MAD 63 Air Guardians

(Monitoring system for PFAS and microplastics in the air)

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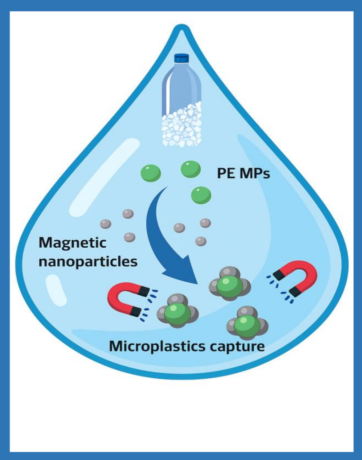
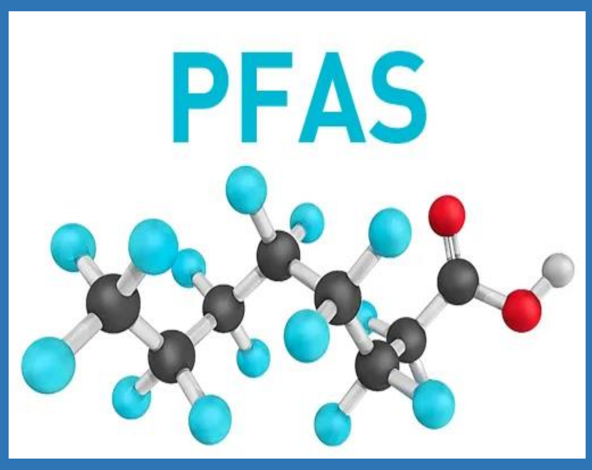
Nano Innovation 2025 Rome, 15-19 September Conference & Exhibition

PROBLEM ANALYSYS

Environmental pollution has become an urgent and complex challenge, primarily due to the accumulation of persistent substances such as PFAS and microplastics. Microplastics, in particular, can serve as vectors for toxic compounds including pesticides, heavy metals, and PFAS thereby increasing the risk of bioaccumulation throughout the food chain.

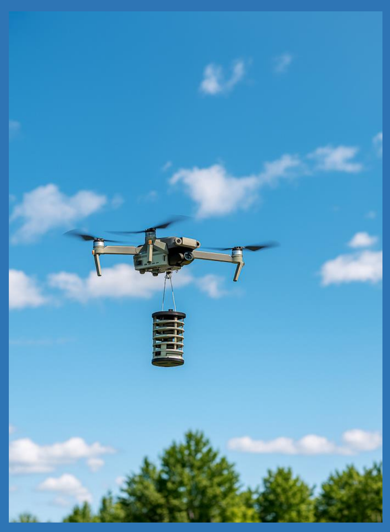




OUR PROJECT

We have developed two advanced chemical sensors

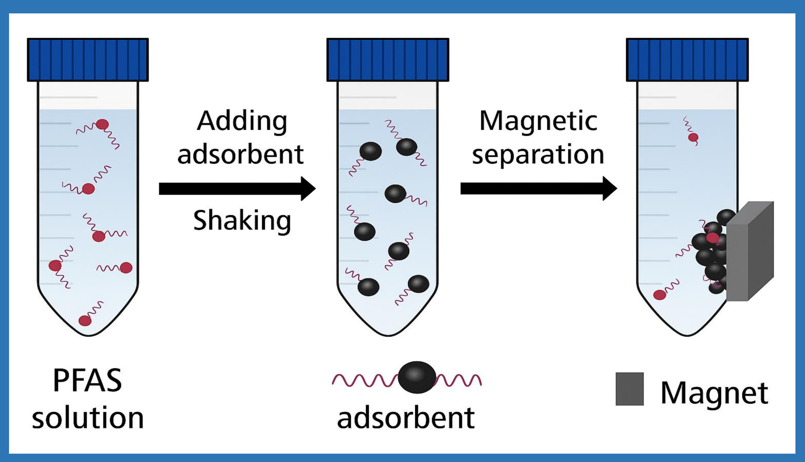
- The first, intended for the analysis of microplastics in the air, uses magnetic nanoparticles functionalized with oleic acid encapsulated in a porous cartridge. The captured microplastics are subsequently analyzed in the laboratory by FTIR-ATR spectroscopy.
- The second sensor, based on magnetic nanoparticles, is designed to capture PFAS, perfluoroalkyl substances known for their toxicity and environmental persistence and then analyzed by UHPLC-MS/MS.

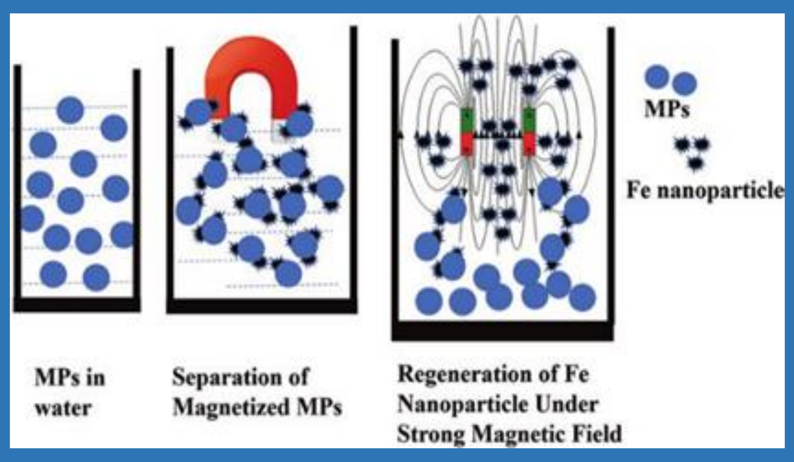


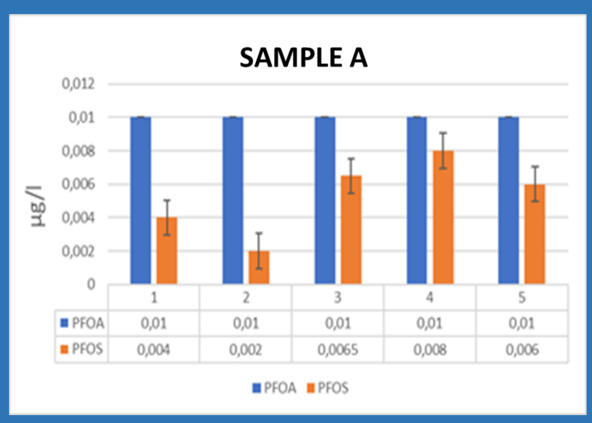
For the treatment of contaminated water, nanotraps were also designed and tested by immobilizing magnetic nanoparticles within biopolymer spheres. This configuration allows for easy recovery of the nanoparticles after treatment, while maintaining high adsorption performance and environmental compatibility.

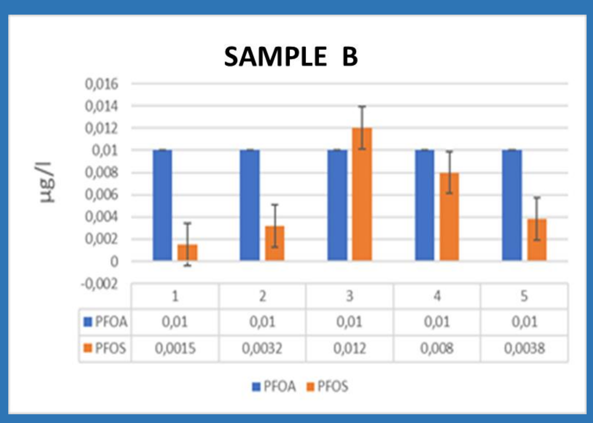
PREPARATION OF ABSORBING FILTERS

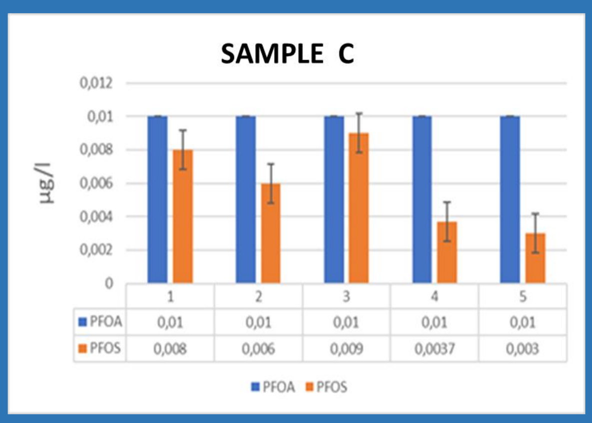
- The Fe_3O_4 and oleic acid functionalized Fe_3O_4 nanoparticles were inserted into the previously adapted and prepared adsorption cartridges.
- The NPs-Fe_3O_4 with an average diameter of 10 nm were loaded into the white cartridge,
- The Fe_3O_4 nanoparticles functionalized with oleic acid with an average diameter of 80 nm.











I PFAS adsorbed with the magnetic nanoparticles inserted into the cartridges were first desorbed and then analyzed by UHPLC-MS/MS. (samples A, B, C)

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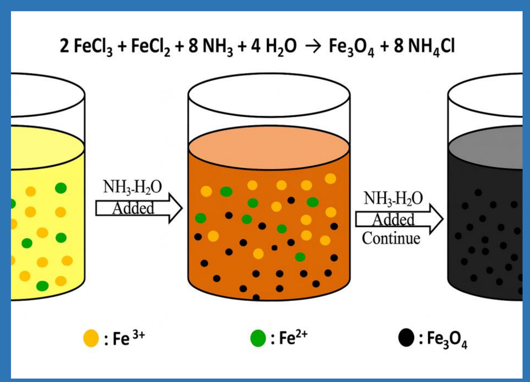
EXPERIMENTAL PROCEDURE

To capture microplastics and PFAS in the air, nano-sensors based on magnetic nanoparticles have been built and tested. In this project, attention was focused on the development and improvement of the co-precipitation production process

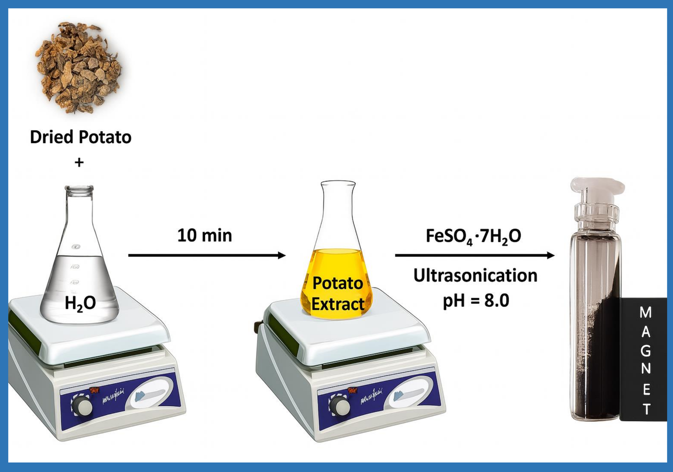


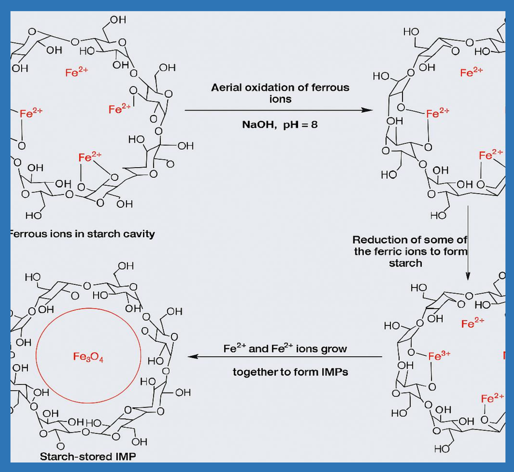
Parameters such as the type of salts used (e.g. chlorides, sulphates, nitrates), the ratio between Fe^{2+}/Fe^{3+} ions, the reaction temperature, the pH and the ionic strength of the medium, considerably influence the composition, shape and size of the particles obtained (20-30 nm).

GREEN SYNTHESIS OF MAGNETIC NPs-Fe_3O_4

For the synthesis of magnetic nanoparticles, two green synthesis methods were tested:

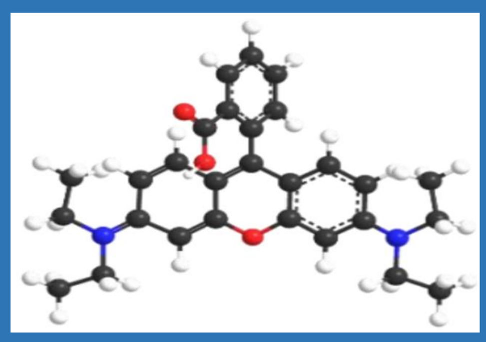
- The first starting from green tea extracts with polyphenols (Polyphenols are made up of flavonoids and catechins. Among catechins, epigallocatechin gallate is the active catechin that mainly participates in the reduction process)
- The second using starch extracted from potatoes both as a reducing agent and as a stabilizer.

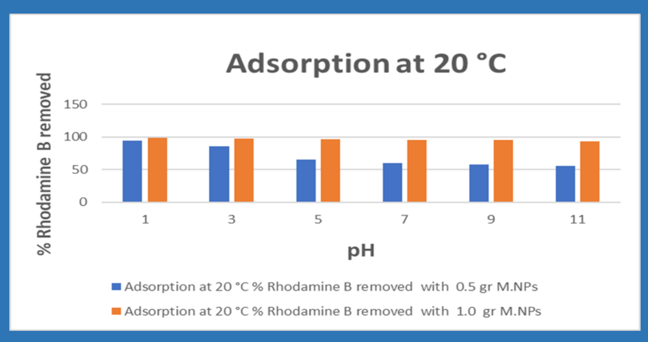




EXPERIMENTAL TESTS

·For the treatment of contaminated water, nanotraps have also been designed and tested by immobilizing magnetic nanoparticles within biopolymer spheres.
The capture tests were carried out using Rhodamine B

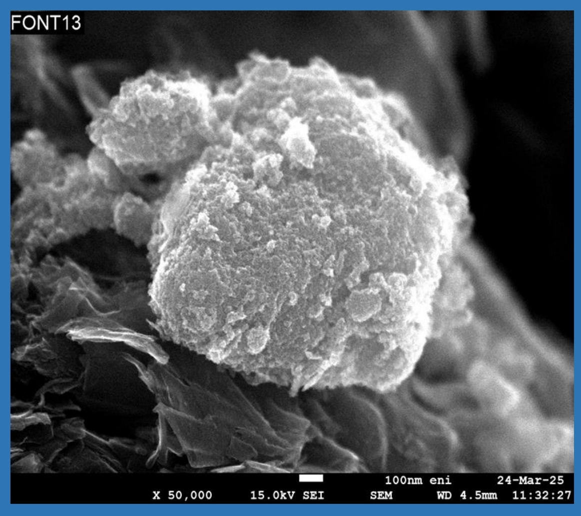


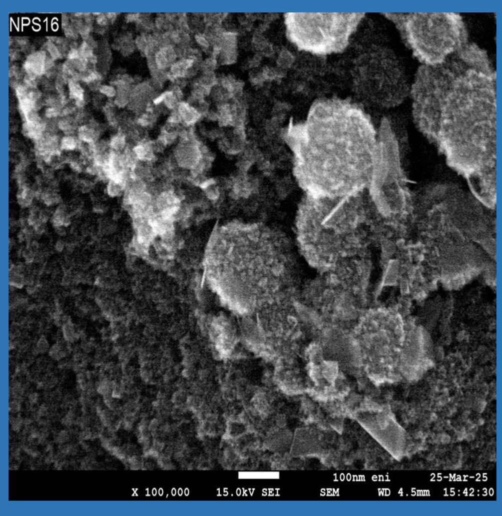


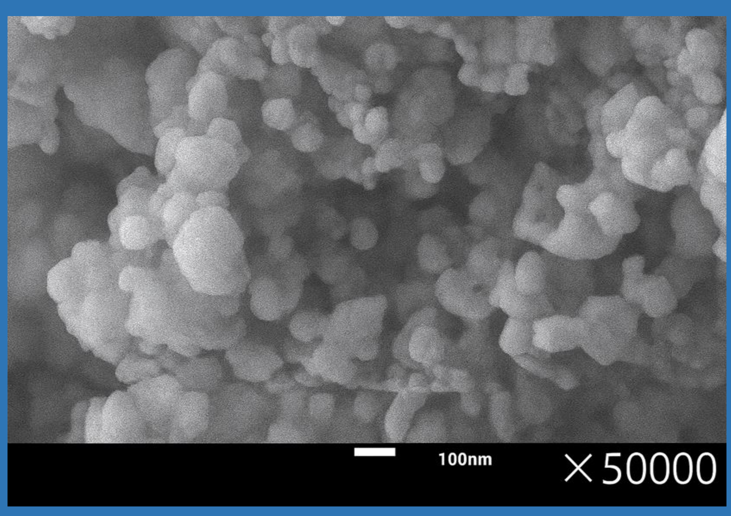
Tests have shown that the filters achieve a removal and capture efficiency close to 90%.

DATE END RESULTS (MAGNETIC NPs-Fe3O4): SEM

SEM confirms the nanometric nature of the oxide particles, reaffirming their size to be below 10 nm.







Further possible applications (measurements with A.I.)

An alternative to traditional chemical analyses for identifying areas with high PFAS concentration is to build a geospatial model based on machine learning methods. The model could be trained on datasets such as the Map of Forever Pollution in Europe (MFPE) project.