Review of the SIA PFAS Consortium Paper "PFOS and PFOA Conversion to Short-Chain PFAS-Containing Materials Used in Semiconductor Manufacturing"

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The June 5, 2023 paper, "PFOS and PFOA Conversion to Short-Chain PFAS-Containing Materials Used in Semiconductor Manufacturing," prepared by the Semiconductor PFAS Consortium Photolithography Working Group, describes the difficulty eliminating Per- and Polyfluorinated Substances (PFAS) from photoresist surfactants, photoacid generators (PAGs), and top anti-reflective coatings (TARCs). Short-chain PFAS compounds are those with six or fewer carbon atoms in a molecule. Long-chain molecules have more than six carbon atoms.

Since photolithography has generally been exempted from restrictions on long-chain PFAS use, industry's replacement of perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) with shorter-chain PFAS has been driven by the phase-out of production of those chemicals. Reading between the lines, this explains why industry opposes anything that constrains the production of other PFAS, such as regulating them as a class. Even if chipmakers are allowed to use specialized PFAS chemicals, they are likely to have difficulty obtaining them at historical prices if restrictions on other uses for them cause cutbacks in production.

One of the reasons replacing PFOS and PFOA was difficult was that "semiconductor device makers did not know exactly which chemical products contained PFOS and PFOA, as safety data sheets do not regularly disclose this information." (p. 8) So the structure of the industry adds to the technical difficulty in reducing PFAS use. The companies that produce feedstocks (such as PFOS in the past) are not the suppliers of specialty chemicals for semiconductor production, and those are different from the device makers.

Removing PFAS from industrial wastewater depends not only upon the specific substance but also on the presence of other substances, such as isopropyl alcohol, in the wastewater. (This reminds me of nitrates fouling perchlorate treatment systems.) This suggests a need to segregate and immediately pre-treat production waste streams. The construction of new wafer fabrication facilities provides an excellent opportunity to design such systems into the plants.

Compounding the problem, standard methods do not detect many PFAS in wastewater: "At present, only a small percentage of PFAS compounds within typical semiconductor wastewater are detectable and quantifiable using conventional U.S. EPA analytical methods for PFAS-containing materials." (p. 11) However emerging analytical methods can overcome this difficulty if plant operators are required to use them.

When industry switched to short-chain PFAS such as perfluorobutane sulfonate (PFBS), it believed—and cites government agencies—that they were not as toxic as long-chain compounds. The paper doesn't mention the fact that short-chain PFAS tend to migrate faster in the environment than their long-chain siblings. As long as PFAS are considered innocent until proven guilty, it is likely that toxic PFAS will be replaced with other toxic PFAS. That's another argument for evaluating and regulating PFAS as a class. Their general characteristics—toxicity as well as fate

and transport—are based upon the carbon-fluorine bond and should be assumed guilty unless proven innocent.

Finally, the paper begins by reporting, "The semiconductor industry has used perfluoroalkyl and polyfluoroalkyl substances (PFAS) in chemical formulations since the 1970s." (p. 3) This is important for those of us who have been working to clean up semiconductor pollution since the 1980s. Not only has no one looked for PFAS contamination at these sites, but groundwater extraction and treatment systems designed to eliminate volatile organic compounds such as TCE may have spread and may be continuing to spread PFAS in the environment.

The SIA PFAS Consortium is made up of chipmakers and their suppliers of equipment and materials. To sign up to receive their technical papers, go to
https://www.semiconductors.org/pfas/