Scientists' declaration on current approaches to plastics and plastic-containing materials, considering all stages of their life cycle

Over the last few decades, polymers have taken a strong leading position in the hierarchy of modern materials and became indispensable in people's lives. Many products that used to be made of traditional materials — glass, metal, wood, leather, and plant and animal fibers — are now made of synthetic polymers and their composites, which gives them the advantage of having low cost and a wide range of useful properties, including chemical inertness and lightness. Polymer production from fossil fuel is increasing, as well as their production from the renewable sources.

A distinctive characteristic of many polymer-containing products is the use of casting (molding) at moderate temperatures up to 150-200 ^{o}C at one of the stages in their production process, a cheap and convenient technology of mass production. There are three basic classes of polymers used in manufacturing: thermoplastics, which become plastic and can be molded when heated, as well as elastomers (rubbers) and thermosets; the latter can be molded before polymerization. In a broader sense, plastics are not only the above classes of polymers but also any complex products based on them. These products can be given a specific shape (usually by heating or applying pressure), and they retain this shape after cooling or curing. By this definition the majority of polymers used in manufacturing of final polymer products can be considered plastics, including rubbers for the production of automotive tires and synthetic fibers, films, and coatings widely used in machine-building, construction, textile and furniture industries, agriculture, etc.

Plastics are currently receiving increased public attention. Non-polymer plastic additives are used to improve the operational properties of the final products: they prevent decomposition under the influence of ultraviolet radiation and oxygen, reduce flammability, improve mechanical properties, etc. Additives can be quite hazardous, although their mere presence inside polymer products does not make them hazardous. The use of additives and their chemical structure is often a trade secret, and the proportion of additives in plastics can be as high as 10 % of the weight (or more in the case of PVC plastisols).

The annual global production of polymers has grown about 200 times since the beginning of their mass production (about 2 million tons in 1950). During this time, the world population has grown from 2.5 billion in 1950 to 8 billion in 2023. A further increase in the population will be accompanied by an inevitable increase in the production volume of polymer products.

However, the improper handling of the discarded plastic products, and lack of sufficient infrastructure for their recycling and disposal, the high demand for polymers, their low cost, and high chemical resistance lead to significant pollution of the environment by plastic waste, which, when broken down, forms small particles less than 5 mm in size, called microplastics. Nanoscale plastic particles, the effect of which on living organisms remains poorly understood, are also often referred to as microplastics. The main difficulties here are related to the high cost and complexity of isolating nanoscale plastics from different media and the analytical characterization of samples, as well as the lack of standardized approaches and methods for their selection, extraction, and analysis.

The growing problem of environmental pollution by plastic waste is of increasing concern, as reflected in UNEP Resolution 5/14 of March 2, 2022, on the need to develop an international legally binding instrument on plastic pollution, including in the marine environment. However, it should be kept in mind that this area is often a subject of speculation.

Balanced, responsible, and effective solutions can only be found using an open approach based on science and consolidated opinion of representatives of all fields of science relevant to plastics and their impact on human health, the environment, the biodiversity conservation and climate change. At the same time, the not always objective attitude towards polymers formed in society often does not take into consideration the opinion of specialists in polymer science, although it should be in many respects determinative.

Taking into account the above, understanding the need to take urgent measures to prevent pollution of the environment by plastic waste using science-based conclusions and supporting the UNEP resolution 5/14 of March 2, 2022, we, the *undersigned scientists*, call for the following.

1. The state, industry and business need to support **and implement already available science-based approaches and more environmentally friendly solutions** for:

    - production of plastics,
    - bringing new plastics and plastics products, including additives, to the market,
    - manufacturing of final plastic products, their use, utilization, disposal, and recycling.

Science-based decisions should be based on comprehensive scientific expertise, including the opinion of experts in polymer science.

2. The widespread use of plastics requires **further development of the scientific and technological bases for their production and use** at all stages of their life cycle, as well as an assessment of their impact on human health, biodiversity, and the environment. Special attention should be paid to the following issues:

    - the possibility of repeated recycling of plastic products, including mechanical and chemical recycling;
    - hazards of used non-polymer additives and their possible impact on the environment and human health, development and introduction of non-hazardous-alternatives;
    - replacement of non-recyclable and hard-to-recycle plastic products, introduction of alternatives to plastic products only when it is proven to be more beneficial for the environment;
    - phasing out single-used plastic products, unless effective recycling and/or environmentally safe disposal methods are proposed;
    - researching, improving and promoting the processes of plastic degradation in the environment and its assimilation in nature;
    - researching the impact of micro- and nano-plastics on human health and the preservation of the planet's biodiversity;
    - investigating the impact of plastic production, use, and disposal on climate change.

3. **The main problem of plastic pollution is not the plastic itself, but the inappropriate treatment of plastics.** This requires prioritizing measures to collect, recycle, and/or dispose of plastic waste already in the environment, rather than reducing the production of polymers. We demand not only increased producer and end-user responsibility for the fate of produced and used plastic products, but also that plastic not be discriminated against all other materials in terms of human health, environmental and climate impact assessments. This approach should be in place until specific evidence of such impacts is established, including the comparison with available and/or proposed alternatives.

4. It is necessary **to establish, as soon as possible, an international interdisciplinary expert scientific body (hereinafter - Scientific Plastic Council (SPC)),** including representatives of all regions and all major scientific fields related to plastic research and its impact on human health, biodiversity, and climate change (experts in polymer physics and chemistry, ecology, biology, medicine, etc.). The work of the Council should be open, based on generally accepted principles of scientific ethics, and free from discriminatory measures of any nature.

5. Development and implementation of **broad educational measures regarding polymer properties**, their development and production, manufacture, use, environmental impact, and end of life of polymer products.

6. **During the development of an international legally binding instrument on plastic pollution, including in the marine environment**, within the framework of UNEP Resolution 5/14 of March 2, 2022, the following measures should be promoted:

   6.1. The treaty should cover all stages of the life cycle of plastics and plastic-containing materials, without affecting primary raw materials (hydrocarbons and their derivatives) and intermediate products (such as monomers for polymer production).

   6.2. Science-based decision-making should be based on SPC expertise; precise definitions, indicators, data collection, and analysis protocols should be used. In addition to scientific expertise, the objective of the SPC is to develop a global concept for monitoring plastics and plastics-containing materials at different life cycle stages, waste management (collection and recycling), including microplastics and their distribution, as well as related hazardous substances.

   6.3. Support research and development aimed at obtaining new knowledge regarding the properties of polymers/materials/products, their interaction with the environment, the evolution of plastic objects, and factors affecting these processes.

   6.4. Promote cooperation and coordination of efforts with relevant national and international instruments and scientific and technical organizations.

   6.5. Develop sustainable mechanisms, including global funding for projects (activities, initiatives) related to the optimal control of all stages of the life cycle of polymeric materials.

   6.6. Provide information and technical support to industries interested in maximizing the use of plastic waste in their production process.

6.7. Promote research and innovation to develop new technological solutions for the collection, treatment, and utilization of discarded plastic products.

6.8. Create a new culture of sustainable plastic consumption that supports re-using, recycling, and collection of discarded plastic products.

First name, Last name	Scientific degree and position	Affiliation	Scientific field	Country	Signature, Date