generation with LEV control (smoke evacuation system (PlumeSafe®Turbo) installed a four-stages filter including charcoal and ULPA filters). Surgical smoke was generated from excised human tissues in unoccupied operating rooms using an electrocautery surgical device for 15 minutes. Flow rate of both LEVs was approximately 35 l min^{-1} (normal setting at the hospital) and suction was maintained within 2 inches of generation point. A total of 4 experiments were carried out. Particle number and mass concentrations were measured in real time with direct reading instruments including a Condensation Particle Counter (CPC), a DustTrak, a Scanning Mobility Particle Sizer (SMPS), an Aerodynamic Particle Sizer (APS) and a BioTrak. VOCs from the surgical smoke were collected using evacuated canisters both area and personal samples (from experimental personnel) following NIOSH draft canister method for VOCs in air. The canister samples were analyzed using a pre-concentrator and gas chromatography-mass spectrometry system.

Results: The average particle number concentrations of background, without LEV, wall suction and smoke evacuation system measured with the CPC were 300, 9000, 2300 and 1500 particles cm^{-3}, respectively. The average particle mass concentrations of background, without LEV, wall suction and smoke evacuation system measured with the DustTrak were 3, 24, 8 and 3 μg m^{-3}, respectively. Count median particle diameters from the SMPS measurements were found at 84 nm (background), 90 nm (without LEV), 81 nm (wall suction unit) and 29 nm (smoke evacuation system). Particle number concentration from the SMPS were close to the concentrations from the CPC in all experimental settings. Particle number concentration in particle size > 0.5 μm including viable particles were not large (< 200 cm^{-3}) in all experimental settings. Ethanol and isopropyl alcohol were dominant VOCs from all canister samples. Acetaldehyde, acetone, acetonitrile, benzene, hexane, styrene and toluene were detected in grab samples but their concentrations were in low range (< 100 ppb).

Conclusions: Utilization of the LEVs for surgical smoke control can reduce possible exposure to healthcare workers in operating rooms but airborne ultrafine particles still remain.

PO101

Assessments of Residential and Workplace Environmental Microbiology Exposure

Monday, May 23, 2016, 10:30 AM - 12:30 PM

CS-101-01

Exposure of Residential Occupants to In-Home Sewage

H. Burge, EMLab PK, San Bruno, CA

Situation/Problem: In healthy people, gut microbial populations are formed of nonpathogenic microbes that are necessary for the maintenance of a healthy digestive system. These and any ongoing disease organisms will be in the sewage. In general, gastrointestinal organisms within residences are shared by hand to mouth transfer, not from sewage. Exposure to gut organisms occurs when using the toilet, and especially when flushing. Gastrointestinal pathogens are shared within families in this way as well. Sewage spills include toilet overflows during flushing, and backup of sewage from a blockage outside the home. In single family residences the sewage from both of these events includes only those organisms that were present in the occupants and visitors and thus are likely to include organisms to which the occupants have already been exposed. A backup from a main sewer line exiting a multifamily unit will contain organisms from all of the occupants in the building. These spills are likely to contain

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