E-nose can help control food plastic quality, new research reveals

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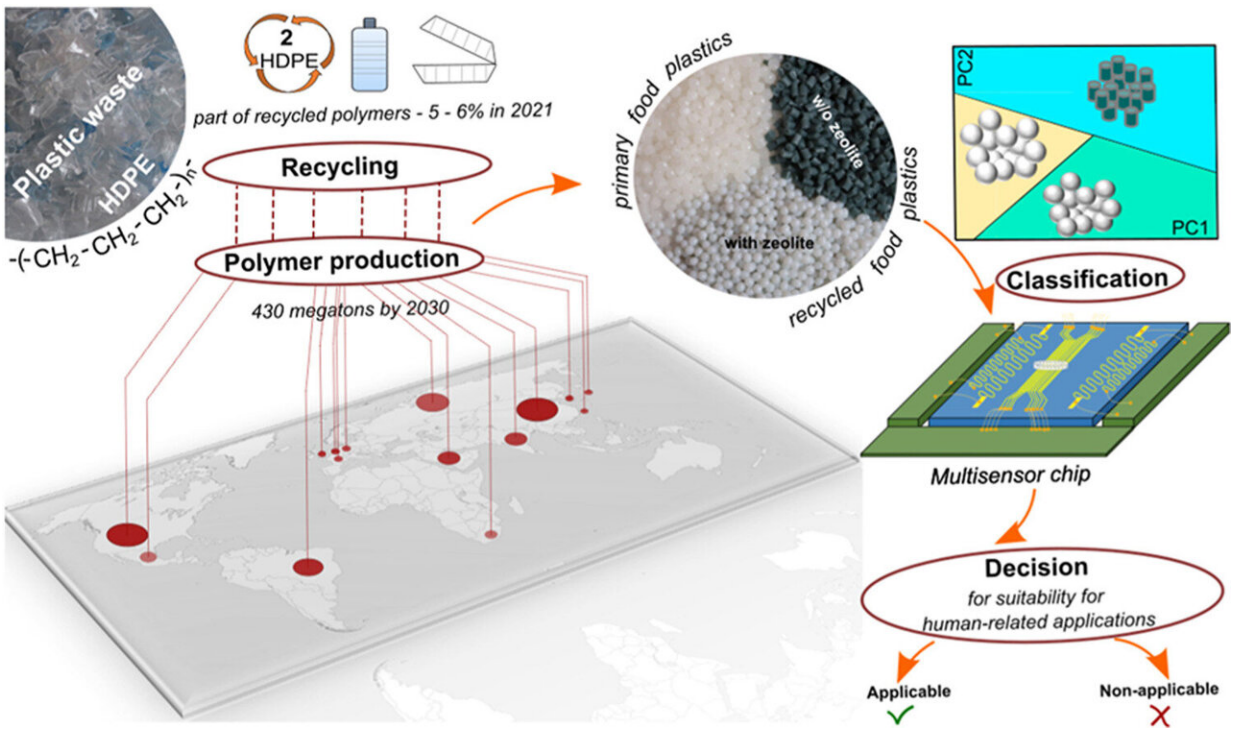

Credit: *Journal of Cleaner Production* (2023). DOI: 10.1016/j.jclepro.2023.138042

Skoltech scientists in collaboration with SIBUR PolyLab Research Center and other universities and organizations presented results of a project exploring the e-nose technology for controlling the quality and technology of food plastic production. The research team introduced a

method for evaluating the consumer-relevant properties of recycled plastics, identifying their smell and its origin with the help of the e-nose.

Using smell evaluation data provided by the expert panel, scientists proposed a model for employing the e-nose instead of a human in the laboratory at the factory. The study was published in the *Journal of Cleaner Production*.

The e-nose includes array of gas sensors and uses smell identification algorithms, those principle of operation mimics the human olfactory system. Unlike a human nose, the e-nose reacts to both odor-active and odorless volatile compounds.

Plastics for food and pharmaceuticals have to meet strict requirements for quality and safety. They should not have any foreign smell, which is related to and signals about harmful chemical substances. The smell can also indicate violations of polymer production technology.

"We expect that our gas analysis system will not only detect the smell of plastics and its origin, but will also help to understand when the production technology was violated to improve it. As a rule, the smell of plastics is assessed by a panel of experts. But, it does not always give objective results and is difficult to automate. The e-nose addresses these challenges, and, also, the e-nose allows classifying the type of the polymer in the plastic. It is not necessary to significantly alter production lines to adopt the new technology," study co-author and Skoltech Assistant Professor Fedor Fedorov explains.

To evaluate the smell of virgin and recycled samples of different polymers, the research team used a gas analytical system based on aluminum-doped zinc oxide employed as the sensing material. Organic compound vapors emitted by the samples changed the resistance of the sensors and returned the fingerprint of the polymer smell. The emitted

substances were also analyzed through headspace gas chromatography and mass spectrometry.

"For analyzing data, we used dimension reduction methods—linear discriminant analysis and principal component analysis. We also proceeded with random forest, a machine learning method for classifying polymer compositions," adds Valeriy Zaytsev, a Skoltech Ph.D. student and co-author.

Research results also contribute to addressing the global problem of excessive plastic use. One of the ways to reduce it is to use recycled plastics, whose use is now limited in food packaging. In other spheres, recycled plastics are more widespread, but they can still contain hazardous elements. The scientists assume that the e-nose will soon learn to detect the origin of recycled plastics and their composites, which will be an important benchmark on the way to combating severe plastic use.

"Our work requires expertise in materials science, sensor technologies, and machine learning. Our laboratory has profound experience in all these spheres. We see considerable academic and practical potential, including an important ecological aspect of the study. Presumably, our results will be relevant for controlling the quality of products in different industries in Russia and other countries," says Albert Nasibulin, the head of Skoltech Laboratory of Nanomaterials and a co-author.

The results mark a significant step in the collaborative project pursued by Skoltech and SIBUR PolyLab, the first research center for developing and testing polymer products in Russia.

"We are pleased to collaborate with SIBUR and find it a good example of the cooperation between science and business. We not only undertook research, but also presented its results at the conference and made a model setup of the e-nose and a pneumatic gas supply system installed at

production and test lines, which is supported by a joint patent application," Fedorov adds.

More information: Valeriy Zaytsev et al, Rapid and accurate quality assessment method of recycled food plastics VOCs by electronic nose based on Al-doped zinc oxide, *Journal of Cleaner Production* (2023). DOI: 10.1016/j.jclepro.2023.138042

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