When Life Gives You Lithium-Metal Anodes, Make PFAS Destruction Technologies

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Researchers at the University of Chicago are riding the lithium surge with their high-voltage innovation. Inspired by failures that make chemicals degrade in lithium-metal batteries, Chibueze Amanchukwu and colleagues strategically manipulated molecular interactions to assess whether this could be used in the destruction of per- and polyfluoroalkyl substances (PFAS).

Lithium's high reactivity can cause trouble in batteries based on lithium-metal anodes; the metal degrades fluorinated electrolytes in the batteries, which impact performance. This shortcoming led Amanchukwu and his team to dissolve PFAS in an electrolyte solution of a lithium-containing electrochemical cell. In doing so, they found that lithium helps break 95% of the carbon-fluorine bonds in perfluorooctanoic acid (PFOA). Rather than turning into a short carbon chain molecule, this lithium-based technique completely breaks PFOA down to lithium fluoride.

Researchers dissolved lithium perchlorate salt in an organic solvent to make an electrolyte, added PFOA to the electrolyte, and placed this in an electrochemical cell with copper and graphite electrodes to recreate battery conditions for PFAS destruction. An electric current ran through the device, which caused metallic lithium to be deposited on the copper surface that reacted with PFOA and broke it apart.

Amanchukwu and colleagues observed that reduction of the PFOA concentration in the electrolyte solution improved the method's effectiveness. In tests of 33 additional PFAS compounds, 22 degraded by more than 70%, with perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFUnA) achieving 99% degradation.

Capitalizing upon battery failure and lithium's high reactivity, University of Chicago researchers were able to create a solution for PFAS remediation. While Amanchukwu and his team aspire to develop a similar reductive system that works in aqueous media, they anticipate challenges, as lithium violently reacts with water.

Although Amanchukwu and colleagues' findings represent an important advancement, they likewise highlight potential obstacles and the extensive, ongoing efforts researchers must undertake in the development of PFAS treatment technologies. Despite the inevitable hurdles, new findings that emerge from subsequent research and experiments may bring us closer to feasible, economic, pragmatic, and widely available solutions to utilize in the destruction and removal of PFAS.