

Exponent®
Engineering & Scientific Consulting

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Professional Profile

Dr. Dilpreet Singh is an environmental engineer and health scientist who specializes in the design and development of lab-based platforms and approaches for assessing lifecycle exposures to engineered nanomaterials and incidental nanoparticles in occupational, consumer product use and environmental settings and associated human health risks. In his doctoral and postdoctoral research, Dr. Singh performed extensive physicochemical, morphological and toxicological characterization of engineered nanomaterial exposures from nano-enabled consumer and industrial products such as thermoplastic polymers, paints, coatings and building insulation materials across different relevant lifecycle scenarios such as sanding (mechanical degradation), accelerated UV aging (environmental weathering) and end-of-life scenarios such as waste incineration, accidental building fires and open waste burning. Dr. Singh is also a part-time instructor at the Harvard T.H. Chan School of Public Health where he instructs the “New Developments in Nanotechnology” module of the annual executive course “Comprehensive Industrial Hygiene: The Application of Basic Principles” attended by environmental health and safety professionals.

Dr. Singh has conducted numerous studies involving exposure characterization and toxicological evaluation of incidental and environmental nanoparticles such as those generated from toner-based photocopiers and laser printers, vaping of electronic cigarette devices with different e-liquids and operational voltages, and burning of hardwoods and softwoods under different combustion conditions in wood stoves and wildfires. Most recently, Dr. Singh’s research focused on the synthesis and characterization of model micro-nano-plastic particles produced from different environmentally relevant degradation scenarios such as cryo-milling (simulating mechanical fragmentation), accelerated UV aging (simulating outdoor weathering) and incineration (simulating thermal decomposition), followed by investigation of their interactions with environmental co-contaminants such as heavy metals, pesticides and endocrine disrupting chemicals and assessment of potential gastrointestinal and systemic toxicological effects arising from the ingestion of such micro-nano-plastics in food and drinking water.

In recent years, Dr. Singh has also applied his interdisciplinary expertise in several COVID-19 related research projects, including assessment of particle filtration efficacy of novel fabric materials for face mask applications, evaluation and characterization of droplet/aerosol production by children undergoing spirometry testing and performing different classroom activities under masked/unmasked conditions, and investigation of the inactivation efficiency of potential UV and visible light intervention technologies against SARS-CoV-2 on surfaces and in air under normal room conditions.

Dr. Singh has demonstrated expertise in a variety of real-time monitoring instrumentation for aerosols and gaseous pollutants (SMPS, CPC, APS, P-Trak, DustTrak, Q-Trak, combustion analyzers, VOC monitors) and time-integrated size-fractionating particulate matter (PM) sampling methods (cascade impactors, bioaerosol samplers), which are commonly employed in onsite industrial hygiene evaluations. He is thoroughly trained in a wide range of state-of-the-art techniques for physicochemical and morphological characterization of nanomaterials including electron microscopy (SEM/EDX, TEM), spectroscopic methods (XRD, XPS, XRF, TGA-FTIR), surface area/porosity measurements (BET), and colloidal particle

analysis (DLS, MALS). Dr. Singh is experienced in analyzing and interpreting quantitative chemical data from a variety of analytical instrumentation such as ICP-MS, OC/EC, NMR, LC-MS and GC-MS.

During his doctoral study, Dr. Singh received the New Investigator Award presented jointly by the U.S. National Nanotechnology Initiative (NNI) and the Consumer Product Safety Commission (CPSC) for his work on investigating environmental health implications during the end-of-life of nano-enabled thermoplastics. Dr. Singh holds an Sc.D. in Environmental Health from Harvard University with specialization in bioengineering, exposure assessment and toxicology, an M.S. in Environmental Engineering from the University of Southern California (USC) with a major in water and wastewater treatment, and a B.Tech. in Civil Engineering from the Indian Institute of Technology (IIT), New Delhi.

Academic Credentials & Professional Honors

Ph.D., Environmental Health, Harvard T.H. Chan School of Public Health, 2018

M.S., Environmental Engineering, University of Southern California, 2013

B.Tech., Civil Engineering, Indian Institute of Technology, 2011

Travel Award, QEEN II Workshop (Quantifying Exposure to Engineered Nanomaterials from Manufactured Products), U.S. National Nanotechnology Initiative (NNI) and Consumer Product Safety Commission (CPSC), Oct 2018

Winner, Abstract Booklet Image Contest, Harvard Chan Poster Day, Apr 2017

Travel Grant, Harvard-National Institute of Environmental Health Sciences (NIEHS) Center for Environmental Health, Dec 2016

Honorable Mention for publication in Toxicological Sciences, Society of Toxicology (SOT), Nov 2016

Travel Award, Sustainable Nanotechnology Organization (SNO) Conference, Nov 2016

Joseph D. Brain Fellowship Fund Scholarship, Department of Environmental Health, Harvard T.H. Chan School of Public Health, Sep 2015

New Investigator Award, QEEN Workshop (Quantifying Exposure to Engineered Nanomaterials from Manufactured Products), U.S. National Nanotechnology Initiative (NNI) and Consumer Product Safety Commission (CPSC), Jul 2015

Engineering Scholarship Award, American Council of Engineering Companies (ACEC) California Los Angeles County Chapter, May 2013

The Honor Society of Phi Kappa Phi, May 2013

Engineering Scholarship Award, American Council of Engineering Companies (ACEC) California Los Angeles County Chapter, May 2012

Academic Appointments

Visiting Scientist, Nanoscience and Advanced Materials Center, Rutgers University School of Public Health, 2022–present

Prior Experience

Instructor for “Comprehensive Industrial Hygiene: The Application of Basic Principles” course, Harvard T.H. Chan School of Public Health Executive and Continuing Professional Education, 2017–present

Postdoctoral Research Fellow, Harvard T.H. Chan School of Public Health, 2019–2022

Management Trainee, Sembcorp Environment Pte Ltd, 2010

Professional Affiliations

American Industrial Hygiene Association (AIHA)

American Industrial Hygiene Association (AIHA), Northern California Section

Publications

Singh, D.; Tassew, D. D.; Nelson, J.; Chalbot, M.-C. G.; Kavouras, I. G.; Tesfaigzi, Y.; Demokritou, P. Physicochemical and Toxicological Properties of Wood Smoke Particulate Matter as a Function of Wood Species and Combustion Condition. J. Hazard. Mater. 2023, 441, 129874. https://doi.org/10.1016/j.jhazmat.2022.129874.

Singh, D.; Tassew, D. D.; Nelson, J.; Chalbot, M.-C. G.; Kavouras, I. G.; Demokritou, P.; Tesfaigzi, Y. Development of an Integrated Platform to Assess the Physicochemical and Toxicological Properties of Wood Combustion Particulate Matter. Chem. Res. Toxicol. 2022. https://doi.org/10.1021/acs.chemrestox.2c00183.

DeLoid, G. M.; Cao, X.; Coreas, R.; Bitounis, D.; Singh, D.; Zhong, W.; Demokritou, P. Incineration-Generated Polyethylene Micro-Nanoplastics Increase Triglyceride Lipolysis and Absorption in an In Vitro Small Intestinal Epithelium Model. Environmental Science and Technology 2022. https://doi.org/10.1021/acs.est.2c03195.

Marrocco, A.; Singh, D.; Christiani, D. C.; Demokritou, P. E-Cigarette Vaping Associated Acute Lung Injury (EVALI): State of Science and Future Research Needs. Crit. Rev. Toxicol. 2022, 1–33. https://doi.org/10.1080/10408444.2022.2082918.

Marrocco, A.; Singh, D.; Christiani, D. C.; Demokritou, P. E-Cigarette (E-Cig) Liquid Composition and Operational Voltage Define the in Vitro Toxicity of Δ8Tetrahydrocannabinol/Vitamin E Acetate (Δ8THC/VEA) E-Cig Aerosols. Toxicol. Sci. 2022. https://doi.org/10.1093/toxsci/kfac047.

Singh, D.; Marrocco, A.; Wohlleben, W.; Park, H. R.; Diwadkar, A. R.; Himes, B. E.; Lu, Q.; Christiani, D. C.; Demokritou, P. Release of Particulate Matter from Nano-Enabled Building Materials (NEBMs) across Their Lifecycle: Potential Occupational Health and Safety Implications. J. Hazard. Mater. 2022, 422, 126771. https://doi.org/10.1016/J.JHAZMAT.2021.126771.

DeLoid, G. M.; Cao, X.; Bitounis, D.; Singh, D.; Llopis, P. M.; Buckley, B.; Demokritou, P. Toxicity, Uptake, and Nuclear Translocation of Ingested Micro-Nanoplastics in an in Vitro Model of the Small Intestinal Epithelium. Food Chem. Toxicol. 2021, 158, 112609. https://doi.org/10.1016/j.fct.2021.112609.

Camaioni, A.; Massimiani, M.; Lacconi, V.; Magrini, A.; Salustri, A.; Sotiriou, G. A.; Singh, D.; Bitounis, D.; Bocca, B.; Pino, A.; Barone, F.; Prota, V.; Iavicoli, I.; Scimeca, M.; Bonanno, E.; Cassee, F. R.; Demokritou, P.; Pietroiusti, A.; Campagnolo, L. Silica Encapsulation of ZnO Nanoparticles Reduces Their Toxicity for Cumulus Cell-Oocyte-Complex Expansion. Part. Fibre Toxicol. 2021, 18 (1), 33. https://doi.org/10.1186/s12989-021-00424-z.

Bello, D.; Chanetsa, L.; Cristophi, C. A.; Poh, T. Y.; Singh, D.; Setyawati, M. I.; Christiani, D.; Chotirmall, S. H.; Ng, K. W.; Demokritou, P. Chronic Upper Airway and Systemic Inflammation from Copier Emitted Particles in Healthy Operators at Six Singaporean Workplaces. NanoImpact 2021, 22 (100325), 100325. https://doi.org/10.1016/j.impact.2021.100325.

Moschovis, P. P.; Yonker, L. M.; Shah, J.; Singh, D.; Demokritou, P.; Kinane, T. B. Aerosol Transmission of SARS-CoV-2 by Children and Adults during the COVID-19 Pandemic. Pediatr. Pulmonol. 2021, 8227 (6), 1389–1394. https://doi.org/10.1002/ppul.25330.

Coyle, J. P.; Derk, R. C.; Kornberg, T. G.; Singh, D.; Jensen, J.; Friend, S.; Mercer, R.; Stueckle, T. A.; Demokritou, P.; Rojanasakul, Y.; Rojanasakul, L. W. Carbon Nanotube Filler Enhances Incinerated Thermoplastics-Induced Cytotoxicity and Metabolic Disruption in Vitro. Part. Fibre Toxicol. 2020, 17 (1), 40. https://doi.org/10.1186/s12989-020-00371-1.

Guo, N. L.; Bello, D.; Ye, Q.; Tagett, R.; Chanetsa, L.; Singh, D.; Poh, T. Y.; Setyawati, M. I.; Chotirmall, S. H.; Ng, K. W.; Demokritou, P. Pilot Deep RNA Sequencing of Worker Blood Samples from Singapore Printing Industry for Occupational Risk Assessment. NanoImpact 2020, 19, 100248. https://doi.org/10.1016/j.impact.2020.100248.

Setyawati, M. I.; Singh, D.; Krishnan, S. P. R.; Huang, X.; Wang, M.; Jia, S.; Goh, B. H. R.; Ho, C. G.; Yusoff, R.; Kathawala, M. H.; Poh, T. Y.; Ali, N. A. B. M.; Chotirmall, S. H.; Aitken, R. J.; Riediker, M.; Christiani, D. C.; Fang, M.; Bello, D.; Demokritou, P.; Ng, K. W. Occupational Inhalation Exposures to Nanoparticles at Six Singapore Printing Centers. Environmental Science and Technology 2020, 54 (4), 2389–2400. https://doi.org/10.1021/acs.est.9b06984.

Singh, D.; Wohlleben, W.; De La Torre Roche, R.; White, J. C.; Demokritou, P. Thermal Decomposition/incineration of Nano-Enabled Coatings and Effects of Nanofiller/matrix Properties and Operational Conditions on Byproduct Release Dynamics: Potential Environmental Health Implications. NanoImpact 2019, 13, 44–55. https://doi.org/10.1016/j.impact.2018.12.003.

Singh, D.; Schifman, L. A.; Watson-Wright, C.; Sotiriou, G. A.; Oyanedel-Craver, V.; Wohlleben, W.; Demokritou, P. Nanofiller Presence Enhances Polycyclic Aromatic Hydrocarbon (PAH) Profile on Nanoparticles Released during Thermal Decomposition of Nano-Enabled Thermoplastics: Potential Environmental Health Implications. Environmental Science and Technology 2017, 51 (9), 5222–5232. https://doi.org/10.1021/acs.est.6b06448.

Watson-Wright, C.; Singh, D.; Demokritou, P. Toxicological Implications of Released Particulate Matter during Thermal Decomposition of Nano-Enabled Thermoplastics. NanoImpact 2017, 5, 29–40. https://doi.org/10.1016/j.impact.2016.12.003.

Singh, D.; Sotiriou, G. A.; Zhang, F.; Mead, J.; Bello, D.; Wohlleben, W.; Demokritou, P. End-of-Life Thermal Decomposition of Nano-Enabled Polymers: Effect of Nanofiller Loading and Polymer Matrix on by-Products. Environ. Sci.: Nano 2016, 3 (6), 1293–1305. https://doi.org/10.1039/C6EN00252H.

Sotiriou, G. A.; Singh, D.; Zhang, F.; Chalbot, M. C. G.; Spielman-Sun, E.; Hoering, L.; Kavouras, I. G.; Lowry, G. V.; Wohlleben, W.; Demokritou, P. Thermal Decomposition of Nano-Enabled Thermoplastics: Possible Environmental Health and Safety Implications. J. Hazard. Mater. 2016, 305, 87–95. https://doi.org/10.1016/j.jhazmat.2015.11.001.

Pal, A. K.; Watson, C. Y.; Pirela, S. V.; Singh, D.; Chalbot, M. C. G.; Kavouras, I.; Demokritou, P. Linking Exposures of Particles Released from Nano-Enabled Products to Toxicology: An Integrated Methodology for Particle Sampling, Extraction, Dispersion, and Dosing. Toxicol. Sci. 2015, 146 (2), 321–333. https://doi.org/10.1093/toxsci/kfv095.

Sotiriou, G. A.; Singh, D.; Zhang, F.; Wohlleben, W.; Chalbot, M.-C. G.; Kavouras, I. G.; Demokritou, P. An Integrated Methodology for the Assessment of Environmental Health Implications during Thermal

Decomposition of Nano-Enabled Products. Environmental science. Nano 2015, 2 (3), 262–272. https://doi.org/10.1039/C4EN00210E.

Presentations

Singh, D. Environmental health and safety implications of nano-enabled building materials across their lifecycle. Presented at Invited Seminar at Division of Environmental and Population Health Biosciences, Environmental and Occupational Health Sciences Institute (EOHSI), Rutgers University, Piscataway, NJ, November 17, 2021.

Singh, D. Occupational health and safety of nano-enabled building materials across their lifecycle. Presented at Molecular and Integrative Physiological Sciences (MIPS) Work-in-Progress Seminar, Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, February 16, 2021.

Singh, D. Occupational health and safety of nano-enabled building materials across their lifecycle. Presented at ERC Pilot Project Symposium, Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, January 22, 2021.

Singh, D. Respiratory and Cardiovascular Health Risk of Engineered Nanomaterials Released from Printing Equipment. Poster Presentation at Department of Environmental Health Winter Retreat, Harvard T.H. Chan School of Public Health, Boston, MA, December 12, 2019.

Singh, D. Incineration/Thermal Decomposition of Nano-Enabled Products: Potential Environmental Health and Safety Implications. Poster Presentation at QEEN II Workshop, Washington D.C., October 9-10, 2018.

Singh, D. Nano-waste: Potential Environmental Health and Safety (EHS) Implications during Thermal Decomposition of Nano-Enabled Products (NEPs). Presented at Sixth Sustainable Nanotechnology Organization Conference, Marina del Rey, CA, November 5-7, 2017.

Singh, D. Nano-waste: Environmental health and safety (EHS) implications during thermal decomposition/incineration of nano-enabled products at their end-of-life. Poster Presentation at Harvard Chan Poster Day, Boston, MA, April 26, 2017.

Singh, D. Burning Nano-waste – what are the implications? Presented 3-minute Science Talk at NIEHS EHS FEST, Durham, NC, December 6-8, 2016.

Singh, D. Engineered Nanoparticles Emitted from Laser Printers: A Case Study of Environmental Health Implications from Nano-Enabled Products During Consumer Use. Poster Presentation at Fifth Sustainable Nanotechnology Organization Conference, Orlando, FL, November 10-12, 2016.

Singh, D. Nano-waste: Environmental health and safety (EHS) implications during thermal degradation/incineration of nano-enabled products at their end-of-life. Presented at 8th International Nanotoxicology Congress, Boston, MA, June 1-4, 2016.

Singh, D. Nano-waste: Environmental health and safety (EHS) implications during thermal decomposition/incineration of nano-enabled products at their end-of-life. Poster Presentation at Harvard Chan Poster Day, Boston, MA, April 8, 2016.

Singh, D. Nano-waste: Environmental health and safety (EHS) implications during thermal degradation of nano-enabled products at their end-of-life. Poster Presentation at NORA Meets BASF Challenges, Cambridge, MA, November 4-5, 2015.

Singh, D. Nano-waste: Environmental health and safety (EHS) implications during thermal degradation/incineration of nano-enabled products at their end-of-life. Poster Presentation at QEEN

Workshop, Washington D.C., July 7-8, 2015.

Singh, D. Novel exposure and toxicological methods to assess thermal decomposition and associated EHS implications of nano-enabled products. Presented at NORA All Projects Day and Tech Push Event, Amherst, MA, May 19-20, 2015.

Singh, D. Nano-waste: Thermal decomposition of nano-enabled products at their end-of-life. Poster Presentation at NORA Meets BASF Challenges, Cambridge, MA, December 10-11, 2014.

Singh, D. An Integrated Exposure Generation System (INEXS) for the thermal decomposition of nano-enabled products. Presented at NORA All Projects Day, Cambridge, MA, May 28, 2014.

Project Experience

List of Exponent Projects

Industrial Hygiene

- Conducted onsite real-time nanoparticle monitoring and time-integrated respirable PM area/personal sampling at an inkjet printing equipment facility.

Consumer Products

- Developing a refined human inhalation exposure assessment model calculator for assessing occupational exposures to volatile organic compounds present in floor stripping/finishing liquid products in order to inform and guide their Proposition 65 compliance.
- Evaluated potential leaching of chemicals including heavy metals and volatile organic compounds into water from the regular use of a gardening hose.
- Conducted a Proposition 65 compliance evaluation of potential human exposure to lead from the regular handling of a brass-based knob.
- Conducted a thorough visual/odor inspection and sampling of new and unused shoes to identify potential presence of mold and its species.
- Reviewed and updated a risk assessment report on potential exposures and health effects arising from unintentional by-products generated from the use/misuse of an aqueous ozone device.

Toxic Torts

- Assisting in reviewing literature on children’s lead exposures in various settings and preparation of case summary documents.
- Assisted in conducting literature reviews and preparing an updated case summary on potential historical exposures to asbestos from occupational/environmental settings.

List of Postdoctoral Projects

Nano-Enabled Building Materials: Lifecycle Environmental Health and Safety (EHS) Implications

- Designed and developed a versatile and reproducible Integrated Exposure Generation System to investigate the end-of-life thermal decomposition behavior of a wide variety of nano-enabled building materials under controlled combustion conditions.

- Investigated nanomaterial release dynamics and potential environmental health implications during various lifecycle degradation scenarios (incineration, sanding, accelerated UV aging) of nano-enabled thermoplastics, coatings, and insulation materials with different compositions of polymer matrix (PE, PU, PP, PC, EVA, acrylic) and nanofiller (TiO_2, Fe_2O_3, SiO_2, CuO, CNT, CB, DPP).
- Performed detailed physicochemical, morphological, and in vitro toxicological characterization of the sampled inhalable particulate matter generated during the different lifecycle degradation scenarios using state-of-the-art analytical methods and bioassays.

Wood Smoke Emissions and Health Effects

- Developed an integrated platform to investigate the physicochemical and toxicological properties of wood burning emissions under well-controlled combustion conditions.
- Employed the integrated platform to characterize the properties of inhalable wood smoke particulate matter (PM10, PM2.5, PM0.1) as a function of wood species (hardwood vs. softwood), wood moisture and combustion condition (flaming vs. smoldering vs. incomplete combustion) assess the ability of the PM to induce excessive mucus production and secretion in an in vitro bioassay.

Micro-Nano-Plastics (MNPs)

- Designed and conducted studies on assessment of interactions between MNPs and environmental pollutants (EPs) (organochlorine pesticides, heavy metals, zeranols) in the freshwater environment and investigation of fate and transformation of co-ingested MNPs and EPs in the gastrointestinal tract. Addressed the hypotheses that the hydrophobic surface of MNPs adsorbs and concentrates toxic pollutants at a much higher concentration than in the surrounding environmental media and that ingested MNPs increase the bioaccessibility and bioavailability of EPs in the gut.
- Developed platforms and methodologies for producing a well-characterized repository of environmentally relevant MNPs intended for environmental fate and transport and toxicological studies using cryo-milling, accelerated UV weathering and incineration approaches.

Printer and Photocopier Emissions

- Developed field sampling methodologies for conducting an extensive indoor air quality and occupational nanoparticle exposure assessment at commercial photocopier and printing centers. Performed a thorough physicochemical and morphological characterization of the collected printer-emitted nanoparticles. Analyzed correlations between various nanoparticle exposure metrics and measured levels of a panel of biomarkers corresponding to oxidative stress, inflammation and cardiovascular disease in the biological fluids (urine, blood, nasal lavage) of exposed operators.

Electronic Cigarettes

- Conducted a detailed physicochemical and in vitro toxicological characterization of vapors and aerosols generated from vaping of e-cigarettes as a function of e-liquid composition (different proportions of delta-8-Tetrahydrocannabinol (THC), vitamin E acetate, nicotine, propylene glycol (PG), vegetable glycerin (VG) and flavorings) and operating voltages.

- Assisted in the preparation of a systematic literature review on the state of science and future research needs pertaining to vaping emissions associated with e-cigarette vaping associated acute lung injury (EVALI).

COVID-19

- Evaluated the dose-response relationship between the light intensity of commercial UV and visible light technologies and the inactivation of aerosolized human coronavirus 229E (surrogate for SARS-CoV-2) using a one-pass environmental exposure chamber under controlled conditions of temperature, relative humidity and bioaerosol residence time.
- Designed experimental apparatus and standard operating protocols (SOPs) for the real-time monitoring of droplet/aerosol production by healthy, asymptomatic children performing a variety of tasks (breathing, talking, singing, coughing, sneezing) in different masked conditions (no mask, cloth mask, N95 mask, face shield). Developed protocols for real-time monitoring of droplets/aerosols generated during children spirometry tests in a clinical microenvironment. Assisted and trained physicians/research assistants in real-time data collection and statistical analysis of aerosol concentration and size from different instruments.
- Developed an integrated lab setup for the generation and characterization of model NaCl aerosol and employed it for the assessment of particle filtration efficiency and pressure drop across different candidate fabric materials for face mask applications.
- Assisted in the writing and editing of a commentary on aerosol transmission of SARS-CoV-2 by children and adults.

List of Doctoral Coursework Projects

- Investigated population-level exposures to mercury by analyzing residual hair samples collected from barber shops/salons in two different communities of contrasting socio-economic status and presented distilled findings to the community leaders.
- Performed a systematic ergonomic evaluation of a chute-based laundry collection job at a prominent hospital and produced specific written recommendations and interventions to minimize worker injury and stress.
- Conducted a comprehensive indoor air quality (IAQ) assessment of a residential apartment including calculation of ventilation rates and monitoring of airborne levels of particles and volatile organic compounds as a function of occupants' activities such as cooking, smoking and chemical cleaning, followed by a detailed report proposing specific recommendations to improve IAQ and occupant health.

Peer Reviews

Chemical Communications

Chemical Physics Letters

Nanoscale Advances

Journal of Hazardous Materials

Patty's Industrial Hygiene and Toxicology

Carbon

NanoImpact

Environmental Science and Pollution Research

International Journal of Nanomedicine

Journal of Nanoparticle Research

Risk Management and Healthcare Policy

Current World Environment

Sustainability