D25 Assessment of Silicon Polymer Composites for the Extraction of Trace Herbicides: A Tool for Environmental Forensics

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The objective is to present the use of silicon polymer composites as a new material for passive sampling. This presentation will impact the forensic community and/or humanity by presenting a new material for passive sampling in order to extract trace herbicides from environmental deployment sites.

Herbicides are found in ground water, freshwater, and saltwater environments and have shown potential for long-range transport throughout sensitive ecosystems. In the U.S. herbicides account for 75% of all pesticides used to control unwanted vegetation. Herbicides found in aquatic environments originate from both agriculture as well as urban landscapes and are easily transported between compartments via water runoff. Due to this, water analysis is the preferred tool to assess their occurrence in the environment. Atrazine and Irgarol are two common types of triazine-based herbicides found in freshwater and saltwater environments respectively. Atrazine is the most commonly used pesticide in the U.S. It is easily detected due to its ability to persist in soil and its water mobility. Atrazine has been found to have environmental effects at levels far lower than that deemed safe by the EPA. Irgarol is an algicide used in formulating antifouling paints for boats and vessels. Irgarol is primarily used to inhibit the growth of copper resistant fouling organisms such as algal slimes and growth of seaweed. It leaches slowly and therefore causes coastal water contamination.

This study introduces the use of silicone polymer composites (PDMS, Fe-PDMS) as a passive sampling media to pre-concentrate analytes found in the environment. Advantages of their usage are based on their capabilities for on-site deployment or through pre-concentration of small volume samples. The composite samplers are assessed for their adsorption/ absorption properties by performing lab experiments with the two model compounds, Irgarol 1051 and Atrazine, and by analyzing environmental water samples impacted with the herbicides.

The initial concentration of both Irgarol and Atrazine was 1 ppb. The concentration of the herbicides was monitored by SPME-GC/MS and showed depletion over time. For PDMS, the concentration of Irgarol was reduced by 83.5% after 48 hours of extraction. Water samples containing triple the amount of composites exhibited an increased depletion of the Irgarol concentration with a reduction by 95.5%. Results for Atrazine were similar to that of Irgarol, however the depletion rates were substantially lower. After 48 hours, the PDMS pellets reduced the concentration of Atrazine by only 63.8%. This study was also conducted using magnetic Fe-PDMS composites. Fe-PDMS composites will allow for easy retrieval of the samplers from environmental deployment sites by magnetic filtration. After 24 hours of extraction with the 2:4 Fe-PDMS composite pellets, the concentration of Irgarol and Atrazine were depleted by 49.5% and 55.3% respectively. Mass balance experiments showed that between 60% and 80% of the herbicides could be successfully recovered from the exposed composites by simple solvent extraction with hexane.

This study proved the ability of PDMS and Iron-PDMS as passive samplers for environmental applications. Parameters such as surface area, Fe-PDMS ratios and agitation rates greatly influence the concentration capacities. Application to the environmental samples is already underway. One of the major disadvantages of the approach is the long equilibration times and the structural dependency for heavily functionalized analytes.

PDMS Composites, Passive Sampling, Environmental Forensics

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