



NATIONAL SCIENCE FOUNDATION
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NSF 20-050

Dear Colleague Letter: Critical Aspects of Sustainability (CAS): Micro- and Nanoplastics (MNP)

March 3, 2020

Dear Colleagues:

This Dear Colleague Letter (DCL) encourages the submission of proposals that tackle some of the fundamental scientific questions underlying micro- and nanoplastic characterization, behavior, and reactivity in the environment (including animal and human health), as well as their elimination from land and water systems.

In the environment, plastics eventually break down as a result of mechanical weathering and/or photodegradation, forming micro- and nanoplastics - plastic fragments <5 millimeters and <100 nanometers, respectively, in diameter. Microplastics have also been manufactured for use in personal care products, though this usage was banned by the United States in 2015. Current water treatment cannot completely remove micro- and nanoplastics. Micro- and nanoplastics have been measured in polar sea ice as well as in fresh and saltwater fish.¹

The degradation pathways of micro- and nanoplastics through photochemistry, ingestion, or microbial interactions are incompletely understood. Additionally, micro- and nanoplastics may adsorb and concentrate hazardous pollutants or acquire coatings of biofilms that affect their fate. Nanosized plastic particles may have very different properties than the larger microplastic particles in terms of environmental fate, aggregation, and sedimentation, and thus individual and ensemble characterization may be needed.² Nanoplastics may cross the blood-brain and gut-blood barrier and present unique health concerns.³ Due to their small size and the complex sampling environments, reproducible analytical techniques are needed to understand the structure-property relationships of micro- and nanoplastic particles as well as their behavior in their environment.

Sustainable solutions to the plastic waste problem require creative approaches from many scientific disciplines, to reduce the burden and harmful effects of micro- and nanoplastics and ensure our ability to track their fate in the environment.

Several Directorates/Offices/Divisions participate in this DCL and welcome the submission of proposals on this topic, though each division will only accept proposals of a certain type, as described in the corresponding sections below. All questions regarding proposals should be addressed to the cognizant Program Officers to whom submission is contemplated.

Proposals involving international collaboration are welcome when the collaboration enhances the proposed research. The NSF funds the U.S. side of international collaborations.

After any solicitation or *NSF Proposal & Award Policies & Procedures Guide* (PAPPG)⁴ specific requirements, titles should include the prefix "CAS-MNP: ".

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES (MPS)

The Division of Chemistry (MPS/CHE) welcomes EARly-concept Grants for Exploratory Research (EAGER) and Rapid Response Research (RAPID) proposals⁵ to its disciplinary research programs (<https://www.nsf.gov/funding/programs.jsp?org=CHE>), including: Chemical Catalysis (CAT); Chemical Measurement and Imaging (CMI); Chemical Structure, Dynamics, and Mechanisms-A and B (CSDM-A and -B); Chemical Synthesis (SYN); Chemical Theory, Models, and Computational Methods (CTMC); Chemistry of Life Processes (CLP); Environmental Chemical Sciences (ECS); and Macromolecular, Supramolecular, and Nanochemistry (MSN).

Suitable topics include, but are not limited to:

- Understanding the fundamental chemical and biochemical processes of the photochemistry and aging of micro- and nanoplastics especially in aqueous or soil media;
- Understanding the ability of micro- and nanoplastics to accumulate toxic substances on their surfaces;
- Understanding the fundamental surface chemistry of micro- and nanoplastics with biological materials (skin, membranes, etc.) and adsorption/absorption of chemical species;
- Developing measurement and imaging approaches that identify and quantify micro- and nanoplastic surface structures in various complex media; and
- Devising and improving understanding of separation mechanisms relevant to the characterization of these systems.

EAGER and RAPID proposals may be submitted to CHE at any time; however, for consideration in Fiscal Year (FY) 2020, submission by June 1, 2020 is strongly recommended. Proposers must contact their cognizant CHE Program Officer before submission (see CHE Program webpages, <https://www.nsf.gov/funding/programs.jsp?org=CHE>). Individual Investigator and collaborative proposals to the CHE Disciplinary

Research Programs (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf19577) are welcome in the September 2020 and October 2020 submission windows, to be considered for FY 2021 funding.

The Division of Materials Research (MPS/DMR) through its Polymers Program (POL) welcomes transformative ideas addressing the global microplastics accumulation problem. All proposals must be focused on fundamental materials research approaches in areas within the domain of DMR and POL. Regular proposals must be submitted in accordance with the current Program Solicitation (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505462&org=DMR&from=home) and within its specified submission window. EAGER proposals must comply with the requirements for EAGER in the NSF PAPPG including contacting the relevant Program Officer prior to submission to determine appropriateness. EAGER proposals to DMR for consideration within a given fiscal year should be submitted by May 1 of that year.

DIRECTORATE FOR ENGINEERING (ENG)

The Chemical, Bioengineering, Environmental and Transport Systems Division (ENG/CBET) has several core programs that review proposals on research topics related to sustainability, including Environmental Sustainability, Nanoscale Interactions, Environmental Engineering, Interfacial Engineering, Particulate and Multiphase Processes, and Process Systems, Reaction Engineering, and Molecular Thermodynamics. CBET welcomes the submission of regular, unsolicited proposals (see the PAPPG⁴ guidelines) to these programs at any time during the year. For the participating CBET programs, the following topics are of particular interest:

- Environmental Sustainability Program: green engineering to reduce the presence of microplastics in the environment.
- Nanoscale Interactions Program: fundamental and quantitative investigations of the interactions between nanoscale plastics and biological and environmental media.
- Environmental Engineering Program: the fate of micro- and nanoplastics in the environment; understanding the role of micro- and nanoplastics as vectors for the transport of hydrophobic pollutants in aquatic, soil, and sediment environments; low cost techniques for concentrating and rapid measurement of micro- and nanoplastics in aquatic systems.
- Interfacial Engineering Program: separation processes to remove micro- and nanoplastics from the environment.
- Process Systems, Reaction Engineering, and Molecular Thermodynamics Program: fundamental investigations into depolymerization processes for micro- and nanoplastics.

All questions regarding proposals to CBET should be addressed to the cognizant Program Officers for the participating Program to which submission is contemplated (see CBET

Program webpages, <https://www.nsf.gov/funding/programs.jsp?org=CBET>).

All full proposals to the participating core programs in the Division of Chemical, Bioengineering, Environmental and Transport Systems (CBET) listed in the corresponding Program Description are accepted anytime.

The Division of Civil, Mechanical and Manufacturing Innovation (ENG/CMMI) welcomes proposals addressing advanced manufacturing and engineering design solutions. Of interest is research in the design and manufacturing of materials, devices, and systems to prevent, remove, or destroy micro- and nanoplastics.

Suitable topics include, but are not limited to:

- Cost-effective recycling and reprocessing methods for polymer waste;
- Cost-effective and market-acceptable remanufacturing methods for products that incorporate polymers;
- Processing methods to reduce the tendency towards micro- and nanoparticle formation;
- Design for disassembly and recycling or reprocessing;
- Plastic lifecycle as a system; and
- Inclusion of micro- and nanoplastic-avoiding criteria (e.g. plastic selection and component geometry) in design/optimization.

All questions regarding proposals to CMMI should be addressed to the cognizant Program Officers for the Advanced Manufacturing Program to which submission is contemplated (see CMMI Program webpage, <https://www.nsf.gov/funding/programs.jsp?org=CMMI>).

All full proposals to the Advanced Manufacturing Program in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) are accepted anytime.

DIRECTORATE FOR GEOSCIENCES (GEO)

The Division of Earth Sciences (GEO/EAR) welcomes fundamental and transformational geosciences projects addressing earth materials and earth systems. Suitable topics involving microplastics (MP) in non-marine systems include:

- The mobility of MP in soils and aquifers, and the potential impact on groundwater resources;
- The interaction between MP and earth materials, in particular clays and soil aggregates;
- The geochemical reactivity of MP particle surfaces toward organic and inorganic contaminants in soils and fresh water;
- The biogeochemistry of MP degradation in fresh water and soils; and
- The association of natural organic material with MP in fresh water.

All full proposals should be submitted to the Geobiology and Low-Temperature Geochemistry (GG) Program. Proposals to the Division of Earth Sciences (EAR) are accepted anytime.

All questions regarding proposals to EAR should be addressed to the cognizant Program Officers for the participating Program (see EAR Program webpages, <https://www.nsf.gov/funding/programs.jsp?org=EAR>).

The Office of Polar Programs (GEO/OPP), Section for Antarctic Sciences (ANT)

welcomes proposals on the topics of micro- and nanoplastics and their impacts on Antarctic organisms and ecosystems. There is recent evidence that micro- and nanoplastics in deep-sea sediments and surface waters could be an emerging issue of potential concern in some regions of the Southern Ocean, especially near areas of higher human impact. However, the extent, quantity and impacts of microplastics on Antarctic organisms and ecosystems remain largely unknown. Micro- and nanoplastic discharges are not specifically addressed by the 1998 Protocol on Environmental Protection to the Antarctic Treaty due largely to a lack of scientific evidence to inform policy development. Successful projects submitted under this call are expected to use complementary, interdisciplinary approaches to investigate the potential impact of microplastics in the Southern Ocean and how they could impact organisms and ecosystems of the region. This call could also provide unique opportunities to train the next generation of scientists in a diversity of approaches and to engage society more generally.

All proposals to ANT must be submitted through the current Antarctic Research solicitation (see https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5519&org=OPP&from=home) and must follow guidelines within this solicitation. Proposals will be accepted anytime.

The Office of Polar Programs (GEO/OPP), Section for Arctic Sciences (ARC), Arctic System Science (ARCSS) Program supports projects that study systems of the Arctic operating at multiple temporal and spatial scales, systems that can inform our understanding of Arctic processes, and the relationship of Arctic systems to other global and regional systems. NSF expects that successful ARCSS projects will propose to study a set of interconnected components and/or processes that work together to form a defined system. Through this DCL, ARCSS welcomes proposals on the interactions of micro- and nanoplastics with systems of the Arctic operating at a variety of temporal and spatial scales. Such projects may include, but are not limited to, improved understanding of the biophysical roles of such plastics in Arctic food webs, the interactions between micro- and nanoplastics and the Arctic environment, and the potential impacts of micro- and nanoplastics on Arctic residents and their livelihoods.

All proposals to ARCSS must be submitted through the current Arctic Research Opportunities solicitation (see https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5521&org=OPP&from=home) and must follow the guidelines therein. Proposals are accepted at any time. ARCSS program officers are always keen to speak with prospective

Principal Investigators about their research ideas.

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)

The Division of Environmental Biology (BIO/DEB) welcomes inquiries that explore basic questions in the ecological and evolutionary sciences. Microplastics represent a relatively new and poorly understood component of ecosystems that may alter fundamental biological processes from cells to ecosystems. In this context, projects that seek to improve understanding of the role of microplastics in fundamental ecological and evolutionary processes will be prioritized. Projects with a primary focus on toxicology will not be considered. PIs interested in submitting an EAGER or RAPID proposal should send a 1-2 page research concept outline to the BIO representative listed below. This prospectus will be used to determine if an invitation to invite a full EAGER or RAPID proposal is warranted. A prospectus is not necessary for submission of a regular core proposal. Please consult the current DEB core solicitation (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503634&org=DEB&from=home) for a detailed description of programs within the division.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES (EHR)

The Division of Research on Learning in Formal and Informal Settings (EHR/DRL) (<https://www.nsf.gov/div/index.jsp?div=DRL>) welcomes research and development proposals with a focus on science learning in relation to micro- and nanoplastics to its Advancing Informal STEM Learning (AISL) and Innovative Technology Experiences for Students and Teachers (ITEST) programs. These should be submitted as regular proposals in response to published program deadlines. The AISL program supports projects that advance what is known about science learning across the lifespan, in informal contexts such as museums, libraries, television and film, and experiences that support public engagement with science. The ITEST program supports projects that engage K-12 learners in technology-rich educational experiences designed to broaden participation in STEM careers and career pathways.

The Division of Undergraduate Education (EHR/DUE) (<https://www.nsf.gov/div/index.jsp?div=DUE>) welcomes regular proposals to its Improving Undergraduate STEM Education: Education and Human Resources (IUSE: EHR) program and its Advanced Technological Education (ATE) program. These must be submitted in response to published program deadlines. DUE also welcomes conference proposals, but investigators must contact a program officer prior to submission.

Example topics include, but are not limited to:

- Stimulating Course-Based Undergraduate Research to address key issues involving

plastics in the environment, leading to enhanced understanding and evidence-based solutions to mitigate problems;

- Integrating systems thinking into undergraduate instruction and technical education to understand the lifecycle of plastics and its implications for environmental health and public safety;
- Fostering student skills such as communication and collaboration through interactions with the public that promote citizen-science, enhance understanding of plastics-related issues, and elicit actionable solutions based on evidence;
- Developing exemplar multidisciplinary and cross-disciplinary curricular materials that demonstrate the scope and complexity of the problem, promote connections across students' STEM education pathways, and encourage students from different disciplines to pool their expertise to address a common problem; and
- Promoting education and industry partnerships that allow undergraduate students to make meaningful contributions to addressing the problem.

OFFICE OF INTERNATIONAL SCIENCE AND ENGINEERING (OD/OISE)

The Office of International Science and Engineering (OD/OISE) welcomes proposals on the topics of micro- and nanoplastics. We recognize the importance of building international research collaborations in this area. Proposals should be submitted as regular proposals in response to published program deadlines. Please go to the following page for information regarding OISE managed opportunities: <https://www.nsf.gov/funding/programs.jsp?org=OISE>.

CONTACTS

General questions about this DCL may be directed to:

MPS: Anne-Marie Schmoltner, Acting Deputy Division Director, CHE, (703) 292-4716, email: aschmolt@nsf.gov or Andrew Lovinger, Program Director, DMR, (703) 292-4933, email: alovinge@nsf.gov.

ENG: Catherine Walker, Associate Program Director, Chemical Process Systems Cluster/CBET, (703) 292-7125, email: cawalker@nsf.gov; Bruce Hamilton, Program Director, Environmental Sustainability/CBET, (703) 292-7066, email: bhamilto@nsf.gov; Nora Savage, Program Director, Nanoscale Interactions/CBET, (703) 292-7949, email: nosavage@nsf.gov; Karl Rockne, Program Director, Environmental Engineering/CBET, (703) 292-5356, email: krockne@nsf.gov; William Olbricht, Program Director, Particulate and Multiphase Processes/CBET, (703) 292-4842, email: wolbrich@nsf.gov; and Khershed Cooper, Program Director, CMMI, 703-292-7017, khcooper@nsf.gov.

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Sincerely,

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2. Nat. Nanotechnol. (2019), 14(299); DOI: 10.1038/s41565-019-0437-7
3. K. Mattsson, E. V. Johnson, A. Malmendal, S. Linse, L.-A. Hansson, T. Cedervall Scientific

Reports, (2017) 7(1), 11452; DOI: 10.1038/s41598-017-10813-0. F. Abdolahpur Monikh, N. Grundschober, S. Romeijn, D. Arenas-Lago, M. G. Vijver, W. Jiskoot, W. J. G. M. Peijnenburg, Environmental Pollution (2019) 255(2), 113304; DOI: 10.1016/j.envpol.2019.113304.

4. NSF PAPPG: [NSF Proposal & Award Policies & Procedures Guide](#)

5. NSF EARly-concept Grants for Exploratory Research (EAGER) Proposals Proposal (EAGER) ([PAPPG Chapter II.E.2](#)) and Rapid Response Research (RAPID) Proposals: ([PAPPG Chapter II.E.1](#))