PROGRESS AND PLANS OF NATIONAL NANOTECHNOLOGY INITIATIVE (NNI) AGENCIES

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Consumer Product Safety Commission (CPSC)[1]

Summary

The CPSC staff engages in a range of activities to understand the commercialization of nanotechnology-enabled products (NEPs) and strategies to adequately address potential implications of these product applications. Other emerging technologies such as wearable technology and three dimensional (3D) printing, or additive manufacturing, are expected to be significant users of nanomaterials, and 3D printing is expected to emerge as a significant producer of NEPs over the next few years. Given the convergence of these technologies, the CPSC staff is supporting research with other Federal agencies, academic institutions, and the private sector to better understand the exposures to nanomaterials incorporated into and produced by new technologies across the life cycle. Studies conducted with the National Institutes for Standards and Technology (NIST) and the National Institute for Occupational Safety and Health (NIOSH) will identify releases of material during 3D printing and the accumulation of these materials in the indoor environment from production and use of finished products. CPSC staff and partners are engaged in voluntary standards activities to create validated methods for quantifying and characterizing exposures from products. The staff will also develop and validate *in vitro* methods to test existing and emerging nanomaterials that are used in consumer products.

Plans and Priorities by Program Component Area (PCA)

PCA 5. Environment, Health, and Safety

Interagency Agreement with NIOSH on the Potential Toxicity of 3D Printer Emissions, Phase 2

There is preliminary evidence from NIOSH that use of 3D printers may result in the release of ultrafine particles and bioactive compounds. Inhalation of these emitted substances may result in pulmonary and/or cardiovascular dysfunction. The specific aims of Phase 1 of this interagency agreement (IAG) research are: (1) measure and characterize emissions from fused deposition modeling (FDM) 3D printers and develop an emission-generation system for toxicological investigations; (2) design, construct, and test a 3D printer emission system for rat whole body inhalation exposure studies, and characterize the composition, particle size, and concentrations of these emissions; (3) determine responses of a lung epithelial/endothelial co-culture system to *in vitro* exposure to 3D printer particles; (4) characterize pulmonary and cardiovascular responses of rats following inhalation exposure to 3D printer emissions. Phase 2 studies will expand on the *in vivo* exposures, to relevant concentrations experienced by consumers when using the technology. In addition, the Phase 2 studies will evaluate gene expression from exposed co-cultured cells, as well as from

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blood, lung, and heart samples from exposed rats, to determine gene induction signatures and identify mechanistic pathways of response.

Interagency Agreement with NIOSH, Factors Influencing Emissions during Fused Deposition Modeling 3D Printing and Feedstock Recycling

Additive manufacturing processes have been used in industrial settings for more than 20 years. With the recent expiration of several key patents on the technology, there has been a rapid push to bring low-cost machines to market. As their cost has declined, their use has become widespread in schools, homes, and libraries, locales without specialized exhaust or contaminant control. Lack of protective technologies is important, since low-cost 3D printers are known to emit organic chemicals and ultrafine particles that contain metals. This proposed project is coordinating with the Environmental Protection Agency (EPA) 3D printer project to evaluate the emissions (organic chemical vapor and aerosol emissions) from FDM 3D printers during operation, feedstock recycling, and printing with recycled plastics and from a metal 3D printer and milling/laser etching machine to understand factors that influence emissions. NIOSH will test the broad hypothesis that emissions are influenced by factors related to device (e.g., FDM or metal printer, recycling extruder) and feedstock (e.g., type of plastic or metal, composition of plastic or metal, virgin versus recycled plastic) under conditions of intended use.

Nanoparticle Releases from Consumer Products, LS Training and Testing Assistance

This collaborative research effort between CPSC and NIST will continue to develop and refine methods to assess the potential release of nanoparticles from consumer products and determine their contributions to human exposure. These efforts focus on the development of laboratory methods to determine the rate of nanoparticle generation from consumer products and nanomaterials. These methods allow for reproducible determinations of release rates, and provide information on the number and size of nanoparticles released as a function of product use, and other key parameters. These protocols need to distinguish between background nanoparticle levels and those released by the product of interest, presumably using attributes of the particles including size, shape, and composition. In particular, methods developed via the fiscal year 2017 interagency agreement for detecting and quantifying nanomaterials in house dust will be applied to dust samples collected from U.S. homes participating in the American Healthy Homes Survey.[2] This project will also take methods developed from CPSC-NIST interagency agreements (e.g., studies on abrasion of nanomaterial paints and coatings) and propose those methods for inclusion into the ASTM voluntary standard work plan. In addition, a program will continue to be developed with NIST to train and assist the staff at CPSC's Laboratory Sciences (LS) Directorate in detecting and measuring nanomaterials in consumer products.

Interagency Agreements and Contracts for Collaborations with Partners Ranging from Federal Authorities, Colleges and Universities, and Other Stakeholders to Expand CPSC's Effectiveness and Reach

Due to the success of this collaborative effort, CPSC, NIST, NIOSH, EPA, the National Science Foundation, and the Department of Defense, in coordination with NNCO, will develop new solicitations for research that will address consumer exposures to nanomaterials throughout the life cycles of the materials. In particular, emphasis will be placed on early-life exposures and long-term health consequences from those exposures to nanomaterials.

[2] https://www.healthypeople.gov/2020/data-source/american-healthy-homes-survey

Key Technical Accomplishments by NNI Goal

Goal 4. Support Responsible Development of Nanotechnology

The CPSC staff developed a contract with the University of Cincinnati to conduct toxicity evaluations of nanomaterials including nanosilver, nanotitanium, and carbon nanotubes (CNTs). These toxicity reviews have been completed and will be used for robust risk assessments of releases from products.

CPSC, NIST, and the Army Engineer Research and Development Center have been working to develop methods to abrade CNT-containing thermoplastics to quantify releases of CNTs and the potential toxicity of the matrix-bound materials.