Barriers associated with trace organics and discoveries on how to reuse semiconductor Fab wastewater for ultrapure make-up water

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Semiconductor fabrication is water-intensive, consuming tens of billions of gallons annually for fabrication and packaging, plus supply chain chemicals. As Arizona faces long-term water constraints, ensuring the industry's sustainability will depend on transformative advances in water reuse. Fabs in Arizona can reuse up to ~30% of their industrial wastewater for cooling towers, gas scrubbers and other facilities. The remaining 70% of the wastewater could be reused to make chips again, but there is concern about industrial chemicals in the wastewater impacting chip production. We hypothesize, and have started demonstrating, that treatment of industrial wastewater by reverse osmosis will be unsatisfactory for reuse, even in passed through a conventional ultrapure water (UPW) system, because of the presence of low molecular weight organics (LWOs). The most concerning LWOs include urea, TMAH, acetone and a few others, which are not removed by conventional UPW systems. While hydroxyl radicals are ineffective at treatment these LWOs in RO permeate, we have successfully demonstrated in the lab that other radical species (e.g., sulfate radical, bromide radical) generated during novel advanced oxidation processes (AOPs) effectively mineralize these compounds to carbon dioxide. Residual salts from our AOPs would be effectively removed by conventional UPW systems, thus providing a path to ultra-low level total organic carbon and other standards needed for ultrapure water suitable for us in making the most advanced computer chips.